MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY



SYLLABUS FOR BACHELOR OF SCIENCE IN NUCLEAR ENGINEERING (NE)

OCTOBER 2020

DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY MIRPUR CANTONMENT DHAKA-1216, BANGLADESH

COMMITTEE OF COURSES

RENAMING THE UNDERGRADUATE PROGRAM OF THE DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING, MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY AS 'NUCLEAR ENGINEERING' AND REVIEWING THE SYLLABUS

References:

A. MIST Letter Number - 23.12.0902.002.01.032.20.31.08.20 dated 31 August 2020.

B. BUP Letter Number - 23.01.902. 858.10.786.03.27.09.20 dated 27 September 2020.

1. The Department of Nuclear Science and Engineering (NSE) of Military Institute of Science and Technology (MIST) started its first undergraduate program on 'Nuclear Science and Engineering' (NSE) on 05 February 2015. The Depertment of NSE felt the necessity to rename the program as 'Nuclear Engineering' (NE) to facilitate diversed engagement opportunities in the field of nuclear technology. In this context, a Committee of Courses was formed by BUP to rename the program and review the syllabus vide Reference B. The meetings of the Committee were held at MIST on 04 and 11 October 2020 to finalize the name and review the syllabus for the aforementioned program.

2. Finally, the Committee of Courses proposed the subject matter to refer to Academic Council.

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CHAPTER 1

GENERAL INFORMATION

1.1 <u>Introduction to MIST</u>

The necessity of establishing a technical institute for the Bangladesh Armed Forces was felt in the late eighties. In the absence of such an institution, officers of Bangladesh Armed Forces had been graduating from Bangladesh University of Engineering and Technology (BUET), Bangladesh Institute of Technology (BIT) and other foreign institutions of science and technology. With a view to meet the increasing demand for the development and dissemination of engineering and technological knowledge, Bangladesh Armed Forces established the Military Institute of Science and Technology (MIST) that promises to provide facilities for higher technical education both for the officers of Bangladesh Armed Forces as well as for civil students from home and abroad. The motto of MIST is -Technology for Advancement. Founded on 19 April 1998, MIST started its journey on 31 January 1999 by offering a four-year bachelor's degree on Civil Engineering. Bachelor degree on Computer Science Engineering course started on 2001. Bachelor courses on Electrical, Electronic & Communication Engineering and Mechanical Engineering started its journey from 2003. Bachelor of Science program on Aeronautical Engineering (AE) and Naval Architecture and Marine Engineering (NAME) program were started from 2008-2009 and 2012-2013 respectively. Besides, four new departments started their academic session from 2014-2015 i.e. Nuclear Science & Engineering (NSE), Biomedical Engineering (BME), Architecture (Arch) and Environmental, Water Resources & Coastal Engineering (EWCE).

Foreign students from Sri Lanka were admitted for the first time at MIST. Presently students from Maldives, Palestine, Nepal and Ghambia are also studying in different Engineering Programs. MIST envisages creating facilities for military as well as civil students from home and abroad dedicated to pursue standard curriculum leading to Graduation Degree. As an Institution without any gender biasness, MIST is already on steady stride upholding its motto "Technology for Advancement". MIST remains committed to contributing to the wider spectrum of national educational arena and play a significant role in the development of human resources and ardently pursuing its goal to grow into a "Centre of Excellence". MIST has well equipped class rooms with multimedia and web camera with internet facilities and laboratories with modern equipment. The medium of instruction for all engineering programs is English. All academic programs of MIST are affiliated with the Bangladesh University of Professionals (BUP) and have close cooperation with Bangladesh University of Engineering and Technology (BUET) and Dhaka University (DU).

1.2 <u>Vision and Mission of MIST</u>

Vision: To be a center of excellence for providing quality education in the field of science, engineering and technology and conduct research to meet the national and global challenges.

Mission:

a. Provide comprehensive education and conduct research in diverse disciplines of science, engineering, technology and engineering management.

b. Produce technologically advanced intellectual leaders and professionals with high moral and ethical values to meet socio- economic development of Bangladesh and global needs.

c. Conduct collaborative research activities with national and international communities for continuous interaction with academician and industry.

d. Provide consultancy, advisory, testing and other related services to government, non-government and autonomous organization including personnel for widening practical knowledge and to contribute in sustainable development of the society.

1.3 <u>Salient Features of MIST</u>

- a. Rigorous admission and selection process for best possible screening interactive sessions in the classroom.
- b. Regular guest lectures and educational visits.
- c. Culture of timeliness, commitment and uninterrupted curriculum.
- d. Flexibility in choosing competent faculties through outsourcing.
- e. Well thought-out and continuous feedback and assessment system.
- f. Effective teaching through innovative method.
- g. Industrial attachment for on job training.
- h. Emphasis on code of conduct and dress code.
- i. Focus to develop students as good human with all possible attributes of successful leader.
- j. Tranquil, pollution free and secure campus life.

1.4 Location

MIST is located at Mirpur Cantonment, northwest edge of the greater Dhaka city, a hub of knowledge for the armed forces. Mirpur Cantonment is a small, calm and quiet education village and free from all possible pollution of a city life. A garland like lake with migratory birds, three sides with extended green fields in the summer and water bodies in the rainy season, whistling birds on the tree branches and overall bounty of nature adds to the already existing splendid academic atmosphere. Other neighboring academic institutions are National Defense College (NDC) and Defense Services Command and Staff College (DSCSC) – two international standard education centers.

1.5 <u>Faculties</u>

- 1.5.1 Faculty of Civil Engineering (FCE):
 - Civil Engineering (CE)
 - Architecture (Arch)
 - Civil, Environment, Water and Coastal Engineering (CEWCE)
 - Petroleum and Mining Engineering (PME)

- 1.5.2 Faculty of Electrical & Computer Engineering (FECE):
 - Computer Science and Engineering (CSE)
 - Electrical, Electronic and Communication Engineering (EECE)
- 1.5.3 Faculty of Mechanical Engineering (FME):
 - Mechanical Engineering (ME)
 - Aeronautical Engineering (AE)
 - Naval Architecture and Marine Engineering (NAME)
 - Industrial and Production Engineering (IPE)
- 1.5.4 Faculty of Science & Engineering (FSE):
 - Biomedical Engineering (BME)
 - Nuclear Science and Engineering (NSE)
 - Department of Science (Mathematics, Physics, Chemistry) and Humanities (Only Post Graduate)

Presently MIST has 12 (twelve) departments to conduct B Sc. Engineering program under 04(four) different engineering faculties. The departments impart education basing on common objectives and outcomes set by MIST and have defined program objectives and outcomes, specific to the departments respectively

1.6 <u>Eligibility of Students for Admission in MIST (Subject to review each year)</u>

The students must fulfill the following requirements:

a. **Bangladeshi Students.** Minimum qualifications to take part in the admission test are as follows:

(1) The applicant must have passed SSC / equivalent examination from Board of Intermediate and Secondary Education/Madrasa Education Board/Technical Education Board in Science Group obtaining GPA 4.00 (without fourth subject) on a 5 point scale and in HSC/Equivalent examination from Board of Intermediate and Secondary Education/Madrasa Education Board/Technical Education Board in Science group the applicant must have obtained minimum GPA 4.00 on a 5 point scale. In HSC/Equivalent and SSC/Equivalent examination: (i) the applicant passed HSC or Equivalent in must obtain minimum total grade point 17 in four subjects (Mathematics, Physics, Chemistry and English), (ii) SSC Examination (or Equivalent).

(2) The applicant must have qualified in minimum five subjects including Mathematics, Physics, Chemistry and English Language with minimum 'B' in average [i.e. A=5, B=4, C=3, D=2 & E=1,minimum required grade point=20] in GCE 'O' Level and in 'A' level/Equivalent background of Minimum 'B' grade in Mathematics, Physics and Chemistry.

(3) Applicants who have passed HSC or Equivalent examination in the current previous year must grade obtain 19 in four subjects (Mathematics, Physics, Chemistry and English).

(4) Sex: Male and Female.

- b. **Foreign Students.** Maximum 3% of overall vacancies available will be kept reserved for the foreign students and will be offered to foreign countries through AFD of the Government of the People's Republic of Bangladesh. Applicants must fulfill the following requirements:
 - (1) Educational qualifications as applicable for Bangladeshi civil students or equivalent.
 - (2) Must have security clearance from respective Embassy/High Commission in Bangladesh.
 - (3) Sex: Male and Female.

In the event of non-availability of foreign students, Bangladeshi civil candidates will fill up the vacancies.

1.7 <u>Number of Seats</u>

The highest number of seats for 04 (Four) years Bachelor Degree in Engineering programmes (Unit – A) and 5 (Five) years Bachelor Degree of Architecture programme are as follows:

Ser	Unit	Department	Seats
1.		Civil Engineering (CE)	60
2.		Computer Science and Engineering (CSE)	60
3.		Electrical, Electronic & Communication Engineering (EECE)	60
4.		Mechanical Engineering (ME)	60
5.		Aeronautical Engineering (AE)	50
6.	Α	Naval Architecture and Marine Engineering (NAME)	40
7.		Biomedical Engineering (BME)	40
8.		Nuclear Science and Engineering (NSE)	40
9.		Civil & Environmental Engineering	60
10.		Civil & Water Resources Engineering	
11.		Industrial and Production Engineering (IPE)	50
12.		Petroleum and Mining Engineering (PME)	25
13.	В	Architecture (Arch)	25
	Total		570

Allocation of Seats

1.8 Admission Procedure

1.8.1 <u>Syllabus for Admission Test</u>. Admission test will be conducted on the basis of the syllabus of Mathematics, Physics, Chemistry and English (comprehension and functional) subjects of HSC examinations of all boards of secondary and higher secondary school certificates. There will be no multiple-choice type questions (MCQ). Admission test will be conducted out of 200 marks and the distribution of marks is given below:

Ser.	Subjects	Marks
a.	Mathematics	80
b.	Physics	60
с.	Chemistry	40
d.	English	20
		Total = 200

1.8.2 <u>Final Selection</u>. Students will be selected on the basis of results of the admission test. Individual choice for selection of departments will be given preference as far as possible. Minimum qualifying marks in the test is 40% for the applicants. In case of tie in the result of admission test, difference will be judged on the basis of marks obtained in Mathematics, Physics, Chemistry and English respectively in admission test.

1.8.3 <u>Medical Checkup.</u> Civil candidates selected through admission test will go for medical checkup in MIST medical center. If the medical authority considers any candidate unfit for study in MIST due to critical/contagious/mental diseases as shown in medical policy of MIST will be declared unsuitable for admission.

1.9 <u>Students Withdrawal Policy</u>

1.9.1 <u>General Policy of Withdrawal</u>

The under graduate (B.Sc) Engineering programs for all engineering disciplines are planned for 04 regular levels, comprising of 08 regular terms for Architecture programme it is planned for 3 & regular levels, comprising of 10 regular terms. It is expected that all students will earn degree by clearing all the offered courses in the stipulated time. In case of failure the following policies will be adopted:

- a. Students failing in any course/subject will have to clear/pass the said course/subject by appearing it in referred examination as per examination policy. In case of students completing level-4, maximum three courses/subjects will be allowed in the referred examination (which is to be cleared within 6 years of registration).
- b. Referred examination will be conducted at this institution before commencement of next level.
- c. Maximum grading for supplementary examination etc. of failed subjects will be B+ as per examination policy.
- d. One student can retake/reappear in a failed subject/course only twice. However, with the Permission of Academic Council of MIST, a student may be allowed for third time as last chance.
- e. In case of sickness, which leads to missing of more than 40% classes or miss term final examination (supported by requisite medical documents), students may be allowed to withdraw temporarily from that term and repeat the whole level with the regular level in the next academic session, subject to the approval of Academic Council, MIST. However, he/she has to complete the whole undergraduate

program within 06 (six) academic years (for Architecture 07 academic years) from the date of his/her registration.

- f. Minimum credit requirement for the award of bachelor's degree in Engineering (Bsc. Engg) and Architecture (B. Arch) will be decided by the respective department as per existing rules. However, the minimum CGPA requirement for obtaining a bachelor degree in engineering and Architecture is 2.20.
- g. Whatever may be the cases, students have to complete the whole undergraduate Program within 06 (six) academic years from the date of registration.
- h. All other terms and condition of MIST Examination Policy remain valid.

1.9.2 <u>Withdrawal on Disciplinary Ground</u>

a. <u>Unfair Means.</u> Adoption of unfair means may result in expulsion of a student from the programme and expulsion so from the Institution. The Academic Council will authorize such expulsion on the basis of recommendation of the Disciplinary Committee, MIST and as per policy approved by the affiliating university. Following would be considered as unfair means adopted during examinations and other contexts:

- (1) Communicating with fellow students for obtaining help in the examination.
- (2) Copying from another student's script/ report /paper.

(3) Copying from desk or palm of a hand or from other incrimination documents.

(4) Possession of any incriminating document whether used or not.

b. <u>Influencing Grades.</u> Academic Council may expel/withdraw any student for approaching directly or indirectly in any form to influence a teacher or MIST authority for grades.

c. <u>Other Indiscipline Behaviours.</u> Academic Council may withdraw/expel any student on disciplinary ground if any form of indiscipline or unruly behavior is seen in him/her which may disrupt the academic environment/programme or is considered detrimental to MIST's image.

d. <u>Immediate Action by the Disciplinary Committee of MIST</u>. The Disciplinary Committee, MIST may take immediate disciplinary action against any student of the Institution. In case of withdrawal/expulsion, the matter will be referred to the Academic Council, MIST for post-facto approval.

1.9.3 <u>Withdrawal on Own Accord</u>

a. **<u>Permanent Withdrawal.</u>** A student who has already completed some courses and has not performed satisfactorily may apply for a withdrawal.

b. <u>**Temporary Withdrawal.**</u> A student, if he/she applies, may be allowed to withdraw temporarily from the program, subject to approval of Academic Council of MIST, he will be allowed to apply fresh in future batch. If approved from the date of his/her registration.

CHAPTER 2

RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAMME AT MIST

2.1 <u>Introduction</u>

MIST has introduced course system for undergraduate studies from the academic session 2017-18. Therefore, the rules and regulations mentioned in this paper will be applicable to students for administering undergraduate curriculum through the Course System. This will be introduced with an aim of creating a continuous, even and consistent workload throughout the term for the students.

2.2 <u>The Course System</u>

The salient features of the Course System are as follows:

a. Number of theory courses will be generally 5 in each term. However, with the recommendation of course coordinator and Head of the Department, Commandant MIST may allow relaxation in this regard. This relaxation is to be reported to Academic Council of MIST.

- b. Students will not face any level repeat for failing.
- c. Students will get scope to improve their grading.
- d. Introduction of more optional courses to enable the students to select courses according to their individual needs and preferences.
- e. Continuous evaluation of students' performance.
- f. Promotion of student-teacher interaction and contact.

2.2.1 Beside the professional courses pertaining to each discipline, the undergraduate curriculum gives a strong emphasis on acquiring thorough knowledge in the basic sciences of mathematics, physics and chemistry. Due importance is also given on the study of several subjects in humanities and social sciences.

2.2.2 The first two years of bachelor's degree programs generally consist of courses on basic engineering, general science and humanities subjects; while the third and subsequent years focus on specific disciplines.

2.3 <u>Number of Terms in a Year</u>

There will be two terms (Spring Term I and Fall Term II) in an academic year.

2.4 **Duration of Terms**

The duration of each of Term I (Spring) and Term II (Fall) (maximum 22 weeks) may be as under:

Ser	Events	Durations
1.	Classes before Mid Term	7 weeks

2.	Mid Term Vacation	1 week
3.	Classes after Mid Term	7 weeks
4.	Makeup Classes and Preparatory leave	2/3 weeks
5.	Term Final Examination	2/3 weeks
6.	Term End Vacation	1/2 week

2.5 <u>Course Pattern and Credit Structure</u>

The undergraduate program is covered by a set of theoretical courses along with a set of laboratories (sessional) courses to support them.

2.6 <u>Course Designation System</u>

Each course is designated by a maximum of four letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

a. The left most digit corresponds to the year/level in which the course is normally taken by the students. The second digit is reserved for departmental use. It usually identifies a specific area/group of study within the department.

b. The right most digit is an odd number for theoretical courses and an even number for sessional courses.

The course designation system is illustrated as Follows:

<u>NE</u> 101	Introduction to Nuclear Engineering		
	Course Title		
	Odd digit designates a theoretical course		
	Reserved for departmental use		
	Signifies 1 st Year/ 1 st Level course		
	Department Identification		
<u>NE</u> 242	Thermal Engineering Sessional		
<u>NE</u> 242	Thermal Engineering Sessional Course Title Even digit designates a sessional course		
<u>NE</u> 242	Thermal Engineering Sessional Course Title Even digit designates a sessional course Reserved for departmental use		
<u>NE</u> 242	Thermal Engineering Sessional Course Title Even digit designates a sessional course Reserved for departmental use Signifies 2 nd Year/ 2 nd Level course		



2.7 <u>Assignment of Credits</u>

The assignment of credits to a theoretical course follows a different rule from that of a sessional course.

a. Theoretical Courses: One lecture per week per term is equivalent to one credit.

b. Sessional Courses: Credits for sessional courses is half of the class hours per week per term.

Credits are also assigned to project and thesis work taken by the students. The amount of credits assigned to such work varies from one discipline to another.

2.8 <u>Types of Courses</u>

The types of courses included in the undergraduate curricula are divided into the following groups:

a. <u>Core Courses</u>. In each discipline, a number of courses are identified as core courses, which form the nucleus of the respective bachelor's degree program. A student has to complete the entire designated core courses of his/her discipline.

b. **<u>Prerequisite Courses</u>**. Some of the core courses are identified as prerequisite courses for a specific subject.

c. **Optional Courses.** Apart from the core courses, the students can choose from a set of optional courses. A required number of optional courses from a specified group have to be chosen.

2.9 <u>Course Offering and Instruction</u>

The courses to be offered in a particular term are announced and published in the Course Catalog along with the tentative Term Schedule before the end of the previous term. The courses to be offered in any term will be decided by Board of Undergraduate Studies (BUGS) of the respective department.

2.9.1 Each course is conducted by a course teacher who is responsible for maintaining the expected standard of the course and for the assessment of students' performance. Depending on the strength of registered students (i.e. on the number of students) enrolled for the course, the teacher concerned might have course associates and Teaching Assistants (TA) to aid in teaching and assessment.

2.10 <u>Teacher Student Interaction</u>

The new course system encourages students to come in close contact with the teachers. For promotion of a high level of teacher-student interaction, each student is assigned to an adviser and the student is free to discuss all academic matters with his/her adviser. Students are also encouraged to meet any time with other teachers for help and guidance in academic matters. However, students are not allowed to interact with teachers after the moderation of questions.

2.11 <u>Students' Adviser</u>

One adviser is normally appointed for a group of students by the BUGS of the concerned department. The adviser advises each student about the courses to be taken in each term by discussing the academic program of that particular term with the student.

2.11.1 However, it is also the student's responsibility to keep regular contact with his/her adviser who will review and eventually approve the student's specific plan of study and monitor subsequent progress of the student.

2.11.2 For a student of second and subsequent terms, the number and nature of courses for which he/she can register is decided on the basis of academic performance during the previous term. The adviser may permit the student to drop one or more courses based on previous academic performance.

2.12 <u>Course Registration</u>

Any student who uses classroom, laboratory facilities or faculty-time is required to register formally. Upon admission to the MIST, students are assigned to advisers. These advisers guide the students in choosing and registering courses.

2.13 <u>Registration Procedure</u>

At the commencement of each term, each student has to register for courses in consultation with and under the guidance of his/her adviser. The date, time and venue of registration are announced in advance by the Registrar's Office. Counseling and advising are accomplished at this time. It is absolutely essential that all the students be present for registration at the specified time.

2.14 <u>Pre-conditions for Registration</u>

a. For first year students, department-wise enrollment/admission is mandatory prior to registration. At the beginning of the first term, an orientation program will be conducted for them where they are handed over with the registration package on submission of the enrolment slip.

b. Any student, other than the new batch, with outstanding dues to the MIST or a hall of residence is not permitted to register. Each student must clear their dues and obtain a clearance certificate, upon production of which, he/she will be given necessary Course Registration Forms to perform course registration.

c. A student is allowed to register in a particular course subject to the class capacity constraints and satisfaction of pre-requisite courses. However, even if a student fails in a pre-requisite course in any term, the concerned department (BUGS) may allow him/her to register for a course which depends upon the pre-requisite course provided that his/her attendance and performance in the continuous assessment of the mentioned pre-requisite course is found to be satisfactory.

2.15 <u>Registration Deadline</u>

Each student must register for the courses to be taken before the commencement of each term. Late registration is permitted only during the first week of classes. Late registration after this date will not be accepted unless the student submits a written application to the registrar through the concerned Head of the department explaining the reasons for delay. Acceptable reasons may be medical problems with supporting documents from the Medical Officer of MIST or some other academic commitments that prohibit enrollment prior to the last date of registration.

2.16 <u>Penalty for Late Registration</u>

Students who fail to register during the designated dates for registration are charged a late registration fee of Tk. 100.00 (One hundred only) per credit hours. Penalty for late registration will not be waived.

2.17 Limits on the Credit Hours to be Taken

2.17.1 A student should be enrolled for at least 15 credit hours and is allowed to take a maximum of 24 credit hours. Relaxation on minimum credit hours may be allowed. A student must enroll for the sessional courses prescribed in a particular term within the allowable credit hour limits.

2.17.2 In special cases where it is not possible to allot the minimum required 15 credit hours to a student, the concerned department (BUGS) may permit with the approval of the Comdt, a lesser number of credit hours to suit individual requirements. Only graduating students may be allowed to register less than 15 Cr Hr without approval of Commandant. A list of all such cases to be forwarded to Register Office, ICT dte andController of Exam Office by the respective Department.

2.18 Course Add/Drop

2.18.1 A student has some limited options to add or drop courses from the registration list. Addition of courses is allowed only within the first two weeks of a regular. Dropping a course is permitted within the first four weeks of a regular term. Add or drop is not allowed after registration of courses for Supplementary-I and Supplementary-II Examination.

2.18.2 Any student willing to add or drop courses has to fill up a Course Adjustment Form. This also has to be done in consultation with and under the guidance of the student's respective adviser. The original copy of the Course Adjustment Form has to be submitted to the Registrar's Office, where the required numbers of photocopies are made for distribution to the concerned adviser, Head, Dean, Controller of Examinations and the student.

2.18.3 All changes must be approved by the adviser and the Head of the concerned department. The Course Adjustment Form has to be submitted after being signed by the concerned persons.

2.19 <u>Withdrawal from a Term</u>

If a student is unable to complete the Term Final Examination due to serious illness or serious accident, he/she may apply to the Head of the degree awarding department for total withdrawal from the term before commencement of term final examination. However, application may be considered during term final examination in special case. The application must be supported by a medical certificate from the Medical Officer of MIST. The concerned student may opt for retaining the sessional courses of the term. The Academic Council will take the final decision about such applications. However, the total duration for graduation will not exceed 6 academic years.

2.20 The Grading System

The total performance of a student in a given course is based on a scheme of continuous assessment, for theory courses this continuous assessment is made through a set of quizzes, class tests, class evaluation, class participation, homework assignment and a term final examination. The assessments for sessional courses are made by evaluating performance of the student at work during the class, viva-voce during laboratory hours and quizzes. Besides that, at the end there will be a final lab test. Each course has a certain number of credits, which describes its corresponding weightages. A student's performance is measured by the number of credits completed satisfactorily and by the weighted average of the grade points earned. A minimum grade point average (GPA) is essential for satisfactory progress. A minimum number of earned credits also have to be acquired in order to qualify for the degree. Letter grades and corresponding grade points will be given as follows:

Numerical Markings	Grade	Grade Points
80% and above	A+	4.00
75% to below 80%	А	3.75
70% to below 75%	A-	3.50
65% to below 70%	B+	3.25
60% to below 65%	В	3.00
55% to below 60%	B-	2.75
50% to below 55%	C+	2.50
45% to below 50%	С	2.25
40% to below 45%	D	2.00
below 40%	F*	0.00
	AB	Absent
	DC	Dis-collegiate
	VW	Voluntary withdrawn
	X	Project/ Thesis Continuatiom
	E	Expelled
	S	Satisfactory

* Subject in which the student gets F grade shall not be regarded as earned credit hours for the calculation of Grade Point Average (GPA).

2.21 Marks Distrubtion

2.21.1 <u>Theory</u>. Forty percent (40%) marks of a theoretical course shall be allotted for continuous assessment, i.e. quizzes, home assignments, class tests, observations/ class participation and class attendance. These marks must be submitted to Office of the Controller of Examinations before commencement of final exam. The rest of the marks will be allotted to the Term Final Examination. The duration of final examination will be three (03) hours. The scheme of continuous assessment that a particular teacher would follow for a course will be announced on the first day of the classes.

Distribution of marks for a given course per credit is as follows:

Class Performance and Attendance	5%+5%=10%
Class Test/ Assignment	20%
Mid Term Assessment (Exam / Project)	10%
Final Examination (Section A & B)	60%
Total	100%

Note:

a. In final exam, each section can be used for achieving not more than two course outcomes (COs). The remaining COs should be attained from mid-term assessment or class tests. Course teacher has to inform the student the beginning of the terms.

b. Course teacher of a particular course has to inform the department whether he/she wants to assess mid-term through exam or project within first two weeks of beginning of a term. The duration of mid-term examination should not be more than 50 minutes which has to be conducted in between 6th to 9th week of a semester. If mid-term assessment is done through project, then there should be project report and presentation.

c. The weightage of class performance can be assessed through checking attentiveness during classes or arranging unnoticed pop quizzes.

d. The number of class tests shall be n for 3.0 and above credit courses and (n-1) shall be considered for grading where n is the number of credits of the course. However, for courses having credits below 3.0, the considered class tests shall be 2 out of 3.

e. All class test will carry 20 marks each. Exam software system will finally convert these achieved marks into total class test marks as per credit hour. i.e for n=1(20), n=2 (40), n=3 (60), n=4(80) etc.

f. Irrespective of the result of the continuous assessment (class performance, class test, mid-term assessment), a student has to appear in the final examination (where applicable) for qualifying/passing the concern course/ subject.

2.21.2 <u>Sessional/Practical Examinations</u>. Sessional courses are designed and conducted by the concerned departments. Examination on sessional/practical subjects will be conducted by the respective department before the commencement of term final examination. The date of practical examination will be fixed by the respective department.

Students will be evaluated in the sessional courses on the basis of the followings (all or as decided by the Examination Sub-Committee):

a.	Conduct of Lab Tests/Class Performance	25%	
b.	Report Writing/ Programming	15%	
c.	Mid-Term Evaluation (exam/project/assignment)	20%	
d.	Final Evaluation (exam/project/assignment)	30%	
e.	Viva Voce/ Presentation	10%	
	Total percentage	100%	

Note: the above distribution of percentage is a general guideline. Department can rearrange to some extent if required

2.21.3 Sessional Course in English / Russian. The distribution will be as under:

a.	Class performance/observation	10
b.	Written Assignment	15
c.	Oral Performance	25
d.	Listening Skill	10
e.	Group Presentation	30
f.	Viva Voce	10
	Total percentage	100%

2.21.4 Class Attendance.

Class attendance may be considered as a part of continuous assessment. No mark should be allotted for attending classes.

2.22 Calculation of GPA

Grade Point Average (GPA) is the weighted average of the grade points obtained of all the courses passed/completed by a student. For example, if a student passes/completes n courses in a term having credits of C_1, C_2, \ldots, C_n and his grade points in these courses are G_1, G_2, \ldots, G_n respectively then

$$GPA = \frac{\sum_{i=1}^{n} CiGi}{\sum_{i=1}^{n} Ci}$$

The Cumulative Grade Point Average (CGPA) is the weighted average of the GPA obtained in all the terms passed/completed by a student. For example, if a student passes/ completes n terms having total credits of TC1, TC2, ..., TCn and his GPA in these terms are GPA1, GPA2, GPAn respectively then

$$CGPA = rac{\sum_{i=1}^{n} TCiGPAi}{\sum_{i=1}^{n} TCi}$$

Numerical Example

Suppose a student has completed eight courses in a term and obtained the following grades:

Course	Credits, C _i	Grade	Grade, G _i	Points, C _I *G _i
Shop 114	1.50	A-	3.50	5.250
NE 101	3.00	A+	4.00	12.000
CHEM 101	3.00	А	3.75	11.250
MATH 209	3.00	В	3.00	9.000
HUM 127	3.00	B-	2.75	8.250
HUM 177	3.00	В	3.00	9.000
PHY 111	3.00	A+	4.00	12.000
CSE 109	1.50	А	3.75	5.625
Total	21.00			72.375

GPA = 72.375/21.00 = 3.45

Suppose a student has completed four terms and obtained the following GPA.

Level	Term	Credit Earned, TC _I	Hours GPA Earned, GPA _i	GPA _i *TC _i
1	1	21.00	3.73	78.330
1	2	20.50	3.93	80.565
2	1	19.75	3.96	78.210
2	2	20.25	4.00	81.000
Total		81.50		318.105

CGPA = 318.105/81.50 = 3.90

2.23 Minimum Earned Credit and GPA Requirement for Obtaining Degree

Minimum credit hour requirements for the award of bachelor's degree in engineering (B.Sc. Engineering) and other discipline will be decided as per existing rules. The minimum CGPA requirement for obtaining a Bachelor's degree in engineering and other discipline is 2.20.

2.24 <u>Minimum Earned Credit and GPA Requirement for Obtaining Degree (Additional Course)</u>

Minimum credit hour requirements for the award of bachelor's degree in engineering (B.Sc. Engineering) and other discipline will be decided by the respective department (BUGS). However, at least 157 credit hours for engineering must be earned to be elegible for graduation. This must include the specified core courses. The minimum GPA requirement for obtaining a Bachelor's degree in Engineering and Architecture is 2.20. A student may take additional courses with the consent of his Advisor in order to raise GPA, but he/she may take a maximum of 15 such additional

credits beyond respective credit-hours requirements for Bachelor's degree during entire period of study.

2.25 Impacts of Grade Earned

The courses in which a student has earned a 'D' or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained an 'F' grade will not be counted towards his/her earned credits or GPA calculation. However, the 'F' grade will remain permanently on the Grade Sheet and the Transcript.

2.25.1 A student who obtains an 'F' grade in a core course will have to repeat that particular course. However, if a student gets an 'F' in an optional course, he/she may choose to repeat that course or take a substitute course if available. When a student will repeat a course in which he/she has previously obtained an 'F', he/she will not be eligible to get a grade better than 'B+' in that repeated course.

2.25.2 If a student obtains a grade lower than 'B+' in a particular course he/she will be allowed to repeat the course only once for the purpose of grade improvement. However, he/she will not be eligible to get a grade better than 'B+' for an improvement course.

2.25.3 A student will be permitted to repeat for grade improvement purposes a maximum of 6 courses in BSc. Engineering programs and a maximum of 7 courses in B. Arch. program.

2.25.4 If a student obtains a 'B+' or a better grade in any course he/she will not be allowed to repeat the course for the purpose of grade improvement.

2.26 <u>Classification of Students</u>

At MIST, regular students are classified according to the number of credit hours completed/ earned towards a degree. The following classification applies to all the students:

Level	Credit Hours Earned	
	Engineering	Architecture
Level 1	0.0 to 36.0	0.0 to 34.0
Level 2	More than 36.0 to 72.0	More than 34.0 to 72.0
Level 3	More than 72.0 to 108.0	More than 72.0 to 110.0
Level 4	More than 108.0	More than 110.0 to 147.0
Level 5		More than 147.0

2.26.1 However, before the commencement of each term all students other than new batch are classified into three categories:

a. **Category 1:** This category consists of students who have passed all the courses described for the term. A student belonging to this category will be eligible to register for all courses prescribed for the upcoming term.

b. **Category 2:** This category consists of students who have earned a minimum of 15 credits but do not belong to category 1. A student belonging to this category is advised to take at least one course less since he might have to register for one or more backlog courses as prescribed by his/her adviser.

c. **Category 3:** This category consists of students who have failed to earn the minimum required 15 credits in the previous term. A student belonging to this category is advised to take at least two courses less than a category 1 student subject to the constraint of registering at least 15 credits. However, he will also be required to register for backlog courses as prescribed by the adviser.

2.27 <u>Definition of Graduating Student</u>.

Graduating students are those students who will have ≤ 24 credit hour for completing the degree requirement.

2.28 <u>Performance Evaluation</u>

The performance of a student will be evaluated in terms of two indices, viz. Term Grade Point Average and Cumulative Grade Point Average which is the grade average for all the terms completed.

2.28.1 Students will be considered to be making normal progress toward a degree if their Cumulative Grade Point Average (CGPA) for all work attempted is 2.20 or higher. Students who regularly maintain a term GPA of 2.20 or better are making good progress toward the degrees and are in good standing with MIST. Students who fail to maintain this minimum rate of progress will not be in good standing. This can happen when any one of the following conditions exists:

- a. The term GPA falls below 2.20.
- b. The Cumulative Grade Point Average (CGPA) falls below 2.20.
- c. The earned number of credits falls below 15 times the number of terms attended.

2.28.2 All such students can make up their deficiencies in GPA and credit requirements by completing courses in the subsequent term(s) and backlog courses, if there are any, with better grades. When the minimum GPA and credit requirements are achieved the student is again returned to good standing.

2.29 Application for Graduation and Award of Degree

A student who has fulfilled all the academic requirements for Bachelor's degree will have to apply to the Controller of Examinations through his/her Adviser for graduation. Provisional Degree will be awarded by BUP on completion of credit and GPA requirements.

2.30 <u>Time Limits for Completion of Bachelor's Degree</u>

A student must complete his studies within a maximum period of six years for engineering and seven years for architecture.

2.31 Attendance, Conduct and Discipline

MIST has strict rules regarding the issues of attendance in class and discipline.

2.31.1 <u>Attendance</u>. All students are expected to attend classes regularly. The university believes that attendance is necessary for effective learning. The first responsibility of a student is to attend classes regularly and one is required to attend the classes as per MIST rules. Students having class attendance of 85% or above in individual subject will be treated as collegiate and less than 85% and up to 70% will be treated as non-collegiate in that subject. The non-collegiate student(s) may be allowed to appear in the examination subject to payment of non-collegiate fee/fine of an amount fixed by MIST/BUP. Students having class attendance below 70% will be treated as discollegiate and will not be allowed to appear in the examination and treated as fail.

2.31.2 <u>Conduct and Discipline</u>. During their stay in MIST all students are required to abide by the existing rules, regulations and code of conduct. Students are strictly forbidden to form or be members of student organization or political party, club, society etc., other than those set up by MIST authority in order to enhance student's physical, intellectual, moral and ethical development. Zero tolerance in regards of sexual abuse and harassment in any forms and drug abuse and addiction are strictly observed in the campus.

2.32 <u>Teacher-Student Interaction</u>

The academic system in MIST encourages students to come in close contact with the teachers. For promotion of high level of teacher-student's interaction, a course coordinator (CC) is assigned to each course. Students are free to discuss with CC about all academic matters. Students are also encouraged to meet other teachers any time for help and guidance for academic matters. Heads of the departments, Director of Administration, Director of Students Welfare (DSW), Dean and Commandant address the students at some intervals. More so, monthly Commandant's Parade is organized in MIST where all faculty members, staff and students are formed up, thereby increasing teacher-student interaction.

2.33 Absence during a Term

A student should not be absent from quizzes, tests, etc. during the term. Such absence will naturally lead to reduction in points/marks, which count towards the final grade. Absence in the Term Final Examination will result in an F grade in the corresponding course. A student who has been absent for short periods, up to a maximum of three weeks due to illness, should approach the course teacher(s) or the course coordinator(s) for make-up quizzes or assignments immediately upon return to classes. Such request has to be supported by medical certificate from competent authority (e.g. CMH/MIST Medical Officer).

2.34 <u>Recognition of Performance</u>

As recognition of performance and ensure continued studies MIST awards medals, scholarships and stipends will be given as per existing rules and practices.

2.35 <u>Types of Different Examinations (Subject to change for different academic session)</u>

Following different types of final Examinations will be conducted in MIST to evaluate the students of Undergraduate Programs:

a. <u>**Term Final Examination:**</u> At the end of each normal term (after 22 wk or so), Term Final Examination will be held. Students will appear in the Term Final Examination for all the theory courses they have taken in the Term.

b. <u>Supplementary Examination</u>: It will take place twice in a year. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun) / Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec) / Spring Term (Jan-Jun) end break, respectively. Students will be allowed to register for a maximum of two theory courses (Failed/Improvement) in Supplementary-II and maximum of one theory course (Failed/Improvement) in Supplementary-II.

c. **Improvement Examination:** It will be taken during Supplementary-I and Supplementary-II Examination. Questions will be same as the question of the regular examination of that Supplementary Examination (if any). Student can take maximum two subjects at a time (two subjects in supplementary-I and one subject in supplementary-II) and maximum 6 subjects in the whole academic duration. If a student obtains a grade lower than 'B+' in a course, he/she will be allowed to repeat the course only once for grade improvement. However, he/she will not be eligible to get a grade better then 'B+' for an improvement course. Among the previous result and improvement examination result, best one will be considered as final result for an individual student. However, performance of all examination i,e previous to improvement examination, shall be reflected in the transcript.

2.36 <u>Rules of Different Examinations (Subject to change for different academic session)</u>

2.36.1 <u>Term Final Examination</u>. Following rules to be followed:

a. Registration to be completed before commencement of the class. A student has to register his desired courses paying registration, examination fee and other related fees.

b. Late registration will be allowed without penalty within first one week of the term.

c. Within 1st two weeks of a term a student can Add/Drop course/courses. To add a course, in the 3rd week, one has to register the course by paying additional fees. To drop a course, one has to apply within three weeks and paid fees will be adjusted/ refunded. If anyone wants to drop a course after three weeks and within 4 weeks, that will be permitted but paid fees will not be refunded in that case.

d. Registrar office will finalize registration of all courses within 7 (seven) weeks, issue registration slip and that will be followed by issuing Admit Card.

e. Term Final Examination to be conducted in the 18-20th week of the term as per approved Academic Calendar.

2.36.2 <u>Supplementary Examination</u>. Following rules to be followed:

a. Supplementary-I is defined as provision of giving exam in the first week of Spring Term (Jan-Jun) / Fall Term (Jul-Dec) end break and Supplementary-II in the first week of Fall Term (Jul-Dec) / Spring Term (Jan-Jun) end break, respectively.

b. Students will be allowed to register for a maximum of two theory courses (Failed/Improvement) in Supplementary-I and maximum of one theory course (Failed/Improvement) in Supplementary-II.

c. No class will be conducted.

d. 40% marks will be considered from the previous exams.

e. Maximum grading in Supplementary Exam will be 'B+'.

f. No Sessional Exam will be conducted.

g. Examination will be taken on 60% marks like Term Final Examination.

h. If a student fails in a course more than once in regular terms, then for calculating 40% marks best one of all continuous assessment marks will be counted.19

j. If anyone fails in the laboratory/sessional course, that course cannot be taken in the supplementary examination.

k. If any student fails in a course, he can clear the course retaking it 2nd time or, he can clear the examination appearing at the supplementary examination as well. Any one fails twice in a course, can only retake it in the regular term for appearing third time. But anyone fails even after appearing third time. He/she has to take approval of Academic Council of MIST for appearing 4th (last) time in a course and need to pay extra financial penalty. If any s0tudent fails even 4th time in a course, will not be allowed to appear anymore in this same course. 1. Registration of Supplementary-I Exam to be done within 5th wk after

completion of Fall Term (July to Dec) and registration of Supplementary-II exam to be done during the Mid-Term break of Spring Term (Jan to Jun), paying all the required fees.

m. There will be no provision for add/drop courses after registration.

n. Question Setting, Moderation, and Result Publication to be done following the same rules of Spring (Jan to Jun) / Fall (July to Dec) Term Final Exam as per existing Examination Policy.

p. Moderation of the questions for Supplementary-I will be done in the 5th week after completion of Fall Term (July to Dec) Final Exam and SupplementaryII with the moderation of the questions of Spring Term(Jan to Jun).

q. Separate Tabulation sheet to be made.

r. Thesis: if a student cannot complete thesis in two consecutive terms, with the recommendation of the supervisor, he/she may continue for next one/two term within six academic years

2.36.3 <u>Improvement Examination</u>. Following rules to be followed:

a. Any student gets a grading below 'B+' and desires to improve that course; he will be allowed to appear the improvement examination for that particular course.

b. Highest grade of Improvement examination will be 'B+'.

c. One student is allowed to appear at Improvement exam in 6 (six) courses in his whole graduation period taking maximum two courses at a time.

d. For Improvement examination, registration is to be done before Term 2 Final Examination or, during the registration of Supplementary Courses by paying all the fees.

e. Improvement examination to be taken during the supplementary examinations.

f. Question Setting, Moderation and Result Publication to be done with courses of regular Term Final Examination.

2.37 Irregular Graduation

If any graduating student clears his/her failed course in Term-1 and his graduation requirements are fulfilled, his graduation will be effective from the result publication date of Term-1 and that student will be allowed to apply for provisional certificate.

CHAPTER 3

DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING (NSE)

3.1 <u>Introduction to the program</u>

The Department of Nuclear Science and Engineering (NSE) provides education for students interested in developing the peaceful applications of nuclear engineering for societal needs. Given the global climate change and fuel supply security concerns, nuclear energy is emerging as an important national energy policy element. The applications of other nuclear technologies in medicine and industry have focused attention on the value of strong Nuclear Engineering program. In response to this demand, MIST has developed a new discipline-focused program of study that prepares professionals for the many diverse applications of nuclear science and technology. Applied nuclear science is the core discipline, comprising low energy nuclear physics, biomedical, agriculture field and the interaction of ionizing radiation with matter. Most of the applications fall within three main sub-categories: nuclear power, nuclear physics and fusion technology, and the broad area of nuclear science and technology. Problems of military and national importance have consequently received great emphasis in the activities of this department.

The Department of Nuclear Science and Engineering (NSE) was raised in 2014 and the first academic session started on 5th February 2015 at Military Institute of Science and Technology (MIST). There were 40 undergraduate students in the maiden batch. The Department of Nuclear Science and Engineering (NSE) has also started MSc, MEngg and PhD programme from October 2015 session.

3.2 <u>Vision and Mission of the Program</u>

Vision: To create skilled and competent professionals in the field of Nuclear Engineering with high morals to meet the national and global needs through creative research and innovations.

Mission:

a. To provide advance Nuclear Engineering knowledge and learning through quality education and research.

b. To discover, demonstrate and secure innovative nuclear technology aided solutions and critical infrastructure.

3.3 <u>Program Educational Objectives (PEOs)</u>

No	PEO Statement				
PEO-1	Graduates of Nuclear Engineering will develop a sound knowledge on				
	mathematical, scientific and engineering fundamentals and advanced				

	knowledge of understanding in the sector of nuclear engineering including analysis techniques, design, developments and implementation methodologies.
PEO-2	Graduates of Nuclear Engineering will acquire technical and communicative knowledge with professional and industry based education to build up successful professional careers in industry, government and academia.
PEO-3	Graduates of Nuclear Engineering will understand sustainable engineering practice, socio-ethical values and life-long learning to adapt the innovation and changes.
PEO-4	Graduates of Nuclear Engineering will be capable of working in the broader area of technology having the capability and responsibility of leadership and teamwork.

3.4 Program Outcomes (POs)

Program Outcomes (POs) represent the knowledge, skills and attitudes the students should have at the end of a four-year engineering program. Based on the suggestion of Board of Accreditation for Engineering and Technical Education (BAETE), Bangladesh, the Nuclear Engineering (NE) program has following 12 Program Outcomes:

NO.1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

NO.2. Problem analysis: Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

NO.3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

NO.4. Investigation: Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

NO.5. Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

NO.6. The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

NO.7. Environment and sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, for sustainable development.

NO.8. Ethics: Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.

NO.9. Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

NO.10. Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

NO.11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multi disciplinary environments.

NO.12. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

3.5 <u>Learning Outcomes (LOs):</u>

The Learning Outcomes (LO) are the resultant knowledge skills the student acquires at the end of a course. It defines the cognitive processes a course provides. Chapter 5 and 6 contain the detailed Learning Outcomes for each of the courses under the heading of Learning Outcomes (LOs).

3.6 <u>Generic Skills</u>

The graduates of the NE program are expected to have the following generic skills:

a. Ability to apply the principles and theory of nuclear engineering knowledge to the requirements, design and development of different nuclear systems with appropriate understanding.

b. Ability to define and use appropriate research methods and modern engineering tools.

c. Ability to apply critical thinking to solve complex engineering problems and design innovative solutions.

d. Ability to analyze real time problems and justify the appropriate use of technology.

e. Ability to work effectively as an individual, and as a member or leader of a team in diverse situations and exhibit social responsibility.

3.7 <u>Curriculum/ Skill Mapping</u>

The courses of NE program are designed in such a way that the corresponding Learning Outcomes (LOs) contribute to the 12 Program Outcomes (POs) which eventually achieves the mission and vision of the program. Chapter 5 and 6 contain the mapping for each of the courses. However, generic curriculum/ skill mapping is shown below:



CHAPTER 4

COURSE CURRICULUM FOR BACHELOR DEGREE IN NE

4.1 <u>Introduction</u>

Keeping the above-mentioned program outcome, the following courses are offered for the undergraduate students of Neclear Engineering (NE) Program of the Department of Nuclear Science and Engineering (NSE).

4.2 List of Core Courses

Ser	Course Code	Course Name	Level- Term	Cr Hr	Ct Hr
1.	NE 101	Introduction to Nuclear Engineering	1-I	3.00	3.00
2.	NE 105	Fundamental of Atomic and Nuclear Physics	1-II	3.00	3.00
3.	NE 141	Fundamental of Thermodynamics	1-II	3.00	3.00
4.	NE 203	Introduction to Nuclear and Radio Chemistry	2-I	3.00	3.00
5.	NE 204	Introduction to Nuclear and Radio Chemistry Sessional	2-I	0.75	1.50
6.	NE 207	Reactor Theory and Analysis - I	2-II	3.00	3.00
7.	NE 243	Fundamentals of Heat Transfer and Thermal Engineering	2-I	4.00	4.00
8.	NE 244	Fundamentals of Heat Transfer and Thermal Engineering Sessional	2-I	1.50	3.00
9.	NE 251	Nuclear Materials	2-I	3.00	3.00
10.	NE 252	Nuclear Materials Sessional	2-I	1.50	3.00
11.	NE 261	Numerical Methods in Nuclear Engineering Analysis	2-II	3.00	3.00
12.	NE 262	Numerical Methods in Nuclear Engineering Sessional	2-II	1.50	3.00
13.	NE 301	Radiation Detection and Measurement	3-I	3.00	3.00
14.	NE 302	RadiationDetectionandMeasurement Sessional	3-I	0.75	1.50
15.	NE 305	Nuclear Reactor Thermal Hydraulics	3-I	3.00	3.00
16.	NE 306	Nuclear Reactor Thermal Hydraulics Sessional	3-I	1.50	3.00
17.	NE 307	Reactor Theory and Analysis - II	3-I	3.00	3.00
18.	NE 317	Nuclear Security and Safeguard Engineering	3-I	3.00	3.00
19.	NE 318	Nuclear Security and Safeguard Engineering Sessional	3-I	0.75	1.5
20.	NE 320	Industrial Training	3-II	1.50	4 Wks
21.	NE 321	Reactor Operation and Safety	3-II	3.00	3.00
-----	--------	--	----------	------	-------
22.	NE 331	Automation, Robotics and Linear Control Systems	3-I	3.00	3.00
23.	NE 333	Reactor Instrumentation and Control	3-II	3.00	3.00
24.	NE 334	Reactor Instrumentation and Control Sessional	3-II	0.75	1.5
25.	NE 353	Mechanics of Materials	3-II	3.00	3.00
26.	NE 354	Mechanics of Materials Sessional	3-II	0.75	1.50
27.	NE 355	Fluid Mechanics and Machinery	3-II	3.00	3.00
28.	NE 356	Fluid Mechanics and Machinery Sessional	3-II	0.75	1.50
29.	NE 400	Final Year Design and Research Project	4-I & II	6.00	12.00
30.	NE 409	Nuclear Fuel Cycle and Radioactive Waste Management	4-I	3.00	3.00
31.	NE 415	Radiation Interactions, Shielding and Protection	4-II	3.00	3.00
32.	NE 417	Nuclear Accidents Analysis and Radiological Emergency	4-I	3.00	3.00
33.	NE 423	Nuclear Power Plant Operation and In-core Fuel Management	4-II	3.00	3.00
34.	NE 425	Nuclear Reactor Design and Features	4-I	4.00	4.00
35.	NE 426	Nuclear Reactor Design and Features Sessional	4-I	1.5	3.00
36.	NE 427	Nuclear Power Plant Engineering	4-II	3.00	3.00
37.	NE 428	Nuclear Power Plant Engineering Sessional	4-II	0.75	1.50

4.3 <u>List of Elective Courses</u>

Ser	Course Code	Course Name Le		Cr Hr	Ct Hr
1.	NE 405	Nuclear Chemical Engineering and Corrosion	4-I or 4-II	3.0	3.0
2.	NE 407	Non-Destructive Testing and Evaluation	4-I or 4-II	3.0	3.0
3.	NE 413	Medical Applications of Nuclear Technology 4-I or 4-I		3.0	3.0
4.	NE 431	Power System Engineering and Interface of Nuclear Power Plant with Grid System	4-I or 4-II	3.0	3.0
5.	NE 433	Fundamentals of Fusion Engineering	4-I or 4-II	3.0	3.0
6.	NE 459	Computational Fluid Dynamics (CFD)	4-I or 4-II	3.0	3.0
7.	NE 479	Radioactive Waste Treatment and Disposal Techniques	4-I or 4-II	3.0	3.0
8.	NE 489	Nuclear Power Project: Construction and Decommissioning Strategies	4-I or 4-II	3.0	3.0
9.	NE 491	Fundamentals of Plasma Engineering	4-I or 4-II	3.0	3.0

Ser	Course Code	Course Name	Level- Term	Cr Hr	Ct Hr
1.	PHY 101	Waves and Oscillations, Optics and Modern Physics	1-I	3.0	3.0
2.	PHY 102	Physics Sessional	1-I	1.5	3.0
3.	MATH 209	Differential Calculus and Integral Calculus	1-I	3.0	3.0
4.	GEBS 101	Bangladesh Studies	1-II	2.0	2.0
5.	EECE 119	Fundamentals of Electrical Circuit Analysis Engineering	1-I	3.0	3.0
6.	EECE 120	Fundamentals of Electrical Circuit Analysis Sessional	1-I	0.75	1.5
7.	LANG 172	Introduction to Russian Language - I	1-I	0.75	1.50
8.	ME 180	Basic Engineering Drawing	1-I	1.5	3.0
9.	CHEM 101	Fundamentals of Chemistry	1-II	3.0	3.0
10.	CHEM 102	Fundamentals of Chemistry Sessional	1-II	1.5	3.0
11.	MATH 209	Differential Equations & Matrix	1-II	3.0	3.0
12.	CSE 121	Introduction to Computer Science and Programming Language	1-II	3.0	3.0
13.	CSE 122	Introduction to Computer Science and Programming Language Sessional	1-II	0.75	1.5
14.	LANG 174	Introduction to Russian Language - II	1-II	0.75	1.50
15.	LANG 102	Communicative English-I	1-II	1.5	3
16.	MATH 209	Vector Analysis, Laplace Transform and Coordinate Geometry	2-I	3.0	3.0
17.	GELM 275	Leadership and Management	2-I	2.0	2.0
18.	GES 101	Fundamentals of Sociology	2-I	2.0	2.0
19.	EECE 221	Electrical and Electronics Technology	2-II	3.0	3.0
20.	EECE 222	ElectricalandElectronicsTechnology Sessional	2-II	1.5	3.0
21.	ME 253	Engineering Mechanics	2-II	3.0	3.0
22.	ME 254	Engineering Mechanics Sessional	2-II	0.75	1.5
23.	GESL 221	Environment, sustainability and law	2-II	2.00	2.00
24.	MATH 209	Fourier Analysis, Complex Variable and Statistics	2-II	3.0	3.0
25.	GERM 352	Fundamentals of Research Methodology	3-I	2.00	4.00
26.	GEEM 351	Engineering Ethics and Moral Philosophy	3-II	2.00	2.00
27.	LANG 202	Communicative English-II	2-I	1.5	3.0
28.	GEPM 381	Project Management and Finance	3-I	2.00	2.00

4.4 List of Interdisciplinary Courses and General Education Courses

4.5 <u>Term Wise Distribution of Courses for B.Sc. Engg. in Nuclear Engineering (NE)</u>

Ser	Course Code	Course Course Title		Ct Hr
1.	NE 101	Introduction to Nuclear Engineering	3.0	3.0
2.	PHY 101	Waves and Oscillations, Optics and Modern Physics	3.0	3.0
3.	MATH 101	Differential and Integral Calculus	3.0	3.0
4.	EECE 119	ECE 119 Fundamentals of Electrical Circuit Analysis		3.0
5.	GES 101	Fundamentals of Sociology		2.0
	Theory Total		14.0	14.0
6.	LANG 172	Introduction to Russian Language - I	0.75	1.5
7.	PHY 102	Physics Sessional	1.5	3.0
8.	EECE 120	Fundamentals of Electrical Circuit Analysis Sessional	0.75	1.5
9.	ME 180 Basic Engineering Drawing		1.5	3.0
	Sessional To	tal	4.5	9.0
	Term Total		18.5	23.0

a. Level – 1, Term – I

b. Level – 1, Term – II

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 105	Fundamentals of Atomic and Nuclear Physics	3.0	3.0
2.	NE 141	Fundamentals of Thermodynamics	3.0	3.0
3.	CHEM 101	Fundamentals of Chemistry	3.0	3.0
4.	MATH 103	Differential Equations and Matrix	3.0	3.0
5.	CSE 121	Introduction to Computer Science and Programming Language	3.0	3.0
6.	GEBS 101	Bangladesh Studies	2.0	2.0
	Theory Total		17.0	17.0
7.	LANG 174	Introduction to Russian Language - II	0.75	1.5
8.	CHEM 102	Chemistry Sessional	1.5	3
9.	LANG 102	Communicative English-I	1.5	3
10.	CSE 122 Introduction to Computer Science and Programming Language Sessional		0.75	1.5
	Sessional Total		4.5	9.0
	Term Total		21.5	26.0

c. Level – 2, Term – I

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 203	Introduction to Nuclear and Radio Chemistry	3.0	3.0
2.	NE 243	Fundamentals of Heat Transfer and Thermal Engineering	4.0	4.0
3.	NE 251	Nuclear Materials	3.0	3.0
4.	MATH 201	Vector Analysis, Laplace Transform and Coordinate Geometry	3.0	3.0
5.	GELM 275	Leadership and Management	2.0	2.0
	Theory Total			15.0
6.	NE 204	Introduction to Nuclear and Radio Chemistry Sessional	0.75	1.5
7.	NE 244	Fundamentals of Heat Transfer and Thermal Engineering Sessional	1.5	3.0
8.	NE 252	Nuclear Materials Sessional	1.5	3.0
9.	LANG 202	Communicative English-II	1.5	3.0
	Sessional Total			10.5
	Term Total	20.25	25.5	

d. Level – 2, Term – II

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 207	Reactor Theory and Analysis-I	3.0	3.0
2.	NE 261	Numerical Methods in Nuclear Engineering Analysis	3.0	3.0
3.	EECE 221	Electrical and Electronics Technology	3.0	3.0
4.	ME 253	Engineering Mechanics	3.0	3.0
5.	MATH 209	Fourier Analysis, Complex Variable and Statistics	3.0	3.0
6.	GESL 221	Environment, Sustainability and Law	2.0	2.0
	Theory Total		17.0	17.0
7.	NE 262	Numerical Methods in Nuclear Engineering Analysis Sessional	1.5	3.0
8.	EECE 222	Electrical and Electronics Technology Sessional	1.5	3.0
9.	ME 254	Engineering Mechanics Sessional		1.5
	Sessional Total		3.75	7.5
	Term Total		20.75	24.5

e. Level -3, Term -I

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 301	Radiation Detection and Measurement	3.0	3.0
2.	NE 305	Nuclear Reactor Thermal Hydraulics	3.0	3.0
3.	NE 307	Reactor Theory and Analysis - II	3.0	3.0
4.	NE 317	Nuclear Security and Safeguard Engineering	3.0	3.0
5.	NE 331	Automation, Robotics and Liner Control System	3.0	3.0
6.	GEPM 381	PM 381 Project Management and Finance		2.0
	Theory Total		17.0	17.0
7.	NE 302	Radiation Detection and Measurement Sessional	0.75	1.5
8.	NE 306	Nuclear Reactor Thermal Hydraulics Sessional	1.5	3.0
9.	NE 318 Nuclear Security and Safeguard Engineering Sessional		0.75	1.5
	Sessional Total		3.0	6.0
	Term Total		20.0	23.0

f. Level – 3, Term – II

Ser	Course Code	Course Code Course Title		Ct Hr
1.	NE 321	Reactor Operation and Safety	3.0	3.0
2.	NE 333	Reactor Instrumentation and Control	3.0	3.0
3.	NE 353	Mechanics of Materials	3.0	3.0
4.	NE 355	Fluid Mechanics and Machinery	3.0	3.0
5.	GEEM 351 Engineering Ethics & Moral Philosophy		2.0	2.0
	Theory Total		14.0	14.0
6.	NE 320	2 320 Industrial Training		4 Wks
7.	NE 334	Reactor Instrumentation and Control Sessional	0.75	1.5
8.	NE 354	Mechanics of Materials Sessional	0.75	1.5
9.	NE 356	Fluid Mechanics and Machinery Sessional	0.75	1.5
10.	GERM 352 Fundamentals of Research Methodology		2.0	4.0
	Sessional Total		5.75	8.5 + 4 Wks
	Term Total		19.75	22.5 + 4 Wks

g. Level – 4, Term – I

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 409	Nuclear Fuel Cycle and Radioactive Waste Management	3.0	3.0
2.	NE 417	Nuclear Accidents Analysis and Radiological Emergency	3.0	3.0
3.	NE 425	Nuclear Reactor Design and Features	4.0	4.0
4.	-	Elective Course-1	3.0	3.0
5.	-	Elective Course-2		3.0
	Theory Total		16.0	16.0
6.	NE 400	Final Year Design and Research Project	3.0	6.0
7.	NE 426	NE 426 Nuclear Reactor Design and Features Sessional		3.0
	Sessional Total		4.5	9.0
	Term Total		20.5	25.0

h. Level – 4, Term – II

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 415	Radiation Interactions, Shielding and Protection	3.0	3.0
2.	NE 423	Nuclear Power Plant Operation and In-core Fuel Management	3.0	3.0
3.	NE 427	Nuclear Power Plant Engineering	3.0	3.0
4.	-	Elective Course-3	3.0	3.0
5.	-	Elective Course-4	3.0	3.0
	Theory Total		15.0	15.0
6.	NE 400	Final Year Design and Research Project	3.0	6.0
7.	NE 428	Nuclear Power Plant Engineering Sessional	0.75	1.50
	Sessional Total		3.75	7.5
	Term Total		18.75	22.5

Level- Term	Contact Hours for Theory Courses	Contact Hours for Sessional Courses	Total Credit Hours	Total Contact Hours
1-I	14	9	18.50	23.0
1-II	17	9	21.5	26.0
2-I	15	10.5	20.25	25.5
2-II	17	7.5	20.75	24.5
3-I	17	6	20.00	23.0
3-II	14	8 + 4 wks	19.75	22.5 + 4 wks
4-I	16	9	20.50	25.0
4-II	15	7.5	18.75	22.5
Total	125	67 + 4 wks	160	192 + 4 wks

4.6 <u>Summary of Credit Distribution - Level and Termwise</u>

4.7 <u>Summary of Theory and Sessional Courses- Level and Termwise</u>

Level	Hours/	/Week	Total	Cree	dits	Total	No. of C	Courses
and Term	Theory	Sessional	Ct Hours	Theory	Sessional	Credits	Theory	Sessional
Level-1 Term-I	14	9	23.0	14.0	4.5	18.50	5	4
Level-1 Term-II	17	9	26.0	17.0	4.5	21.5	6	4
Level-2 Term-I	15	10.5	25.5	15.0	5.25	20.25	5	4
Level-2 Term-II	17	7.5	24.5	17.0	3.75	20.75	6	3
Level-3 Term-I	17	6	23.0	17.0	3.0	20.00	6	3
Level-3 Term-II	14	8 + 4 wks	22.5 + 4 wks	14.0	5.75	19.75	5	5
Level-4 Term-I	16	9	25.0	16.0	4.5	20.50	5	2
Level-4 Term-II	15	7.5	22.5	15.0	3.75	18.75	5	2
Grand Total	125	67 + 4 wks	192 + 4 wks	125	35	160	43	27





4.8 <u>Summary of Departmental Theory and Sessional Courses - Level and Termwise</u>

Level/ Term	Theory	Sessional	Total			
Level-1 Term-I	3.0	-	3.0			
Level-1 Term-II	6.0	-	6.0			
Level-2 Term-I	10.0	3.75	13.75			
Level-2 Term-II	6.0	1.5	7.5			
Level-3 Term-I	15.0	3.0	18.0			
Level-3 Term-II	12.0	3.75	15.75			
Level-4 Term-I	16.0	4.5	20.5			
Level-4 Term-II	15.0	3.75	18.75			
Total	83.0	20.25	103.25			

Departmental Theory and Sessional Credit Hours Ratio



4.9 <u>Summary of Departmental, Inter-disciplinary, Basic Science and General Education</u> <u>Courses</u>

Level/ Term	Dept	Inter- disciplinary	Basic Science	Mathematics	Language	General Education	Total
Level-1 Term-I	3	5.25	4.5	3	0.75	2	18.50
Level-1 Term-II	6	3.75	4.5	3	2.25	2	21.5
Level-2 Term-I	13.75	-	-	3	1.5	2	20.25
Level-2 Term-II	7.5	8.25	-	3	-	2	20.75
Level-3 Term-I	18	-	-	-	-	2	20.00
Level-3 Term-II	15.75	-	-	-		4	19.75
Level-4 Term-I	20.5	-	-	-	-	-	20.50
Level-4 Term-II	18.75	-	-	-	-	-	18.75
Total	103.25	17.25	9	12	4.5	14	160
% of Courses	64.53%	10.78%	5.63%	7.50%	2.81%	8.75%	100%

Summary of Departmental, Inter-disciplinary, Basic Science and General Education Courses



4.10 <u>Teaching Strategy</u>

Multiple teaching and learning activities are necessary to achieve the intended outcomes, since students have different learning styles. It is therefore we planned to choose appropriate teaching and learning methods that will foster student's engagement in the learning process rather than them (students) listening to the lectures passively. Student centred learning is about active participation of students in the classroom, and that active participation will be achieved by content/curriculum, teacher's interaction with the students and the environment that are directed towards students learning. The strategy includes:

a. **Face-to-Face Learning**

- Lecture /Presentation/ Discussion
- Practical / Tutorial / Studio
- Case Studies
- Assignment/Quiz
- Group discussion/projects
- Design and Research

b. Self-Directed Learning

- Non-face-to-face learning
- Revision
- Preparation of presentation
- Preparation of Lab Reports
- Preparation of Lab Test
- Engagement in Group Projects
- Preparation of Assignment/Quiz
- Preparation for final Examination

Details of teaching strategy for each of the courses under the heading of Teaching Learning Strategy is given in Chapter 5 and 6.

4.11 Assesment Strategy

Assessment of student achievement is an important aspect of Outcome-based education. Assessment process is aligned with the learning outcomes. Assessment supports the learners in their progress and validates the achievement of the intended learning outcomes at the end of the lecture/course/module. Assessment methods are adapted depending on the kind of outcomes that are aimed to be achived. The assessment strategy is given below:

a. Theory Based Course

Ser		Components	Grading
1	a i	Class Test/ Assignment (1-3)	20%
	Continuous	Class Participation	5%
	Assessment (40%)	Mid term Exam	15%
2	Fi	nal Examination	60%
		100%	

b. Sessional Course

Ser	Co	omponents	Grading		
1	Class Participation		5%		
	Continuous	Conduct of Lab Test	20%		
	Assessment (60%)	Report Writing	15%		
		Mid term	20%		
2	Final Evaluation (10%)	Exam	30%		
	Fillal Evaluation (40%)	Viva Voce/ Presentation	10%		
	Te	Total Marks			

Details of assessment strategy for each of the courses under the heading of assessment Strategy is given in Chapter 5 and 6.

<u>CHAPTER – 5</u>

5. <u>Course Description</u> 5.1 <u>Core Courses Offered</u>

Level-1, Term-I

	COURSE INFORMATION											
Course Code Course Title	: NE 101 : Introduction to Nuclear Engineering	g Cre	cture Contact	Hours		: 3.0 : 3.0)0)0					
	PRE-REQUISITE					1						
	None											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/ RATIONALE											
	This course is designed to provide a general understanding on the basics of nuclear engineering and to introduce a variety of applications of this field.											
	OBJECTIVES											
	 To provide an introduction on the basics of nuclear engineering and its applications. To familiarize students with different types of nuclear and radiation related phenomenon. To understand the basics of biological, radiological effects of radiation and its shielding principles. To give an illustration about classifications of nuclear reactors, the basic working principle of nuclear power plants, their safety and licensing procedure. 											
	LEARNING OUTCOMES											
	 Upon completion of the course, the standard standard	tudents will be ear engineerin lear reactions ogical effects on nuclear power,	able to g and the va and basic nuc of radiation a future researc	riety o clear pl nd the ch scop	of app henor meth bes an	plicati nenon nods id app	ons of this in nuclear of radiation plications of					
	COURSE OUTCOMES & GENER	RIC SKILLS	D1 '									
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
C01	Understand the basics of nuclear engineering and the variety of applications of this engineering field.	PO1	C2			1	T, Q, F					

CO2	Explain reactions phenome	different type s and ba enon in nuclear	es of nuclear sic nuclear reactors.	I	PO2			C2					1	I	MT, F	
CO3	Analyze effects o radiatior	the biologica f radiation and the shielding.	l, radiological the methods of	F	PO2			C4					1	A	ASG, F	T
CO4	Evaluat power, applicati	e the characteris future research ons of nuclear e	stics of nuclear n scopes and engineering.	F	PO1			C5					1		T, F	
	(CP- Co Quiz; A	mplex Problems SG – Assignmer	s, CA-Complex nt; Pr – Presenta	Activiti tion; R ·	ies, - Re	KP-l port;	Know F –	/ledge Final	Prof Exan	file, T n, MT	Г — Т Г- М	Test ; id Te	PR – erm Ez	- Proj xam)	ect;(2 –
	COUR	SE CONTEN	Т													
	nuclear physics, basic concepts in neutron reactions, neutron moderation and diffusion. The fission chain reaction; non-nuclear components of nuclear power plants; components of nuclear reactors; the history of radiation effects; radiation units; exposure, radiation dose and biological dose; population dose; the biological effects of radiation; natural and man-made radiation sources; fissile material, fissionable material, fertile material; ionizing and non-ionizing radiation; neutron moderation and basics; radiation shielding, alpha, beta, gamma, neutron radiation; attenuation formula, attenuation coefficient; half value layer. Power reactors, nuclear reactor safety and licensing.															
	SKILL MAPPING (CO-PO MAPPING)															
							DI	POCP	AM	OUT	CON	1ES	(\mathbf{PO})			1
	No.	Course Le	earning Outcome	e -	1	2	PF 3	ROGR	AM 5 6	OUT 7	CON 8	AES 9	(PO) 10	11	12]
	No.	Course Le Understand t engineering a applications field.	earning Outcome he basics of nu and the variet of this engine	e iclear y of vering	1	2	PF 3	ROGR 4 5	AM 5 6	OUT 7	CON 8	AES 9	(PO) 10	11	12	
	No. CO1 CO2	Course Le Understand t engineering a applications of field. Explain differ reactions ar phenomenon i	earning Outcome he basics of nu and the variet of this engine rent types of nu nd basic nu n nuclear reactor	e	1	2 2 2	PF 3	A S	AM 5 6	OUT 7	CON 8	AES 9	(PO) 10	11	12	
	No. CO1 CO2 CO3	Course Le Understand t engineering a applications field. Explain differ reactions ar phenomenon i Analyze the bi effects of radia of radiation sh	earning Outcome he basics of nu and the variet of this engine rent types of nu nd basic nu n nuclear reactor iological, radiolo ation and the me ielding.	e	2	2 2 2 1	PF 3	ROGR 4 5	AM 5 6	OUT 7	CON 8	AES 9	(PO) 10	11	12	
	No. CO1 CO2 CO3 CO4	Course Le Understand t engineering a applications of field. Explain differ reactions ar phenomenon i Analyze the bi effects of radia of radiation sh Evaluate the nuclear powe scopes and ap engineering.	earning Outcome he basics of nu and the variet of this engine rent types of nu n nuclear reactor iological, radiolo ation and the me ielding. e characteristic er, future resu pplications of nu	e clear y of eering iclear iclear rs. ogical thods s of earch iclear	1 2 1	2 2 1	PF 3	ROGR	AM 5 6	OUT 7	CON 8	9 9	(PO) 10	11	12	
JUSTIFICAT	No. CO1 CO2 CO3 CO4 (3 - Hig ION FOI	Course Le Understand t engineering a applications field. Explain differ reactions ar phenomenon i Analyze the bi effects of radia of radiation sh Evaluate the nuclear powe scopes and ap engineering. h, 2- Medium, 1 R CO-PO MA	earning Outcome he basics of nu and the variet of this engine rent types of nu n nuclear reactor iological, radiolo ation and the me ielding. e characteristic er, future resu oplications of nu -low)	e	1 2 1	2 2 2 1	PP 3	ROGR 4 5	AM 5 6	OUT 7		AES 9	(PO) 10	11		
JUSTIFICAT Mapping	No. CO1 CO2 CO3 CO4 (3 - Hig Corr Level of	Course Le Understand t engineering a applications field. Explain differ reactions ar phenomenon i Analyze the bi effects of radia of radiation sh Evaluate the nuclear powe scopes and ap engineering. h, 2- Medium, 1 R CO-PO MA esponding of Matching	earning Outcome he basics of nu and the variet of this engine rent types of nu n nuclear reactor iological, radiolo ation and the me ielding. e characteristic er, future resu pplications of nu -low)	e	1 2 1 1	2 2 2 1	PF 3		AM 5 6	OUT 7		AES 9	(PO) 10			
JUSTIFICAT Mapping CO1-PO1	No. CO1 CO2 CO3 CO4 (3 - Hig COrr Level of	Course Le Understand t engineering a applications of field. Explain differ reactions an phenomenon i Analyze the bi effects of radia of radiation sh Evaluate the nuclear powe scopes and ap engineering. h, 2- Medium, 1 R CO-PO MA esponding of Matching 2	earning Outcome he basics of nu and the variet of this engine rent types of nu n nuclear reactor iological, radiolo ation and the me ielding. e characteristic er, future resu pplications of nu -low) PPING In order to a applications in	e clear y of eering iclear iclear rs. ogical thods s of earch iclear	1 2 1 funda g van	2 2 1 amen	PF 3 J Ju tals engi,	ROGR 4 5	AM 5 6 6	OUT 7	CON 8	AES 9	(PO) 10 and to nuc	a va	12	of

CO3-PO2	1	In order to undertake nuclear relevant problem identification solution.	ation, formulation and						
CO4-PO1	1	In order to apply fundamentals of nuclear engineering	and a variety of						
TEACHING I	LEARNING STRATE	applications in solving various engineering problems related to GY	o nuclear.						
Teaching and I	earning Activities		Engagement						
			(hours)						
	Face-to-Face Learning	g	42						
	Practical / Tu	torial / Studio	-						
	Student-Cent	red Learning	-						
Self-Directed Learning									
	Non-face-to-face learning Revision								
	Formal Assessment		21						
	Continuous A	ssessment	2						
	Mid-Term		1						
	Final Examin	ation	<u> </u>						
TEACHING N	METHODOLOGY		155						
Lecture and Di	scussion, Co-operative	and Collaborative Method, Problem Based Method							
COURSE SCI	HEDILE								
Weeks		Topics	Remarks						
Weeks Week-1	Introduction to nuclea	Topics ar engineering, a short review of nuclear physics	Remarks Class Test						
Weeks Week-1 Week-2	Introduction to nuclea Basic concepts in neu	Topics ar engineering, a short review of nuclear physics tron reactions	Remarks Class Test 1, Final						
Weeks Week-1 Week-2 Week-3	Introduction to nuclea Basic concepts in neu Nuclear reactor safety	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction	Remarks Class Test 1, Final Exam						
Weeks Week-1 Week-2 Week-3 Week-4	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure	Remarks Class Test 1, Final Exam						
Weeks Week-1 Week-2 Week-3 Week-4 Week-5	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, r	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation	Remarks Class Test 1, Final Exam Class Test Class Test 2 Final						
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer	Remarks Class Test 1, Final Exam Class Test 2, Final Exam						
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health	Remarks Class Test 1, Final Exam Class Test 2, Final Exam						
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing The biological effects	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health of radiation, natural and man-made radiation sources	Remarks Class Test 1, Final Exam Class Test 2, Final Exam Mid						
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8 Week-9	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing The biological effects Non-nuclear compone	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health of radiation, natural and man-made radiation sources ents of nuclear power plants, components of nuclear reactor	Remarks Class Test 1, Final Exam Class Test 2, Final Exam Mid Term, Final						
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-8 Week-9 Week-10	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing The biological effects Non-nuclear compone Radiation dose and bi	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health of radiation, natural and man-made radiation sources ents of nuclear power plants, components of nuclear reactor ological dose, population dose	Remarks Class Test 1, Final Exam Class Test 2, Final Exam Mid Term, Final Exam						
WeeksWeek-1Week-2Week-3Week-3Week-4Week-5Week-6Week-6Week-7Week-8Week-9Week-10Week-11	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing The biological effects Non-nuclear compone Radiation dose and bi Elements of nuclear p	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health of radiation, natural and man-made radiation sources ents of nuclear power plants, components of nuclear reactor ological dose, population dose ower reactor system	Remarks Class Test 1, Final Exam Class Test 2, Final Exam OTS Mid Exam						
WeeksWeek-1Week-2Week-3Week-3Week-4Week-5Week-6Week-6Week-7Week-8Week-9Week-10Week-11Week-12	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing The biological effects Non-nuclear compone Radiation dose and bi Elements of nuclear p Radiation shielding	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health of radiation, natural and man-made radiation sources ents of nuclear power plants, components of nuclear reactor ological dose, population dose ower reactor system	Remarks Class Test 1, Final Exam Class Test 2, Final Exam OTS Final Exam OTS Class Test A Class Test Class Test A Class Test A Final Exam						
WeeksWeek-1Week-2Week-3Week-3Week-4Week-5Week-6Week-6Week-7Week-8Week-9Week-10Week-11Week-12Week-13	Introduction to nuclea Basic concepts in neu Nuclear reactor safety The history of radiatio Alpha, beta, gamma, n Attenuation formula, a Interaction of ionizing The biological effects Non-nuclear compone Radiation dose and bi Elements of nuclear p Radiation shielding Neutron moderation a	Topics ar engineering, a short review of nuclear physics tron reactions and licensing, The fission chain reaction on effects, radiation units, exposure neutron radiation attenuation coefficient, half value layer g radiation with matter, radiation effects on human health of radiation, natural and man-made radiation sources ents of nuclear power plants, components of nuclear reactor ological dose, population dose ower reactor system nd diffusion	Remarks Class Test 1, Final Exam Class Test 2, Final Exam OTS Mid Term, Final Exam OTS Class Test 3, Final Exam						

Components		Grading	СО	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1	C2
	Mid term	10%	CO2	C2
F	inal Examination	60%	CO1-CO4	C2, C4, C5
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

REFERENCE BOOKS

- 1. Lamarsh, J.R. and Baratta, A.J., *Introduction to Nuclear Engineering*, 4th Edition, London, United Kingdom: Pearson Education, 2017.
- 2. Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering: Reactor Design Basics*, 4th Edition, USA: Springer, 2013.
- 3. J. Kenneth Shultis, Richard E. Faw, *Fundamentals of Nuclear Science and Engineering*, 3rd Edition, Boca Raton, Florida, United States: CRC Press, 2016.
- 4. Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering: Reactor System Engineering*, 4th Edition, Springer US, 2013.

REFERENCE SITE

Level-1, Term-II

	COURSE INFORMATION									
Course Code Course Title	: NE 105 : Fundamentals of Atomic and Nuclear Physics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00							
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	This course is designed to provide a general l principal models of the nuclear study and radioac	knowledge on the basics of Nutrivity.	clear Physics and							

	OBJECTIVES												
	 To introduce the principal models To understand the characteristics of deuteron properties. To discuss the spontaneous decay To understand the nuclear force, n 	of the nuclear stu of the nuclear forc of nuclei, nuclear uclear reactions r	dy and radioa ce, electron sca reactions, fise nethods and re	ctivity. attering sion an eaction	g, neuti nd fusic n theory	rino hy on proo y.	ypothesis and cesses.						
	LEARNING OUTCOMES												
	Upon completion of the course, the students will be able to												
	 Apply the principal models of the nuclear study and radioactivity. Analyze the nuclear force, electron scattering, neutrino hypothesis and deuteron properties. Explain the spontaneous decay of nuclei, nuclear reactions, fission and fusion process. Evaluate the nuclear force, nuclear reactions methods and reaction theory. 												
	COURSE OUTCOMES & GENERIC SKILLS												
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	Apply the principal models of the nuclear study and radioactivity.	PO1	C3	-	-	1	T, Q, F						
CO2	Analyze the nuclear force, electron scattering, neutrino hypothesis and deuteron properties.	-	1	ASG, T, F									
CO3	Explain the spontaneous decay of nuclei, nuclear reactions, fission and fusion process.	PO2	C2	-	-	1	MT, F						
CO4	Evaluate the nuclear force, nuclear reactions methods and reaction theory.	PO1	C5	-	1	1	T, F						
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kı tion; R - Report; F	nowledge Prof 7 – Final Exam	ile, T - 1, MT-	- Test : Mid Te	; PR – erm Ex	Project ; Q –						
	COURSE CONTENT												
	The nucleus: nuclear size, packing fr laws, carbon dating, half-life and me positron emission, electron capture neutrino hypothesis, nuclear reaction properties of nucleus: nuclear dens deuteron : ground state of deuteron, d moments of the deuteron; neutron- dependence of n-p scattering, effective scattering, nuclear force: central a conditions; symmetry and charge ef and coulomb energy, nuclear reaction classification, the methods of direct magic numbers and nuclear shell m model, optical model.	raction and bind an life; radioacti e, internal conv a: different types ity distribution, leuteron ground s proton scatterin ve range theory in nd non-central ffects; charge into ons : reaction cru- reaction theory; nodel, 1-s couplin	ing energy; ra ive series: alp version, pair of reactions, iso-spin, ma state wave fun ag at low end n the n-p scatt forces; exch dependence of oss-section, of analysis of st ng scheme; j	adioac ha, be produ nuclea gnetic nction, ergies; tering; ange 1 of nucl direct 1 trippin -j couj	tivity: ta and iction ir fusio mom magn scatte coher forces; lear fo reactio g and pling	radioa gamm and a on in s ents, g etic ar ering ent an ; nucl prce; n ons: de pick-u schem	active decay na emission, annihilation; tars; general g-factor; the nd quadruple length; spin d incoherent ear stability nirror nuclei efinition and up reactions; e, collective						

	SKILL	MAPPING	(CO-PO MAPPING))														
	Na	Course I				Р	ROC	GRA	M	DUT	CON	IES	(PO)			1		
	NO.	Course I	insing Outcome	1	2	3	4	5	6	7	8	9	10	11	12			
	CO1	nuclear study	and radioactivity.	2														
	CO2	Analyze the	nuclear force, electron		2													
		deuteron prot	perties.		2													
		Explain the	Explain the spontaneous decay of															
	CO3	nuclei, nucle	nuclei, nuclear reactions, fission															
		and fusion pr	ocess.															
		Evaluate the	nuclear force, nuclear	2														
	04	theory.	emous and reaction	2														
	(3 - Hig)	h, 2- Medium,	1-low)				1	1				1				1		
	(5 mgn, 2 monum, 1 m)																	
JUSTIFICAT	ION FO	R CO-PO M	APPING															
Mapping	Corresponding Justification																	
			In order to apply the p	orinc	ipal	mod	els o	of th	e nu	clear	r stud	dy ar	nd radioactivity, the					
CO1-PO1		2	knowledge of mathem	natic	s, n	atura	l sci	ienc	e, ei	ngin	eerin	g fu	ndam	entals	and	an		
			engineering specialization to the solution of complex engineering problems is to apply.													to		
			In order to analyze the nuclear force, electron scattering, neutrino hypothesis and												ind			
		2	deuteron properties, identification, formulation, research literature and analysis of											of				
02-102		2	complex engineering problems reaching substantiated conclusions using first															
			principles of mathema	tics,	cs, natural sciences and engineering sciences are required								ed.					
~~~~~			fusion process, identi	ficat	ion.	forr	nula	tion	res	earc	h lit	eratu	re an	d ana	sion a ilvsis	of		
CO3-PO2		2	complex engineering	pro	olem	s re	achii	ng s	subst	antia	ated	conc	lusio	ns us	ing fi	irst		
			principles of mathema	ics, natural sciences and engineering sciences are required											ed.			
			In order to evaluate t	he r	ucle	ar fo	orce,	nuc	clear	read	ction	s me	thods	and	reacti	ion		
CO4-PO1		2	mathematics natural	ng a scie	g aspects of nuclear reactor safety, the knowledge of science, engineering fundamentals and an engineering													
			specialization to the so	olutio	on of	con	plex	i eng	gine	ering	g prol	blem	s is to	appli	ed.	шş		
TEACHING I	LEARNI	NG STRATH	EGY				,											
Teaching and I	Learning	Activities											E	ngag	emen	ıt		
														(hoi	ırs)			
	Face-to	-Face Learnin	ng															
		Lecture												42	2			
		Practical / Tu	utorial / Studio											-				
	Calf D'	Student-Cen	tred Learning										<u> </u>	-				
	Self-Di	Non face to	ng faca laarning											0.	1			
		Revision	face learning											2	+ 1			
	Formal	Assessment												<u> </u>	<u> </u>			
		Continuous	Assessment										2					
		Mid-Term											1					
		Final Examin	nation										3					
	Total												153					

#### **TEACHING METHODOLOGY**

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

#### **COURSE SCHEDULE**

eeensi se							
Weeks	Topics	Remarks					
Week-1	The nucleus: nuclear size, packing fraction and binding energy; radioactivity: radioactive decay laws						
Week-2	-2 Carbon dating, half-life and mean life						
Week-3	Radioactive series: alpha, beta and gamma emission, positron	Exam					
Week-4	Positron emission, electron capture, internal conversion, pair production and annihilation						
Week-5	Neutrino hypothesis, nuclear reaction	Class Test 2. Final					
Week-6	Nuclear fusion in stars; general properties of nucleus: nuclear density distribution	Exam					
Week-7	Iso-spin, magnetic moments, g-factor; the deuteron : ground state of deuteron						
Week-8	Deuteron ground state wave function, magnetic and quadruple moments of the deuteron	Mid					
Week-9	Neutron-proton scattering at low energies; scattering length	Term, Final					
Week-10	Spin dependence of n-p scattering, effective range theory in the n-p scattering; exchange	Exam					
Week-11	Coherent and incoherent scattering, nuclear force: central and non-central forces						
Week-12	Nuclear stability conditions; symmetry and charge effects; charge independence of nuclear force						
Week-13	Exchange forces; nuclear stability conditions; symmetry and charge effects; charge independence of nuclear force; mirror nuclei and coulomb energy, nuclear reactions: reaction cross-section, direct reactions: definition and classification	Class Test 3, Final Exam					
Week-14	The methods of direct reaction theory; analysis of stripping and pick-up reactions; magic numbers and nuclear shell model, l-s coupling scheme; j-j coupling scheme, collective model, optical model						

#### ASSESSMENT STRATEGY

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C3, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C3,C4
	Mid term	10%	CO3	C2
Final Examination		60%	CO1-CO4	C2,C3, C4,C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. R. R. Roy and B. P. Nigam, Nuclear Physics: Theory and Experiment, Wiley, 1967, Digitized 21 Nov 2007.
- 2. Irving Kaplan, Nuclear Physics, Narosa Book Distributors, 2002.
- 3. Kenneth S. Krane, *Introductory Nuclear Physics*, Wiley India, 2008.
- 4. H.M. Sen Gupta, Nucleo Padartha Bidya, 1967.
- 5. Meyerhof E. Walter, *Elements of Nuclear Physics*, McGraw-Hill, 1967, Digitized 21 Nov 2007.

#### **REFERENCE SITE**

#### Level-1, Term-II

	COURSE INFORMATION									
Course Code Course Title	: NE 141 : Fundamentals of Thermodynamics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00							
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	This course provides an introduction to the essential theoretical basis of engineering thermodynamic and its application to a range of problems, relevant to practical engineering as well as to equip to students with the basic tools and methodologies for carrying out thermodynamic analysis engineering systems.									
	OBJECTIVES									
	<ol> <li>To introduce the fundamentals of thermodyna between systems encountered in engineering.</li> <li>To incorporate the laws of thermodynamics at To understand the thermodynamic cycles.</li> <li>To formulate the thermodynamic relation to v</li> <li>To evaluate psychrometry and psychometric p</li> </ol>	amics and operating principle nd their corollaries. arious thermodynamic proce processes.	es of energy transfer sses.							
	LEARNING OUTCOMES									
	<ol> <li>Upon completion of the course, the students will be the fundamentals of thermodynamics is process of energy transfer.</li> <li>Explain the laws of thermodynamics to the the fundamental of thermodynamics is the fundamental of the fundamental of</li></ol>	be able to in solving various engineerin ermodynamic cycles and cyc	g problem related to lic devices.							
	<ol> <li>Interpret psychrometry and psychometric prod</li> <li>Analyze the thermodynamic relation to variou energy balance and conservation.</li> </ol>	cesses. Is thermodynamic processes u	using the equation of							

	COURSE OUTCOMES & GENERIC SKILLS													
No.	Co	ourse Learning Outcome	Corresp PC	onding Os	; ,	Bloon Taxono	n's omy	СР	С	A	KP	As N	sessm Iethod	ent ds
CO1	<b>Define</b> thermod engineer of energ	the fundamentals of ynamics in solving various ing problem related to process y transfer.	PC	01		C2		-		-	1	]	Г, Q, I	F
CO2	Explain to the the devices.	the laws of thermodynamics ermodynamic cycles and cyclic	PC	02		C3		-		-	1	A	ASG, I	F
CO3	Interpropriet	et the psychrometry and netric processes.	PC	02		C3		-		-	1	,	MT, F	7
CO4	Analyze various using th and cons	e the thermodynamic relation to thermodynamic processes e equation of energy balance servation.	PC	02		C4		-		-	2		T, F	
	(CP- Co ASG – A	mplex Problems, CA-Complex Assignment; Pr – Presentation; F	Activities R - Report	, KP-K t; F – F	now inal	ledge I Exam,	Profile MT-	e, T – Mid '	Test Term	; PF n Ex	R – Pro am)	oject ;	Q – Ç	Quiz;
	COUR	SE CONTENT												
	gases a volume cycle, Refrige Thermo process	nd vapours, properties of pu system, non-flow and flow Otto cycle, Diesel cycle; C ration cycles; Second La odynamics relations; Mixtur es.	re subst processe das pow w of ' e of ga	tances; s; Idea er cyc Therm ses ar	En El ga Eles Ody Ind	ergy a ases ar – Bra namic vapour	analy nd the ayton s; E rs. P	sis o eir cy cyc Introj sychi	f cor vcles ele; py rome	ntro : Id Vap and etry	ol mas leal cy our l exe and	ss and vcles Powe rgy psyc	d con – Ca r cyc analy home	ntrol rnot cles; vsis; etric
	SKILL	MAPPING(CO-PO MAPP	PING)											
		Γ												
	No.	Course Learning Outcome	e	2	2 2	ROGR	AM (		20M 8	ES (	(PO) 10	11	12	
	CO1	<b>Define</b> the fundamentals thermodynamics in solving va engineering problem relate process of energy transfer.	of trious d to	2	5	4 5		/	0	,	10	11	12	
	CO2	<b>Explain</b> the laws thermodynamics to thermodynamic cycles and o devices.	of the cyclic	2										
	CO3	<b>Interpret</b> the psychrometry psychometric processes.	and	2										
	CO4	Analyze the thermodyr relation to various thermodyr processes using the equation energy balance and conservation	namic namic on of on.	2										
HISTIFICA	(3 – Hig	h, 2- Medium, 1-low)			_					_				
JUSTIFICA	TION F	OK CO-PO MAPPING												

Mapping	Corresponding Level of Matching	Justification					
CO1-PO1	2	The knowledge of mathematics, science, engineering fundamentals is required to define the fundamentals of thermodynamics in solving various engineering problem related to process of energy transfer.					
CO2-PO2	2	In order to explain the laws of thermodynamics to the thermodynamic cycles and cyclic devices, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required					
CO3-PO2	2	In order to interpret the psychrometry and psychometric pro formulation, research literature and analysis of complex engineer substantiated conclusions using first principles of mathematics engineering sciences are required.	cesses, identification, ing problems reaching , natural sciences and				
CO4-PO2	2	In order to analyze the thermodynamic relation to various thermodynamic processes using the equation of energy balance and conservation, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.					
TEACHING	LEARNING STR	ATEGY					
Teaching and	Learning Activities	;	Engagement (hours)				
	Face-to-Face Learning Lecture Practical / Tutorial / Studio						
	Self-Directed Learning Non-face-to-face learning Revision						
	Formal Assessmen Continuou Mid-Term Final Exar	it is Assessment inination	2 1 3				
	Total		153				
TEACHING	; METHODOLOG	Y					
Lecture and I	Discussion, Co-operation	ative and Collaborative Method, Problem Based Method					
COURSE S	CHEDULE						
Week-1	Fundamental conce	epts, energy and energy transfer	Class Test				
Week-2	First Law of Thermodynamics     1, Fir						
Week-3	Properties of gases and vapours Exam						
Week-4	Properties of pure	substances	Close Teet				
Week-5	Energy analysis of	control mass and control volume system	2, Final				
Week-6	Non-flow and flow processes         Exam						

Week-7	Ideal gases and their cycles: Carnot cycle, Otto cycle, Diesel cycle	
Week-8	Ideal gases and their cycles: Brayton cycle; Vapour power cycles	
Week-9	Second Law of Thermodynamics; Entropy and exergy analysis	Mid Term, Final Exam
Week-10	Thermodynamics relations	
Week-11	Mixture of gases and vapours	
Week-12	Psychrometry and psychometric processes	Class Test
Week-13	Psychrometry and psychometric processes	Exam
Week-14	Revision	

	Components	Grading	CO	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C3, C4
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO2	C3
	Mid term	10%	CO3	C3
Final Examination (60%)		60%	CO1-CO4	C2-C4
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Yunus A. Cengel, Michael A. Boles , *Thermodynamics: An Engineering Approach*, 4th Edition, McGraw-Hill, 2004.
- 2. A W Culp , Principles of Energy Conversion , 2nd Edition, McGraw-Hill, 1991.
- 3. R. S. Khurmi & J. K. Gupta, A Text Book of Thermal Engineering, 14th Edition, Chand, 1997.
- 4. R K Rajput, Basic Mechanical Engineering, Laxmi Publications Pvt Limited, 2008.
- 5. Ahmadul Ameen, Refrigeration and Air conditioning, PHI Learning Pvt. Ltd., 2006.
- 6. Michael J. Moran & Howard N. Shapiro, *Fundamentals of Engineering Thermodynamic*,7th Edition, John Wiley & Sons, 2010.
- 7. R E Sonntag, C. Borgnakke, G J. Van Wylen, Fundamentals of Thermodynamics, 7th Edition, 2014.

#### **REFERENCE SITE**

# Level-1, Term-I

	COURSE INFORMATION									
Course Code Course Title	LANG 172 Introduction to Russian Language-I	ssian Language-I Lecture Contact Hours : 1.50 Credit Hour : 0.75								
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	This course has mainly been designed to improve speaking and oral communication skills of the students. The course includes instructions and experience in speech preparation and speech delivery within various real-life situations, formal and informal. Emphasis will be given on various speeches, such as informative, persuasive and interactive. This course will help students progress in real life both personally and professionally. Students will be able to understand class lectures and can comfortably continue the Engineering course, and also to compete in the global job market and increase career skills.									
	OBJECTIVES									
	<ol> <li>To develop the four basics skills of Russian language, i.e. listening, speaking, reading and writing.</li> <li>To develop students' interpersonal skills engaging them in various group interactions and activities.</li> <li>To improve students' pronunciation in order to improve their level of comprehensibility in both speaking and listening.</li> <li>To give the students exposure to different types of texts in Russian language in order to make them informed using different techniques of reading.</li> <li>To gain an understanding of the underlying writing well-organized paragraphs and also to teach how to edit and revise their own as well as peer's writing</li> </ol>									
	LEARNING OUTCOME									
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Listen, understand, and learn the techniques of note taking and answering questions.</li> <li>Understand reading techniques and speak Russian language quickly and smartly using the techniques learnt in the class.</li> <li>Communicate effectively within the shortest possible time to present their ideas and opinions.</li> <li>Develop competency in reading, writing and oral communication /presentation</li> </ol>									
	COURSE OUTCOMES & GENERIC	C SKILLS								
No.	Course Learning Outcome	Correspond ing POs	Bloom's Taxonomy	CP C	KP	Assessment Methods				
CO1	Listen, <b>understand</b> , and <b>learn</b> the techniques of note taking and answering questions.	PO1	C2		1	ASG, Q				

CO2	Underst Russian techniqu	and reading techniques and speak quickly and smartly using the les learnt in the class.	PO	D1		C3	-		-	1	AS	G/ Pr, Q
CO3	Commu shortest and opin	<b>nicate effectively</b> within the possible time to present their ideas ions.	PC	010		C4	-		-	1		Pr, Q
CO4	<b>Develop</b> and oral	competency in reading, writing communication /presentation.	PC	010		C3	-		-	2	AS	G/ Pr, Q
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)											
	COURSE CONTENT											
	<ul> <li>Introduction to Language: Introducing basic skills of language, Russian language for Science and Technology.</li> <li>Self-introduction and introducing others: How a speaker should introduce himself to any stranger/ unknown person/ a crowd; name, family background, education, experience, any special quality/interest, likings/disliking, etc. asking and answering questions, expressing likings and disliking (food, fashion etc.); asking and giving directions, discussing everyday routines and habits, making requests/ offers/ invitations/ excuses/ apologies/ complaints, describing personality, discussing and making plans (for a holiday or an outing to the cinema), describing pictures/ any incident/ event, practicing storytelling, narrating personal experiences/Anecdotes, telephone conversations (role play in group or pair), situational talks/ dialogues: practicing different professional conversation (role play of doctor-patient conversation, teacher–student conversation).</li> <li>Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions, Listening to short conversations between two persons/more than two persons.</li> <li>Reading techniques: scanning, skimming, predicting, inference; Reading Techniques: analysis, summarizing and interpretation of texts.</li> <li>Introductory discussion on writing, prewriting, drafting; Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event.</li> </ul>											
	SKILL	MAPPING (CO-PO MAPPIN	G)									
					DBU	GRAN	1 017	$\Gamma \cap \Gamma$	MES	(PO)		
	No.	Course Learning Outcome	1	2	3 4		6 7	8	9	10	11	12
	CO1	Listen, <b>understand</b> , and <b>learn</b> the techniques of note taking and answering questions.	e 1 3									
	CO2	<b>Understand</b> reading technique and speak Russian quickly and smartly using the techniques learn in the class.	$\begin{bmatrix} s \\ 1 \\ t \end{bmatrix} 3$									
	CO3	<b>Communicate effectively</b> within the shortest possible time to present their ideas and opinions.	n t							2		
	CO4	<b>Develop</b> competency in reading writing and oral communication /presentation.	, 1							1		
	(3 – High, 2- Medium, 1-low)											

JUSTIFICATION FOR CO-PO MAPPING								
Mapping	Corresponding Level of Matching	Justification						
CO1-PO1	CO1-PO1 3 In order to listen, understand, and learn the techniques of note taking and answering questions, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.							
CO2-PO1	CO2-PO1 3 In order to listen, understand, and learn the techniques of note taking and answering questions, identification, formulation, research literature and analysi of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required							
CO3-PO10	CO3-PO10 2 In order to communicate effectively within the shortest possible time to prese their ideas and opinions, it is required to communicate effectively on comple engineering activities with the engineering community and with society at larg such as being able to comprehend and write effective reports and desig documentation, make effective presentations, and give and receive cle instructions.							
CO4-PO10	CO4-PO10 1 In order to develop competency in reading, writing and oral communication is required to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, manual effective presentations, and give and receive clear instructions.							
<b>TEACHING I</b>	LEARNING STRATI	EGY						
Teaching and I	Engagement (hours)							
	Face-to-Face Learnin	ng						
	Lecture							
	Practical / T	Practical / Tutorial / Studio						
	Student-Cen	tred Learning	-					
	Self-Directed Learnin	ng of Loh Donosto	1.4					
	Preparation	of Lab Test	14					
	Preparation of preser	of Lab Test	9					
	Formal Asse	ssment	,					
	Continuous	Assessment	14					
	Fina	1 Quiz	1					
	Total	-	90					
TEACHING N	METHODOLOGY							
Discussion, Pa Method	rticipation, Pair Work	, Group Presentation, Co-operative and Collaborative and	student-centred					
COURSE SCI	COURSE SCHEDULE							
Weeks		Topics	Remarks					
Week-1	Introduction to Lang Science and Technol	guage: Introducing basic skills of language, Russian for ogy						
Week-2	Self-introduction an himself to any strang education, experience Asking and answerin	d introducing others: How a speaker should introduce er / unknown person / a crowd; name, family background, e, any special quality/interest, likings/disliking, etc.	Participation/ Assignment, Quiz					
Week-3								

Week-4	Discussing everyday routines and habits, making requests/ offers/ invitations/ excuses/ apologies/ complaints				
Week-5	Week-5 Describing personality, discussing and making plans (for a holiday or an outing to the cinema), describing pictures / any incident / event				
Week-6	Week-6 Practicing storytelling, narrating personal experiences/ anecdotes				
Week-7	Telephone conversations (role play in group or pair); situational talks / dialogues: practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)				
Week-8	Listening and understanding: Listening, note taking and answering questions				
Week-9	Students will listen to recorded text, note down important information and later on will answer to some questions				
Week-10	Listening to short conversations between two persons/more than two persons				
Week-11	Reading techniques: scanning, skimming, predicting, inference				
Week-12	Reading techniques: analysis, summarizing and interpretation of texts	Assignments/			
Week-13 Introductory discussion on writing, prewriting, drafting; topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event		Presentation, Quiz			
Week-14	Paragraph writing, Compare-contrast and cause- effect paragraph				

	Components	Grading	СО	Blooms Taxonomy
Continuous Assessment	Class Participation/ Assignment	20%	CO1, CO2, CO4	C2, C3
	Reading Test	15%	CO1, CO2, CO4	C2, C3
(40%)	Listening Test	15%	CO1, CO2, CO4	C2, C3
	Public Speaking	20%	CO2, CO3, CO4	C3-C5
Group Presentation		30%	CO2-CO4	C2-C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Z. I. Yesina, E.R Maxinova, *Lesions in Russian Phonetics*, Russky Yazyk, 1990.
- 2. Gulnara Useinova, Russian in an Easy Way for Beginners, St. Petersburg : Zlatoust, 2000.

#### **REFERENCE SITE**

# Level-1, Term-II

	COURSE INFORMATION											
Course Code Course Title	LANG 174Lecture Contact Hours: 1.50Introduction to Russian Language-IICredit Hour: 0.75											
	PRE-REQUISITE				1							
	LANG 172											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/RATIONALE											
	The Russian language course is designed for the students to develop their competence in communication skills for academic purposes especially in reading and writing. The approach will be communicative and interactive and will involve individual, pair and group work. Students will be exposed to different types of texts to develop efficient reading skill. Reading will also involve activities and discussions leading to effective writing. The course incorporates a wide range of reading texts to develop students' critical thinking which is one of the most essential elements required to write a good piece of academic writing. Emphasis is particularly put on the various forms of essay writing such as descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, students are expected to be able to communicate at various situations, participate in group activities and prepare formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. In addition, the course emphasizes on providing constructive feedback on students' or parformances											
	OBJECTIVES											
	<ol> <li>To develop Russian language skills to con</li> <li>To strengthen students' presentation skills</li> <li>To develop competency in academic reading</li> </ol>	nmunicate effe s. ing and writing	ctively and	profes	siona	lly.						
	LEARNING OUTCOMES											
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Understand the techniques of academic reading and become familiar with technical terms and develop competency in academic reading, preparing report written communication/ presentation.</li> <li>Analyse any problem critically, analyse and interpret data and synthesize information to provide valid conclusions.</li> <li>Communicate effectively within the shortest possible time to present their reports and academic writings.</li> <li>Apply the techniques to find out the main points of any long article within a very limited time as well as larger the techniques of arm effective present.</li> </ol>											
	<b>COURSE OUTCOMES &amp; GENERIC SKI</b>	LLS		-								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP C	A KP	Assessment Methods						
CO1	<b>Understand</b> the techniques of academic reading and become familiar with technical terms and <b>develop</b> competency in academic reading,	PO1	C2		1	ASG, Q						

	preparin	g report written communication/													
CO2	Analyse interpret provide	e any problem critically, analyse and t data and synthesize information to valid conclusions.			C4		-	-	1	A	SG/ Pi	r, Q			
CO3	Commu possible academi	<b>inicate effectively</b> within the shortest time to present their reports and c writings.	)		C6		-	-	1		Pr, Q	)			
CO4	Apply the of any le well as writing.	he techniques to find out the main points ong article within a very limited time as know the techniques of any effective	PO10	)		C3		-	-	2	A	SG/ Pi	r, Q		
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)														
	COUR	COURSE CONTENT													
	departm for both Writing and Cur editing, argumen charts; I Public S Speech: Individu preparin Listenin accents.	nental or subject related passages; Vocabu general and dept specific); Reading sub semi-formal, Formal/official letters, Off rriculum Vitae; Essay writing: writing proofreading; Narrative and descriptive ntative and opinion expression, assign Practicing analytical and argumentative Speaking: Basic elements and qualities of How to get ready for any speech – set of tal / Group presentation: How to be reading power point slides, etc. Selected book and to long lecture on some topics; Lister	ulary for E bject specif ficial E-ma steps, prin we writing ment writ writing. of a good p or extempo ady for pro- as/Selected hing and u	ngine fic tex iil; Ap iciple : con ing; publio ore. esenta l stori nders	eers (s at to c oplyin s and nparis Analy c spe- ation, es fo tandi	some level- ng for l tech son-c- yzing aker; prep r prep r pres ng sp	con op v r a jo niniq ontr an Set Set senta	nm /oc ob: ues cast d ( Sp sci atic hes	on E abul Wri 3, ou : and desc : and desc ript on. s/lec	Engi lary iting iting d ca ribi h an for	ineer g Co uing, ause ng g nd E goo es of	ing te ver Le revis – eff graphs xtemp d spee	rms etter ing, fect, s or oore ech, rent		
	SKILL	MAPPING (CO-PO MAPPING)													
				PROGRAM OUTCOMES (PO)											
	No.	Course Learning Outcome		1 2	3	4 5	6	7	8	9	10	11	12		
	CO1	<b>Understand</b> the techniques of academic and become familiar with technical te <b>develop</b> competency in academic preparing report written commu- presentation.	<b>Understand</b> the techniques of academic reading nd become familiar with technical terms and <b>levelop</b> competency in academic reading, for preparing report written communication/												
	CO2	<b>Analyse</b> any problem critically, anal interpret data and synthesize inform provide valid conclusions.	Analyse any problem critically, analyse and interpret data and synthesize information to provide valid conclusions. Communicate effectively within the shortest possible time to present their reports and academic writings.												
	CO3	<b>Communicate effectively</b> within the possible time to present their report academic writings.									2				
	CO4	<b>Apply</b> the techniques to find out the ma of any long article within a very limited well as know the techniques of any writing.	in points l time as effective								1				
	(3 – Hig	h, 2- Medium, 1-low)													

JUSTIFICATION FOR CO-PO MAPPING											
Mapping	Corresponding Level of Matching	Justification									
CO1-PO1	3	In order to understand the techniques of academic reading and with technical terms and develop competency in academic report written communication/ presentation, the knowledge natural science, engineering fundamentals and an engineering sp solution of complex engineering problems is to applied.	l become familiar eading, preparing of mathematics, pecialization to the								
CO2-PO1	3	In order to analyse any problem critically, analyse and is synthesize information to provide valid conclusions, the mathematics, natural science, engineering fundamentals and specialization to the solution of complex engineering problems	nterpret data and e knowledge of d an engineering is to applied.								
CO3-PO10	2	In order to communicate effectively within the shortest possib their reports and academic writings, it is required to communic complex engineering activities with the engineering communit at large, such as being able to comprehend and write effective documentation, make effective presentations, and give a instructions.	le time to present cate effectively on y and with society reports and design nd receive clear								
CO4-PO10	PO10 1 In order to apply the techniques to find out the main points of any long article within a very limited time as well as know the techniques of any effective writing, it is required to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.										
TEACHING	LEARNING STRATI	EGY									
Teaching and I	Learning Activities		Engagement (hours)								
	Face-to-Face Learnin Lecture Practical / T Student-Cen	ng utorial / Studio tred Learning	14 28								
	Self-Directed Learni Preparation Preparation	ng of Lab Reports of Lab Test	14 10								
	Preparation of preser Preparation Engagement	ntation of Quiz in Group Projects	9 - -								
	Continuous Final Quiz	Assessment	<u>14</u> 1								
TEACHING	METHODOLOGY		90								
Discussion, Pa Learning Meth	rticipation, Pair Work	, Group Presentation, Co-operative and Collaborative and	l student-centred								
COURSE SCI	HEDULE										
Weeks		Topics	Remarks								
Week-1	Reading Comprehens	ding Comprehension: Practice using different techniques Participation,									
Week-2	Academic reading: co	mprehension from departmental or subject related passages	Quiz								

Week-3	Vocabulary for Engineers (some common Engineering terms for both general and dept specific), reading subject specific text to develop vocabulary					
Week-4	Writing semi-formal, formal/official letters, official e-mail					
Week-5	Applying for a job: Writing Cover Letter and Curriculum Vitae	Assignment				
Week-6	Week-6         Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading           Numerities         Superities         Superities					
Week-7	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing					
Week-8	Analyzing and describing graphs or charts					
Week-9	Practicing analytical and argumentative writing					
Week-10	Public Speaking: Basic elements and qualities of a good public speaker					
Week-11	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore					
Week-12	Individual/ group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. selected books/selected stories for presentation	Presentation, Quiz				
Week-13	Listening to long lecture on some topics					
Week-14	Listening and understanding speeches/lectures of different accents					

	Components	Grading	CO	<b>Blooms Taxonomy</b>
Continuous Assessment	Class Participation/ Assignment	20%	CO1, CO2, CO4	C2-C4
	Reading Test	15%	CO1, CO2, CO4	C2-C4
(40%)	Listening Test	15%	CO1, CO2, CO4	C2-C4
	Public Speaking	20%	CO2, CO3, CO4	C3, C4, C6
Group Presentation		30%	CO2-CO4	C3, C4, C6
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Z. I. Yesina, E.R Maxinova, Lesions in Russian Phonetics, Russky Yazyk, 1990.
- 2. Gulnara Useinova, Russian in an Easy Way for Beginners, St. Petersburg : Zlatoust, 2000.

#### **REFERENCE SITE**

### Level-2, Term-I

#### **COURSE INFORMATION**

Course Code Course Title	: NE 203 : Introduction to Nuclear and Radio Ch	nemistry	Lecture Contact Credit Hours	Hours		: 3.0 : 3.0	)0 )0						
	PRE-REQUISITE	<b>1</b>				<u> </u>							
	CHEM 101												
	CURRICULUM STRUCTURE												
	Outcome Based Education (OBE)												
	SYNOPSIS/RATIONALE												
	This course is designed to introduce the basic concept of Nuclear and Radio Chemistry and understand the nature of nuclear reaction and its mechanisms.												
	OBJECTIVES												
	<ol> <li>To understand the concept of nuclear and radiochemistry.</li> <li>To know about the nature of nuclear reaction and reaction mechanisms.</li> <li>To understand the concepts of stability of nuclear material.</li> <li>To know the application of radioisotope in different sector.</li> <li>To know about separation of radioisotopes and introduce different separation method.</li> </ol>												
	LEARNING OUTCOMES												
	<ol> <li>Upon completion of the course, the standard concepts of n nuclear and chemical reaction.</li> <li>Analyse stability of nuclear mat analysis using radiotracers, isotop</li> <li>Explain production of radionucli radioisotope in different sector.</li> <li>Evaluate decay law, half-life, mea like solvent extraction method, ice</li> </ol>	tudents will uclear react erial, activa pe dilution ides, enviro an life, radi on exchange	l be able to tion and reaction r ation analysis of a analysis, and deca onmental aspects of oactive equilibriu e method etc.	nechar radioad ny chai of radi m, diff	nisms, ctive r n anal onucli erent s	and co nateria ysis. de, ap separa	ompare with al, chemical oplication of ation method						
	COURSE OUTCOMES & GENER	RIC SKILI	ĴS										
No.	Course Learning Outcome	Correspond POs	ling Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	<b>Apply</b> fundamental concepts of nuclear reaction and reaction mechanisms, and compare with Nuclear and chemical reaction.	PO1	C3	1	-	3	T, Q, F						
CO2	Analyse stability of nuclear material, activation analysis of radioactive material, chemical analysis using radiotracers, isotope dilution analysis, and decay chain. analysis	PO1, PO2 PO3	^{2,} C4	2	-	4, 5	ASG, F						
CO3	<b>Explain</b> production of radionuclides, environmental aspects of radionuclide, application of radioisotope in different sector.	PO1, PO	3 C2	1	-	4	MT, F						

CO4	Evaluat life, rad separatio extractio method	e decay law, ioactive equilil on method on method, etc.	half-life, mean prium, different like solvent ion exchange	nalf-life, mean rium, different like solvent PO1 on exchange				C5			2		1	3		T, F		
	(CP- Co Quiz; A	mplex Problen SG – Assignme	ns, CA-Complex ent; Pr – Presenta	Activi tion; R	ties, - Re	KP-	Kno ; F -	wled - Fina	ge I al E	Profi xam,	le, T , MT-	– Te Mio	est ; d Te	PR – erm Ex	Proje am)	ect;Q	<b>)</b> –	
	COUR	SE CONTEN	T															
	History stability radionu radioac inducec differer of cesiu radioiso	History of nuclear and radio chemistry; Definitions (atomic nucleus, isotopes etc.); Mass and stability of the atomic nucleus, production of radionuclides, environmental aspects of radionuclide; Detection and measurement of radioactivity; Activation analysis of different radioactive material; Nature of nuclear reaction and reaction mechanisms; Chemical effects induced by nuclear reactions, chemical analysis using radiotracers; Separation of radioisotopes: different separation method like solvent extraction method, ion exchange method etc., separation of cesium, strontium, plutonium, americium etc., isotope dilution analysis, and application of radioisotope in different sector.												nd of ent ets es: on of				
	SKILL	SKILL MAPPING (CO-PO MAPPING)																
	No.	Course I	Course Learning Outcome					PROGRAM OUTCOMES (PO								11 12		
	CO1	Apply fundation nuclear real mechanisms, Nuclear and other sectors.	undamental concepts of reaction and reaction ms, and compare with nd chemical reaction							-		_	-					
	CO2	Analyse st material, ac radioactive analysis usin dilution analy analysis	ability of nu tivation analysi material, che g radiotracers, is ysis, and decay o	iclear is of mical otope chain.	2	2	2											
	CO3	Explain radionuclides aspects of rad of radioisotop	production , environm lionuclide, applic be in different sec	of nental cation ctor.	3		3											
	CO4	<b>Evaluate</b> dec life, radio different sep solvent extr exchange me	aluate decay law, half-life, mean radioactive equilibrium, ferent separation method like vent extraction method, ion change method etc.															
	(3 – Hig	h, 2- Medium,	1-low)															
JUSTIFICAT	ION FO	R CO-PO M	APPING															
Mapping	Corre Level o	esponding of Matching					Jı	ıstif	icat	ion								
CO1-PO1		2	In order to ap mechanisms, an measurement o	pply f nd con f radic	unda nparo activ	imen e wi vity,	tal th n the	conc uclea knov	epts ar a wlec	of nd c lge d	nucl hemi of ma	ear cal 1 ather	read reac natio	ction tion, o cs, na	and detect tural	reacti tion a scien	on nd ce,	

		engineering fundamentals and an engineering specialization complex engineering problems is to be applied	to the solution of								
CO2-PO1	2	In order to analyse stability of nuclear material, activation and material, chemical analysis using radiotracers, isotope dilution chain analysis, the knowledge of mathematics, natural sc fundamentals and an engineering specialization to the sol engineering problems is to applied.	lysis of radioactive analysis, and decay ience, engineering ution of complex								
CO2-PO2	2	In order to analyse stability of nuclear material, activation and material, chemical analysis using radiotracers, isotope dilution chain analysis, identification, formulation, research literatur complex engineering problems reaching substantiated conc principles of mathematics, natural sciences and engineering sci	lysis of radioactive analysis, and decay re and analysis of lusions using first ences are required.								
CO2-PO3	2	In order to analyse stability of nuclear material, activation and material, chemical analysis using radiotracers, isotope dilution chain analysis, it is required to design solutions for complex en- and design systems, components or processes that meet spe appropriate consideration for public health and safety, cult environmental considerations.	lysis of radioactive analysis, and decay gineering problems ecified needs with ural, societal, and								
CO3-PO1	3 In order to explain production of radionuclides, environmental aspects of radionuclide, application of radioisotope in different sector, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.										
CO3-PO3	3 3 3 In order to explain production of radionuclides, environmental aspects of radionuclide, application of radioisotope in different sector, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.										
CO4-PO1	2	In order to evaluate decay law, half-life, mean life, radioa different separation method like solvent extraction method, ion etc., the knowledge of mathematics, natural science, engineering an engineering specialization to the solution of complex engin to applied.	active equilibrium, n exchange method g fundamentals and leering problems is								
CO4-PO2	2	In order to evaluate decay law, half-life, mean life, radioa different separation method like solvent extraction method, ion etc. identification, formulation, research literature and an engineering problems reaching substantiated conclusions using mathematics, natural sciences and engineering sciences are req	active equilibrium, n exchange method alysis of complex g first principles of uired.								
<b>TEACHING I</b>	LEARNING STRATI	EGY									
Teaching and I	Learning Activities		Engagement (hours)								
	Face-to-Face Learnin Lecture	ng	42								
	Practical / T	utorial / Studio	-								
	Self-Directed Learni	ng	-								
	Non-face-to- Revision	-face learning	84 21								
	Formal Assessment		21								
	Continuous	Assessment	2								
	Mid-Term	nation	1								
	Total	nation	153								
TEACHING N	METHODOLOGY										

Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method	
COURSE SCI	HEDULE	
Weeks	Topics	Remarks
Week-1	History of nuclear and radio chemistry; definitions (atomic nucleus, isotopes etc.), decay law, half-life	
Week-2	Mean life, nature of nuclear reaction	Class Test 1. Final
Week-3	Mass and stability of the atomic nucleus, chemical effects induced by nuclear reactions	-,
Week-4	Radioactive equilibrium	
Week-5	Nuclear reaction mechanisms	Class Test
Week-6	Detection and measurement of radioactivity	2 Final
Week-7	Production of radionuclides	
Week-8	Environmental aspects of radionuclide ,chemical analysis using radiotracers	
Week-9	Activation analysis of radioactive material	Mid Term Final
Week-10	Different separation methods, solvent extraction method, ion exchange method	
Week-11	Separation of cesium, strontium	
Week-12	Separation of plutonium, americium etc.	Class Test
Week-13	Isotope dilution analysis	3 Final
Week-14	Application of radioisotope in different sector	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	C01	C3
	Mid term	10%	CO3	C2
Final Examination		60%	CO1-CO4	C2-C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Navratil O. et. al. Nuclear Chemistry 2nd Edition, Cambridge, 1992
- 2. Gerhart Friedlander, Joseph W. Kennedy, Edward S. Macias, Julian M. Miller *Nuclear and Radiochemistry* 3rd Edition, Toronto, Wiley-Interscience Publication, 1981
- 3. Peter A C Mcpherson *Principle of Nuclear Chemistry* 1st Edition, London, World Scientific Publishing Europe Ltd., 2017

#### **REFERENCE SITE**

# Level-2, Term-I

	COURSE INFORMATION													
Course Code Course Title	: NE 204 : Introduction to Nuclear and Radio Chemistry Sessional		Lect	ture Contact ] dit Hours	Hours		: 1.: : 0.'	50 75						
	PRE-REQUISITE													
	NE 203													
	CURRICULUM STRUCTURE													
	Outcome Based Education (OBE)													
	SYNOPSIS/RATIONALE													
	To learn and familiarize the basics of Nuclear and radiochemistry.													
	OBJECTIVES													
	To verify practically the theories and concepts learned in NE 203.													
	LEARNING OUTCOMES													
	Upon completion of the course, the students will be able to understand and analyse the basic nuclear and chemical properties of nuclear material and radio isotopes.													
	COURSE OUTCOMES & GENERIC SKILLS													
No.	Course Learning Outcome	Correspond POs	ding	Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	<b>Apply</b> fundamental concepts of detection and measurement of radioactivity.	PO1, PC	)4	C3	1	-	4	R, Q, T						
CO2	<b>Analyse</b> different separation method like solvent extraction method, ion exchange method etc. for various radioisotopes.	PO2, PC	)4	C4	1	-	4	R, Q, T						
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, F tion; R - Rep	KP-Kn port; F	10wledge Profi 7 – Final Exam	ile, T - , MT- 1	- Test Mid Te	; PR – erm Ex	Project ; Q – am)						
	COURSE CONTENT													
	<ol> <li>Measurement of external dose us</li> <li>Preparation and measurements system: soil, water and food stuf</li> <li>Effect of shielding materials in r</li> <li>Calibration of Gamma spectrom terms of energy and activity.</li> <li>Survey of background radiation</li> <li>Separation of radioisotopes i.e. c</li> </ol>	sing Therm for enviro f. adiation pro netry, alpha using Surve cesium, stro	olumi onmer otectio spec ey me ontiun	inesence Dos ntal samples on. trometry, and eter and GPS. a, plutonium,	imeter using l ZnS ameri	· (TLE g Gan Scinti	)). nma s illation etc.	spectrometry n Counter in						

	SKILL MAPPING (CO-PO MAPPING)																
	No	Course I	earning Outcome			Р	ROC	GRA	M (	DUT	CON	1ES	(PO)				
	NO.			1	2	3	4	5	6	7	8	9	10	11	12	_	
	CO1	Apply fund detection an radioactivity.	amental concepts of nd measurement of	2			3										
	CO2	Analyse of method like method, ion for various ra	lifferent separation e solvent extraction exchange method etc. dioisotopes.		2		3										
	(3 – Hig	h, 2- Medium,	1-low)														
JUSTIFICATION FOR CO-PO MAPPING																	
Mapping	Corre Level o	esponding of Matching				Ju	stif	icat	tion								
CO1-PO1		2 In order to apply fundamental concepts of detection and radioactivity, the knowledge of mathematics, natural scie fundamentals and an engineering specialization to the sol engineering problems are to apply.									d me ience lutior	asure , eng 1 of	ment jineer comp	of ing olex			
CO1-PO4		3 In order to apply fundamental concepts of detection and radioactivity, ability to design and conduct experiments, as we interpretation of data.									n and measurement of as well as to analyse and				of and		
CO2-PO2		2 In order to analyze different separation method like solvent ext exchange method etc. for various radioisotopes, identific research literature and analysis of complex engineering substantiated conclusions using first principles of mathematic and angineering sciences are required								extraction method, ion ification, formulation, ig problems reaching natics, natural sciences			ion on, ing ces				
CO2-PO4		3	In order to analyze diff exchange method etc. experiments, as well a	ferer for s to a	t sep vari analy	arati ous vse ai	on n radio nd in	neth Diso Iterr	od li tope oreta	ke so s, at tion	olver oility of da	nt ext to o ata.	traction method, ion design and conduct				
TEACHING I	LEARNI	NG STRATH	CGY		Ť			Î									
Teaching and I	Learning A	Activities											E	ngag (hou	emei	nt	
	Teachin	ng and Learnin	ng Activities										Eng (ho	gager	nent		
	Student	Face-to-Face Lecture Practical / Tu -Centred Lear	E Learning Itorial / Studio											1.2	4 8		
		Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test									1-	4					
		Pre	paration of Presentati	on										9	)		
	-	Formal Assessment Continuous Assessment Final Quiz											- 14 1	4			
	Total	`											1	9	0		
TEACHING N	METHO	DOLOGY															
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

#### COURSE SCHEDULE

Weeks	Topics	Remarks					
Week-1	Measurement of external dose using Thermoluminesence Dosimeter (TLD)						
Week-2	Preparation and measurements for environmental samples using Gamma spectrometry system: soil, water and food stuff						
Week-3	Effect of shielding materials in radiation protection						
Week-4	Calibration of Gamma spectrometry, alpha spectrometry, and ZnS Scintillation Counter in terms of energy and activity						
Week-5	Survey of background radiation using Survey meter and GPS						
Week-6	Separation of radioisotopes i.e. cesium, strontium, plutonium, americium etc.						
Week-7	Practice Lab, Quiz Test, Project submission						

### ASSESSMENT STRATEGY

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Lab participation and Report	20%	CO 1, CO2	C3, C4
Assessment	Labtest-1, Labtest-2	40%	CO1, CO2	C3, C4
(40%)	Viva Voce	15%	CO1, CO2	C3, C4
	Lab Quiz	25%	CO1, CO2	C3, C4
	Total Marks	100%		1

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

 Attila Vértes, Sándor Nagy, Zoltán Klencsár, Rezso György Lovas, Frank Rösch – Handbook of Nuclear Chemistry: Vol. 1 – 2nd Edition, NY, Springer Science & Business Media, 2011

**REFERENCE SITE** 

	COURSE INFORMATION								
Course Code Course Title	NE 207 Reactor Theory and Analysis – I	Lecture Contact Hours Credit Hours	: 3.00 : 3.00						
	PRE-REQUISITE								
	NSE 101								

	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	This course is designed to explore the fundamental properties of neutron transport and thermal nuclear reactor.								
	OBJECTIVES								
	<ol> <li>To introduce the neutron transport and diffusion theory.</li> <li>To understand fundamental properties of the NTE, neutron interactions and development of one-group neutron diffusion theory.</li> <li>To discuss the basic definitions and concepts of chain-reacting systems.</li> <li>To understand the reactivity effects of reactor power and transmutation of radionuclide in nuclear reactors.</li> </ol>								
	LEARNING OUTCOMES								
	Upon completion of the course, the students will be able to								
	<ol> <li>Apply neutron transport and diffusion theory in various reactor core configurations.</li> <li>Analyze the diffusion theories depending on source geometry.</li> <li>Explain the basic concepts and definitions of chain-reacting systems.</li> <li>Evaluate the reactivity effect and Doppler Effect on reactor power.</li> </ol>								
	COURSE OUTCOMES & GENERIC SKILLS								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Apply</b> neutron transport and diffusion theory in various reactor core configurations.	PO1, PO2	C3	-	-	3	T, Q, F		
CO2	<b>Analyze</b> the diffusion theories depending on source geometry.	PO3	C4	-	-	4	T, ASG, F		
CO3	<b>Explain</b> the basic concepts and definitions of chain-reacting systems.	PO2, PO3	C2	-	-	4	MT, F		
CO4	<b>Evaluate</b> the reactivity effect and Doppler Effect on reactor power.	PO1, PO3	C5	-	-	3	T, F		
	(CP- Complex Problems, CA-Complex A Quiz; ASG – Assignment; Pr – Presentat	Activities, KP-Kn tion; R - Report; F	owledge Profil 7 – Final Exam	e, T – , MT-	Test ; F Mid Te	PR – Pi erm Ex	roject ; Q – am)		
	COURSE CONTENT								
	<b>COURSE CONTENT</b> Neutron transport: Four and six-factor formula, neutron transport and diffusion theory, derivation of the Neutron Transport Equation (NTE), fundamental properties of the NTE, neutron interactions and development of one-group neutron diffusion theory with point, plane, and fission sources, application to one-and two-region reactors, introduction to buckling, multiplication constants, critical size, neutron slowing down, and resonance capture, applications using two-group theory, methodologies of neutron flux calculations. The chain-reacting systems, thermal nuclear reactor, the calculation of the multiplication factor for a homogenous thermal reactor, heterogeneous thermal reactor, the critical size of a thermal reactor, power and breeding, fission and fusion reaction, fission characteristics, chain reaction,								

SKILL MAPPING (CO-PO MAPPING)           No.         Course Learning Outcome         PROGRAM OUTCOMES (PO)           (O1         Apply neuron transport and diffusion theory         3         3         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1		power, in-hour equation, delay neutron, doppler effect, production and transmutation of radionuclide in nuclear reactors.															
No.         Course Learning Outcome         I 2 3 4 5 6 7 8 9 10 11 12           COI         Apply neutron transport and diffusion theory in various reactor core configurations.         3 3         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1		SKILL	MAPPING	(CO-PO MAPPING)													
No.         Course Learning Outcome         PROGRAM OUTCOMES (PO)           11         2         3         4         5         6         7         8         9         10         11         12         3         4         5         6         7         8         9         10         11         12         3         3         1         1         1         11         12         3         3         1         1         1         10         11         12         3         3         1         1         1         1         11         12         3         3         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1																	
Col       Apply neutron transport and diffusion theory       3       3       4       5       6       7       8       9       10       11       12         C01       Apply neutron transport and diffusion theories depending on invarious reactor core configurations.       3       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		No.	Cou	urse Learning Outcome			PR	06	RA	M	OU	TC	OM	1ES (	PO)	1.1.0	
C01       Fraction code configurations.       3       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1			Apply neutro	n transport and diffusion theory	1	2	3	4	5	6	7	8	9	10	11	12	-
CO2         Analyze the diffusion theories depending on chain reacting systems.         2         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <th1< th="">         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         <th1< th=""> <th1< th="">         1</th1<></th1<></th1<>		CO1	in various rea	ctor core configurations.	3	3											
Bottlety:         Cool         Explain the basic concepts and definitions of chain-reacting systems.         2         2         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <th1< th=""> <th1< th=""> <th1< th=""> <th1< th=""></th1<></th1<></th1<></th1<>		CO2	Analyze the	diffusion theories depending on			2										
CO3         chain-reacting systems.         2         2         2         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <td></td> <td></td> <td>Explain the l</td> <td>basic concepts and definitions of</td> <td></td> <td></td> <td>_</td> <td></td> <th></th> <th></th> <th></th> <th></th> <td></td> <td></td> <td></td> <td></td> <td>-</td>			Explain the l	basic concepts and definitions of			_										-
CO4         Evaluate the reactivity effect and Doppler         2         2         1           3 - High, 2- Medium, 1-low)         JUSTIFICATION FOR CO-PO MAPPING           Mapping         Corresponding Level of Matching         Justification           CO1-PO1         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.           C01-PO2         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.           CO1-PO2         3         In order to analyze the diffusion theories depending on source geometry, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.           CO2-PO3         2         In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.           CO3-PO2         2         In order to explain the basic concepts a		CO3	chain-reactin	g systems.		2	2										
Interference         Interference           (3 - High, 2 · Medium, 1-low)         JUSTIFICATION FOR CO-PO MAPPING           Mapping         Corresponding Level of Matching         Justification           C01-P01         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.           C01-P02         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.           C02-P03         2         In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.           C03-P02         2         In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.           C03-P03         2         In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of		CO4	<b>Evaluate</b> the	e reactivity effect and Doppler	2		2										
JUSTIFICATION FOR CO-PO MAPPING           Mapping         Corresponding Level of Matching         Justification           C01-P01         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.           C01-P02         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.           C02-P03         2         In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.           C03-P02         2         In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations           C03-P03         2         In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems an		(3 – Hig	h, 2- Medium,	1-low)	1											I	
Mapping         Corresponding Level of Matching         Justification           C01-P01         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.           C01-P02         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.           C02-P03         2         systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental consideration for public health and safety, cultural, societal, and environmental considerations.           C03-P02         2         In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of considerations.           C03-P03         2         systems, components or processes that meet specified needs with appropriate considerations.           C04-P01         2         In order to explain the basic concepts and definitions of chain reacting systems, i is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.           C04-P01         2         In order to evaluate the r	JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping         Level of Matching         Justication           C01-P01         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.           C01-P02         3         In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.           C02-P03         2         In order to analyze the diffusion theories depending on source geometry, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental consideration for public health and safety, cultural, societal, and environmental consideration for public meets and engineering problems and design systems, required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.           C03-P03         2         In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration.           C03-P03         2 <t< td=""><td>Manning</td><td>Corre</td><td>esponding</td><td></td><td>Т</td><td>neti</td><td>ific</td><td>otic</td><th>m</th><th></th><th></th><th></th><td></td><td></td><td></td><td></td><td></td></t<>	Manning	Corre	esponding		Т	neti	ific	otic	m								
C01-P013In order to apply neutron transport and dirtusion theory in various reactor core configurations, the knowledge of mathematics, natural science, engineering problems are to apply.C01-P023In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems are to apply.C01-P023In order to analyze the diffusion theories depending on source geometry, it is required to design solutions for complex engineering sciences are required. In order to analyze the diffusion theories depending on source geometry, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental consideration, antural sciences and engineering problems and design systems, engineering problems reach literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental consideration for public health and safety, cultural, societal, and environmental considerations.C03-P032In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.C03-P032In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering problem	mapping	Level o	of Matching						4								
CO1-PO13fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.C01-PO23In order to apply neutron transport and diffusion theory in various reactor core configurations, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required. In order to analyze the diffusion theories depending on source geometry, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO3-PO22In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO22In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO32In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO3-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural s	CO1 DO1		2	configurations, the knowledge	por of	t an m	a a	imu ema	sior tics	ntn 5, n	eor atu	y ii ral	ı va sci	ence.	s reac	ineer	ore ing
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CO2-PO32required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO3-PO22In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex 				In order to analyze the diffusion theories depending on source geometry, it is													
CO2-PO32systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.CO3-PO22In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO32In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO3-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering problems is to applied.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design solution of complex engineering problems is to applied.CO4-PO3222systems, components or processes that meet specified needs with appropriate considerations.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental consideration for public health and safety, cultural, societal, and environmen	CO2 DO2		0	required to design solutions for complex engineering problems and design													
CO3-PO22In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO32In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering specialization to the solution of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental consideration for public health and safety, cultural, societal, and environmental consideration for public health	CO2-PO3		2	systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural societal and environmental													
CO3-PO22In order to explain the basic concepts and definitions of chain reacting systems, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO32In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, not complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, not complex engineering problems is to applied.				considerations.													
CO3-PO22Inclusion, restance and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO32In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design solution of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design solution of complex engineering problems is to applied.				In order to explain the basic concepts and definitions of chain reacting systems,													
CO3-PO32In order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations	CO3-PO2		2	engineering problems reaching	sub	star	ntiat	ed o	cone	clus	sion	is u	sing	g first	t prine	ciples	s of
CO3-PO32In order to explain the basic concepts and definitions of chain feacing systems, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate considerations.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations				mathematics, natural sciences and	nd e	engi	nee	ring dofi	<u>sci</u>	ienc	ces	are	req	uired	na au	stom	
CO3-PO32systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, 				in order to explain the basic concepts and definitions of chain reacting systems, it is required to design solutions for complex engineering problems and design													
CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations	CO3-PO3		2	systems, components or proces	sses	th	at r	nee	t sp	eci	fiec	1 ne	eeds	s wit	h app	oropri	ate
CO4-PO12In order to evaluate the reactivity effect and Doppler effect on reactor power, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations				consideration for public health considerations.	anc	i sa	fety	, ει	iltu	ral,	SO	cieta	al, a	and e	nviro	nmer	ital
CO4-PO12engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.CO4-PO32In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations				In order to evaluate the reactivit	y e	ffec	t an	d D	opp	oler	eff	ect	on	react	or po	wer, a	and
CO4-PO3       2       In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations	CO4-PO1		2	engineering aspects of nuclear	rea dam	acto nent	or sa tals	afet and	y, t an	he eng	kno ine	owle erin	edg	e of necia	math lizatio	emat	ics, the
CO4-PO3 2 In order to evaluate the reactivity effect and Doppler effect on reactor power, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations				solution of complex engineering	g pro	oble	ems	is t	o ap	opli	ed.	2111	·o .º.	r		511 10	
CO4-PO3 2 systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations				In order to evaluate the reactivit	y ef	ffec	t an	d D	opp	oler	eff	ect	on	react	or pov	wer, i	t is
consideration for public health and safety, cultural, societal, and environmental considerations	CO4-PO3		2	systems, components or proces	sses	th	at r	ex nee	eng t sp	nie eci	fiec	ig ] i ne	eds	s wit	s and h apr	ropri	ate
L considerations				consideration for public health and safety, cultural, societal, and environmental													
	TEACHINC		NC STDATI	considerations.													

Teaching and	Learning Activities			H	Engagement (hours)		
	Face-to-Face Learning				()		
	Lecture				42		
	Practical / Tutorial / Studio Student-Centred Learning	)			-		
	Self-Directed Learning						
	Non-face-to-face learning				84		
	Formal Assessment				21		
	Continuous Assessment				2		
	Mid-Term				1		
	Final Examination				3		
	Total				153		
TEACHING	METHODOLOGY						
Lecture and D	Discussion, Co-operative and Collaboration	ative Method,	Problem Based Metho	od			
COURSE SC	CHEDULE						
Weeks		Topics			Remarks		
Week-1	Four and six-factor formula, neutro	on transport and	d diffusion theory				
Week-2	2 Derivation of the Neutron Transport Equation (NTE)						
Week-3 Fundamental properties of the NTE, neutron interactions and development of one- group neutron diffusion theory with point, plane, and fission sources							
Week-4	Application to one-and two-region	reactors					
Week-5	Introduction to buckling, multiplica	ation constants	, critical size		Class Test		
Week-6	Neutron slowing down, and resona	nce capture			2 Final		
Week-7	Applications using two-group theory	ry, methodolog	gies of neutron flux ca	lculations			
Week-8	The chain-reacting systems, therma	al nuclear react	tor				
Week-9	The calculation of the multiplicat heterogeneous thermal reactor	ion factor for	a homogenous therm	nal reactor,	Mid Term		
Week-10	The critical size of a thermal reactor	or, power and b	preeding				
Week-11	Fission and fusion reaction, fission	characteristics	s, chain reaction				
Week-12	Fast and thermal spectrum calculat	ions, reactor d	ynamics		Class Test		
Week-13         Reactivity, reactivity effects on reactor power, in-hour equation, delay neutron							
Week-14	Doppler effect, production and tran	smutation of r	adionuclide in nuclear	reactors			
ASSESSMEN	NT STRATEGY						
	Components	Grading	CO	Blooms 7	axonomy		
	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3. (	C4. C5		
		2070		0.5,0	,		

Continuous Assessment	Class Participation and Class attendance	5+5=10%	CO1, CO2	C3, C4
(40%)	Mid term	10%	CO3	C2
	Final Examination	60%	CO1-CO4	C2-C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

- 1. Duderstadt, J.J. and Hamilton, L.J. Nuclear Reactor Analysis London, John Wiley and Sons, 1976.
- 2. G.I. Bell and S. Glasstone Nuclear Reactor Theory 1st Edition, 1970
- 3. D. G. Cacuci Handbook of Nuclear Engineering: Nuclear reactor analysis, Vol. 3 London, Springer, 2010

#### **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: NE 243 : Fundamentals of Heat Transfer and Thermal Engineering	Lecture Contact Hours Credit Hours	: 4.00 : 4.00								
	PRE-REQUISITE										
	NE 141										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	This course is designed to understand the fundamentals of heat transfer and thermal engineering and provides an introduction to the essential theoretical basis of engineering thermodynamics and its application to a range of problems of relevance to practical engineering problem.										
	OBJECTIVES										
	<ol> <li>To provide an introduction to heat and momentum transfer encountering practical application in industry.</li> <li>To introduce the sources of conventional and renewable energy.</li> <li>To know the function of steam generators and turbines.</li> <li>To familiarize with the different types of refrigeration and air conditioning systems.</li> </ol>										
	LEARNING OUTCOMES										

	Upon completion of the course, the students will be able to								
	<ol> <li>Define the principles of heat and momentum transfer to basic engineering systems.</li> <li>Analyze and calculate heat and momentum transfer in complex systems involving several heat transfer mechanisms.</li> <li>Explain the essential parts and functions of steam generators and turbines.</li> <li>Evaluate the thermodynamic relations to various air-conditioning and refrigeration processes.</li> </ol>								
	COURSE OUTCOMES & GENERIC SKILLS								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Define</b> the principles of heat and momentum transfer to basic engineering systems.	PO1	C1	1	1	1	T, Q, F		
CO2	<b>Analyze</b> and <b>calculate</b> heat and momentum transfer in complex systems involving several heat transfer mechanisms.	PO2	C4, C5	3	2	2	ASG, F		
CO3	<b>Explain</b> the essential parts and functions of steam generators and turbines.	PO2	C2	2	1	1	MT, F		
CO4	<b>Evaluate</b> the thermodynamic relations to various air-conditioning and refrigeration processes.	PO1, PO2	C5	2	1	2	T, F		
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT- 1	- Test ; Mid Te	; PR – erm Ex	Project ; Q – am)		
	COURSE CONTENT								
	Basic modes of heat transfer; General conduction equation; Steady State conduction in different geometries and composite structures; Thermal contact resistance; Heat and momentum transfer associated with laminar and turbulent flows of fluids in forced convection; Natural convection heat transfer; Boiling and condensation; Laws of radiation heat transfer; Radiation shape factor; radiation interchange between two surfaces; Gas radiation. Study of sources of energy: conventional and renewable, environmental pollution; Study of steam generation units with their accessories and mountings. Introduction to steam turbine and gas turbines with their accessories. Refrigeration and Air-conditioning systems: concept of refrigeration and its applications, study of different refrigeration methods, refrigerants; concept of air conditioning and its uses, air conditioning systems.								

[	1														
	No.	Course	Learning Outcome			H	2RO	GR/	АМ (			IES	(PO)	11	10
				1	2	3	4	5	6	7	8	9	10	11	12
		<b>Define</b> the	principles of heat and												
	COI	momentum	transfer to basic	3											
			d coloriate heat and												
		Analyze an	transfor in complex												
	CO2	systems in	volving several heat		3										
		transfer mecl	nanisms.												
		Explain the	<b>xplain</b> the essential parts and												
	CO3	functions of	steam generators and		3										
		turbines.	b												
		Evaluate	the thermodynamic												
	CO4	relations to	various air-conditioning	3	3										
		and refrigera	tion processes.												
	(3 - High, 2 - Medium, 1 - low)														
JUSTIFICAT	ION FO	R CO-PO M	APPING												
	Corre	esponding				-									
Mapping	Level o	of Matching	g Justification												
CO1 PO1		3	The knowledge of math	nema	tics,	sciei	nce, (	engi	ineer	ing f	funda	amen	tals is	requi	red to
C01-F01		3	define the principles of	heat	and 1	mom	entu	m tı	ansf	er to	basi	c eng	gineeri	ing sys	stems.
			In order to analyze and	calcu	ilate	heat	and	moi	nent	um ti	ransf	er in	comp	olex sy	stems
CO2 PO2		3 literature and analysis					anisn	ns, i	ident	lifica	tion,	forn	nulatio	on, res	search
C02-P02		5	conclusions using first r	orinci	inles	of m	ngino athe	mat	ics r	natur	al sci	ence	ing s es and	engin	ering
			sciences are required.		ipics	01 11	iutiie	mat	100,1	iacai	ui sei	ence	o una	engin	comg
			In order to analyze and	calcı	ılate	heat	and	moi	nent	um ti	ransf	er in	comp	olex sy	stems
		_	involving several heat	at transfer mechanisms, it is required to design solutions for											
CO2-PO3		2	complex engineering problems and design systems, components or processes that												
			meet specified needs with appropriate consideration for public health and safety,												
			In order to explain the	e ess	sentia	al pa	rts a	ind	func	tions	of	stear	n ger	nerator	s and
CO2 DO2		2	turbines, identification,	turbines, identification, formulation, research literature and analysis of complex											
C03-P02		3	engineering problems r	each	ing s	ubsta	antia	ted	conc	lusic	ons u	sing	first p	orincip	oles of
			mathematics, natural sc	ience	es an	d en	ginee	ering	g sci	ences	s are	requ	ired.	<del></del>	
			In order to evaluate the	e ther	mod	ynar	nic r	elat	ions	to va	iriou	s air	-cond	itionir	ig and
CO4-PO1		3	engineering fundament	s, u	ne k	CHOW	neug	e ( erir	) I I I I I I I I I I I I I I I I I I I	natne	emau lizati	lcs,	natur	soluti	on of
			complex engineering p	roble	ms is	s to a	pplie	ed.	15 31	Jeena	IIZati	UII t	o inc	30100	011 01
			In order to evaluate the	e ther	mod	ynar	nic r	elat	ions	to va	ariou	s air	-cond	itionir	g and
CO4-PO2		3	refrigeration processes,	iden	tifica	tion	, forr	nula	ation	, rese	arch	liter	ature	and an	alysis
004-102		5	of complex engineering	g pro	blen	is re	achir	ng s	ubst	antia	ted c	concl	usion	s usin	g first
			principles of mathemati	ics, n	atura	al sci	ence	s an	d en	ginee	ering	scie	nces a	are req	uired.
TEACHING I	LEARNI	NG STRATI	EGY												
Teaching and I	Learning	Activities				_		_	_		_			Eng	agem
														e	nt
	[_													(hc	ours)
	Face-to	-Face Learnir	ng												
		Lecture												-	6
		Practical / T	utorial / Studio												-

	Student-Centred Learning	-				
	Self-Directed Learning					
	Non-face-to-face learning	112				
	Revision	28				
	Formal Assessment	3				
	Mid-Term	1				
	Final Examination	3				
	Total	203				
<b>TEACHING</b>	METHODOLOGY					
Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method					
COURSE SC	HEDULE					
Weeks	Topics	Remarks				
Week-1	Basic modes of heat transfer; General conduction equation					
Week-2	Steady state conduction in different geometries and composite structures; Thermal contact resistance					
Week-3	Heat and momentum transfer associated with laminar and turbulent flows of fluids in forced convection					
Week-4	Natural convection heat transfer; Boiling and condensation					
Week-5	Laws of radiation heat transfer; Radiation shape factor	Class Test				
Week-6	Radiation interchange between two surfaces; Gas radiation	2, Final				
Week-7	Study of sources of energy: conventional and renewable, environmental pollution					
Week-8	Study of steam generation units with their accessories and mountings (I)	Mid				
Week-9	Study of steam generation units with their accessories and mountings (II)	Term,				
Week-10	Introduction to steam turbine with accessories (I)	Final				
Week-11	Introduction to gas turbines with accessories (II)					
Week-12	Refrigeration and Air-conditioning systems: concept of refrigeration and its applications, study of different refrigeration methods	Class Test				
Week-13	Study of different refrigeration methods; refrigerants	<b>5</b> , <b>F</b> mai				
Week-14	Concept of air conditioning and its uses; air conditioning systems					

	Components	Grading	CO	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO4	C1, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO2	C1-C5
	Mid term	10%	CO3	C2
Fi	nal Examination (60%)	60%	CO1-CO4	C1, C2, C4, C5
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Yunus A. Cengel, Michael A. Boles *Thermodynamics: An Engineering Approach* 7th Edition, London, McGraw-Hill Companies, 2011
- 2. Yunus A. Cengel, Afshin J. Ghajar *Heat and Mass Transfer: Fundamentals & Applications* 6th Edition, NY, McGraw-Hill Higher Education, 2019
- 3. A W Culp *Principles of Energy Conversion* 2nd Edition, United State, Mc Graw-Hill Senes, 1999.
- 4. R. S. Khurmi & J. K. Gupta A Text Book of Thermal Engineering 14th Edition, India, Chand (S.) & Co Ltd, 2006
- 5. R.S. Khurmi, J.K. Gupta A *Textbook of Refrigeration and Air-conditioning* 14th Edition, New Delhi, Eurasia Publishing House (P) Ltd., 2006
- 6. Ameen Ahmadul *Refrigeration And Air Conditioning* 1st Edition, New Delhi, Prentice-hall of India Pvt. ltd, 2006

#### **REFERENCE SITE**

	COURSE INFORMATION											
Course Code Course Title	: NE 244 : Fundamentals of Heat Transfer and Thermal Engineering Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50									
	PRE-REQUISITE	QUISITE										
	NE 243	NE 243										
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/RATIONALE	SYNOPSIS/RATIONALE										
	To learn and familiarize with the basics and operation of h associate with complex problems of practical life.	To learn and familiarize with the basics and operation of heat transfer and thermal engineering associate with complex problems of practical life.										
	OBJECTIVES											
	To verify practically the theories and concepts learned in N	E 243.										
	LEARNING OUTCOMES											
	Upon completion of the course, the students will be able to											
	<ol> <li>Apply principles of heat and momentum transfer to basi</li> <li>Analyze the systems examining trade-offs in different the</li> </ol>	ic engineering systems. hermal engineering proble	ems.									
	COURSE OUTCOMES & GENERIC SKILLS											

No.	Co	ourse Learning	Outcome		Corres	spono Os	ling	l T	Bloon	n's omv	СР	CA	K	Р	Asses: Meth	sment
CO1	Apply moment engineer	principles um transfer ring systems.	of heat to	and basic	PO2	2, PO	4		C3	<u>, , , , , , , , , , , , , , , , , , , </u>	2	2	3	;	R, Q	), T
CO2	Analyze offs in problem	the systems e different therm s.	xamining t nal engine	trade- ering	PO-	4, PO	9		C4		3	2	2 4 ^R ,			T, T, r
	(CP- Co Quiz; AS	mplex Problen SG – Assignme	ns, CA-Co ent; Pr – Pr	mplex . resentat	Activiti ion; R	ies, k - Rep	KP-K ort; ]	now F – I	ledge Final 1	Profi Exam	ile, T - , MT-	- Test Mid T	;PR [°] erm	R – F Exa	Project m)	; Q –
	COUR	SE CONTEN	JT													
	<ol> <li>Vis</li> <li>Det</li> <li>Stud</li> <li>Stud</li> <li>Stud</li> <li>Stud</li> <li>Det</li> <li>T. Stud</li> <li>Der</li> <li>Stud</li> <li>Det</li> </ol>	<ol> <li>Visual demonstration of the three boiling modes (convective, nucleate and film boiling).</li> <li>Determination of thermal contact conductance.</li> <li>Study of free convection of fin/flat plate/pipe bundle.</li> <li>Study of thermal radiation unit.</li> <li>Study of condensation of water.</li> <li>Determination of calorific value of a gaseous fuel by Boy's Calorimeter.</li> <li>Study of a boiler.</li> <li>Demonstration of the cause of liquid carry over or priming in boilers.</li> <li>Study of a Refrigeration and Air-conditioning Unit.</li> <li>Determination of the pressure-temperature relationship (<i>p</i>-<i>T</i> diagram) of a pure substance.</li> </ol>														
	SKILL MAPPING(CO-PO MAPPING)															
	No.	Course	Learning C	Dutcom	e	1	2	I 3	PROC	GRAM		COM	ES (F	20)	11	12
	CO1	Apply prin momentum engineering s	ciples of transfer systems.	f heat to	and basic		3	5	2	5 (	, ,	0	,	10	11	12
	CO2	Analyze th trade-offs engineering	e systems in differe problems.	s exan ent th	nining nermal				3				3			
	(3 – Hig	h, 2- Medium,	1-low)													
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corre Level o	esponding f Matching						Jus	stifica	ation						
CO1-PO2		3	In order to systems, to and an en is to be a	to apply the kno igineeri pplied.	y princi wledge ng spec	iples of m cializ	of he athei ation	eat a matio to tl	ind m cs, na he sol	omen tural s ution	tum tr science of con	ansfer e, engi nplex (	to b neeri engin	asic ng fu leeri	engino Indam ng pro	ering entals blems
CO1-PO4		2	In order to systems, research- analysis a conclusic	In order to apply principles of heat and momentum transfer to basic engineering systems, it is required to conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.												
CO2-PO4		3	In order engineeri using res experime provide v	to an ing prob search-l ents, ana valid co	alyze to blems, i based alysis a nclusio	the st is re know and in ns.	syster equire /ledg nterpr	ms ed to e ai retat	exam cond nd re ion o	ining luct in searcl f data	trade vestig h met , and	-offs ations hods synthe	in d of co inclu esis o	iffer ompl iding of inf	ent th ex pro g desig format	ermal blems gn of ion to

	In order to analyze the systems examining trade-offs in	different thermal
CO2-PO9	3 engineering problems, it is needed to function effectively as an	individual, and as
TEACHING	<b>EXAMPLE</b> A memoer of leader in diverse teams and in multi-disciplinary se	uings.
Teaching ar	ad Learning Activities	Engagement
i enering u		(hours)
	Face-to-Face Learning	
	Lecture	28
	Practical / Tutorial / Studio	28
	Self-Directed Learning	-
	Preparation of Lab Reports	28
	Preparation of Lab Test	20
	Preparation of presentation	14
	Preparation of Quiz	-
	Engagement in Group Projects	-
	Continuous Assessment	1
	Final Quiz	1
	Total	120
<b>TEACHING</b>	METHODOLOGY	
Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method	
COURSE SCI	HEDULE	
Weeks	Topics	Remarks
Weeks Week-1	Topics Introduction	Remarks
Weeks Week-1 Week-2	Topics Introduction Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)	m Remarks
Weeks Week-1 Week-2 Week-3	Topics         Introduction         Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)         Determination of thermal contact conductance	m
Weeks Week-1 Week-2 Week-3 Week-4	Topics         Introduction         Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)         Determination of thermal contact conductance         Study of free convection of fin/flat plate/pipe bundle	m
Weeks Week-1 Week-2 Week-3 Week-4 Week-5	Topics         Introduction         Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)         Determination of thermal contact conductance         Study of free convection of fin/flat plate/pipe bundle         Study of thermal radiation unit	m
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6	Topics         Introduction         Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)         Determination of thermal contact conductance         Study of free convection of fin/flat plate/pipe bundle         Study of thermal radiation unit         Study of condensation of water	m contraction of the second se
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7	Topics         Introduction         Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)         Determination of thermal contact conductance         Study of free convection of fin/flat plate/pipe bundle         Study of thermal radiation unit         Study of condensation of water         Mid-term	Remarks
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8	Topics         Introduction         Visual demonstration of the three boiling modes (convective, nucleate and fil boiling)         Determination of thermal contact conductance         Study of free convection of fin/flat plate/pipe bundle         Study of thermal radiation unit         Study of condensation of water         Mid-term         Determination of calorific value of a gaseous fuel by Boy's Calorimeter	Remarks
Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8 Week-9	TopicsIntroductionVisual demonstration of the three boiling modes (convective, nucleate and fil boiling)Determination of thermal contact conductanceStudy of free convection of fin/flat plate/pipe bundleStudy of thermal radiation unitStudy of condensation of waterMid-termDetermination of calorific value of a gaseous fuel by Boy's CalorimeterStudy of a boiler	Remarks
Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8 Week-9 Week-10	TopicsIntroductionVisual demonstration of the three boiling modes (convective, nucleate and fil boiling)Determination of thermal contact conductanceStudy of free convection of fin/flat plate/pipe bundleStudy of thermal radiation unitStudy of condensation of waterMid-termDetermination of calorific value of a gaseous fuel by Boy's CalorimeterStudy of a boilerDemonstration of the cause of liquid carry over or priming in boilers	Remarks
WeeksWeek-1Week-2Week-3Week-4Week-5Week-6Week-7Week-8Week-9Week-10Week-11	TopicsIntroductionVisual demonstration of the three boiling modes (convective, nucleate and fil boiling)Determination of thermal contact conductanceStudy of free convection of fin/flat plate/pipe bundleStudy of thermal radiation unitStudy of condensation of waterMid-termDetermination of calorific value of a gaseous fuel by Boy's CalorimeterStudy of a boilerDemonstration of the cause of liquid carry over or priming in boilersStudy of a Refrigeration and Air-conditioning Unit	Remarks
WeeksWeek-1Week-2Week-3Week-4Week-5Week-6Week-7Week-8Week-9Week-10Week-11Week-12	TopicsIntroductionVisual demonstration of the three boiling modes (convective, nucleate and fil boiling)Determination of thermal contact conductanceStudy of free convection of fin/flat plate/pipe bundleStudy of thermal radiation unitStudy of condensation of waterMid-termDetermination of calorific value of a gaseous fuel by Boy's CalorimeterStudy of a boilerDemonstration of the cause of liquid carry over or priming in boilersStudy of a Refrigeration and Air-conditioning UnitDetermination of the pressure-temperature relationship (p-T diagram) of a pu substance	Remarks
WeeksWeek-1Week-2Week-3Week-4Week-5Week-6Week-7Week-8Week-9Week-10Week-11Week-12Week-13	TopicsIntroductionVisual demonstration of the three boiling modes (convective, nucleate and fil boiling)Determination of thermal contact conductanceStudy of free convection of fin/flat plate/pipe bundleStudy of thermal radiation unitStudy of condensation of waterMid-termDetermination of calorific value of a gaseous fuel by Boy's CalorimeterStudy of a boilerDemonstration of the cause of liquid carry over or priming in boilersStudy of a Refrigeration and Air-conditioning UnitDetermination of the pressure-temperature relationship (p-T diagram) of a pusubstanceLab practice	Remarks
WeeksWeek-1Week-2Week-3Week-4Week-5Week-6Week-7Week-8Week-9Week-10Week-11Week-12Week-13Week-14	TopicsIntroductionVisual demonstration of the three boiling modes (convective, nucleate and fil boiling)Determination of thermal contact conductanceStudy of free convection of fin/flat plate/pipe bundleStudy of thermal radiation unitStudy of condensation of waterMid-termDetermination of calorific value of a gaseous fuel by Boy's CalorimeterStudy of a boilerDemonstration of the cause of liquid carry over or priming in boilersStudy of a Refrigeration and Air-conditioning UnitDetermination of the pressure-temperature relationship (p-T diagram) of a pu substanceLab practiceFinal examination	Remarks

	Components	Grading	СО	Blooms Taxonomy
	Class Participation+ Attendance	5+5=10%	CO1	C2
Continuous Assessment	Conduct of Lab Test	20%	CO2	C2-C4
(60%)	Report Writing	15%	CO1, CO2	C2-C4
	Mid term	15%	CO2	C2-C4
Final	Exam	30%	CO1	C4
Evaluation (40%)	Viva Voce/ Presentation	10%	CO2	C3
	Total Marks	100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. R K Rajput Basic Mechanical Engineering 4th Edition, India, Laxmi Publications, 2008
- 2. Jesse Seymour Doolittle Mechanical Engineering Laboratory: Instrumentation and Its Application Hardcover 4th Edition, McGraw-Hill, 1957

#### **REFERENCE SITE**

	COURSE INFORMATION										
Course Code	: NE 251	Lecture Contact Hours	: 3.00								
Course Title		Credit Hours	: 3.00								
	'RE-REQUISITE										
	ne										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	This course is designed to provide a general int and their properties and applications. Besides, relevant to crystallographic structure, material s	troduction to different types of this course will introduce so trengthening process and phase	nuclear materials me basic concept diagram.								
	OBJECTIVES										

	<ol> <li>To understand the different phase and structure of materials by phase diagram.</li> <li>To know the structure of the metals, crystal defects, fracture mechanics and heat treatment process.</li> <li>To understand the characteristics of fission materials-density, melting point, electrical and thermal conductivity, fission cross section of coolants and cladding materials.</li> </ol>													
	LEARNING OUTCOMES													
	Upon completion of the course, the s	students will be a	able to											
	<ol> <li>Apply different types of mechanical test on metals.</li> <li>Analyze material phase diagram and iron-iron carbide diagram.</li> <li>Explain the structure of the metals, crystal defects and heat treatment process.</li> <li>Evaluate the characteristics of fission materials, cladding materials, shielding materials and moderating materials.</li> </ol>													
	COURSE OUTCOMES & GENERIC SKILLS Corresponding Bloom's Assessment													
No.	Course Learning Outcome	Course Learning Outcome     Corresponding POs     Bloom's Taxonomy     CP     CA     K       pply different types of mechanical     Data     Data     Data     Data     Data												
CO1	<b>Apply</b> different types of mechanical test on metals.	PO1	C3	2		1	T, MT, F							
CO2	Analyze material phase diagram and iron-iron carbide diagram.     PO2     C4     1													
CO3	Explain the structure of the metals, crystal defects and heat treatmentPO2C223T, F													
CO4	<b>Evaluate</b> the characteristics of fission materials, cladding materials, shielding materials and moderating materials.	PO1	C5	1		1,4	T,F							
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT-	- Test ; Mid Te	; PR – erm Ex	Project ; Q – am)							
	COURSE CONTENT													
	Phase diagram, different types of material phases, diffusion, non-equilibrium cooling, halogenation; different types of mechanical test, Charpy impact test, tensile test, hardness test; Structure of the metals, crystallography, crystal defects, dislocation, precipitation, segregation, cold work, fatigue, fracture mechanics, heat treatment, stress corrosion cracking; iron carbide equilibrium diagram; heat treatment of the metal, alloy steels, swelling, creep, atom and ion movement in solid, atomic bonding and material property-imperfection and atomic arrangements.													
	Requirements of reactor structure n uranium and thorium and their alloy and shielding materials- magnesium materials-mechanical properties of m point- electrical and thermal conduct	naterials for stru s and compound a and its alloys, naterials, characte tivity-fission cro	actural integri l core materia aluminum an eristics of fiss ss section- co	ity, fu ils, ber id its a ion ma olants	el mat rylliun alloys- aterial: - clado	terials n, grap corro s-dens ding m	, plutonium, phite control psion reactor hty - melting paterials.							
	SKILL MAPPING (CO-PO MAP	PING)												

	No.	Course L	earning Outcome	1	2	P		JRA 5	AM (			AES	(PO)	11	12	
	CO1	Apply dif	fferent types of	2	2	3	4	5	0	/	0	9	10	11	12	
	CO2	Analyze ma	terial phase diagram		3											
	CO3	<b>Explain</b> the s crystal defec process.	structure of the metals, ts and heat treatment		2											
	CO4	<b>Evaluate</b> the fission meterials, she moderating meterials and the second secon	the characteristics of naterials, cladding ielding materials and naterials.	2												
HISTIFICAT		N FOR CO-PO MAPPING														
JUSTITICAL	Com	agnonding														
Mapping	Level o	of Matching				Ju	istifi	icat	tion							
CO1-PO1		2	Fundamentals scientifi	ic kn	owle	edge	is re	quii	ed to	o ver	ify s	treng	th of the metal.			
CO2-PO2		3 Problem solving capability is highly essential to analyze ph Fundamentals scientific knowledge is required to explain								phas	se diagram.					
CO3-PO2		2 Fundamentals scientific knowledge is required to explain the metals.									the st	he structure of the				
CO4-PO1		2 Fundamentals scientific knowledge is required to evaluate the fission materials.									ne cha	aracter	ristics	of		
<b>TEACHING I</b>	LEARNI	NG STRATE	EGY													
Teaching and I	Learning	Activities											E	ngag (hou	emen ırs)	t
	Face-to	-Face Learnin	ng													
		Lecture												42	2	
		Practical / Tu Student-Cent	tered Learning											-		
	Self-Di	rected Learnii	ng													
		Non-face-to-	face learning											84	4	
		Revision												2	1	
	Formal	Assessment											1	-		
		Continuous A	Assessment											2		
		Mid-Term	notion										1	1		
	Total	rinai Examii	nauon											3 15	3	
TEACHING	METHO	DOLOGY												15	5	
Lecture and Di	scussion	Co-operativa	and Collaborative M	etho	d D	robl	em 1	Rac	ed N	/leth	bod					
				euro	u, P	1001		Das		/ietil	lou					
Wooks		2	Toni	CS										Po	marl	<b>F</b>
West 1												ле	mari			
week-1	Phase c	nagram-differ	ent types of material	pnas	es, c	IIITU	sion									
Week-2	Non-equilibrium cooling, homogenation															

Week-3 Week-4	Different types of mechanical test, Charpy impact test, tensile test, hardness test Structure of the metals, crystallography, crystal defects	Class Test 1, Final Exam
Week-5	Dislocation, precipitation, segregation, cold work	Class Test
Week-6	Fatigue, fracture mechanics, heat treatment, stress corrosion cracking	2, Final
Week-7	Iron carbide equilibrium diagram, heat treatment of the metal, alloy steels	Exam
Week-8	Swelling, creep, atom and ion movement in solid	
Week-9	Requirements of reactor materials, fuel materials and plutonium	Mid Term.
Week-10	Uranium and thorium and their alloys and compound core materials	Final
Week-11	Aluminium and its alloys- corrosion reactor materials-mechanical properties of materials	Exam
Week-12	Characteristics of fission materials-density - melting point	Class Test
Week-13	Atomic bonding and material property-imperfection and atomic arrangements	3, Final
Week-14	Beryllium, graphite control and shielding materials- magnesium and its alloys	Exam

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1-CO4	C2-C5
	Class Participation and Class attendance	5+5=10%	CO2	C4
(,.)	Mid term	10%	CO1	C3
Final Examination		60%	CO1-CO4	C2-C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Kopelman B. Materials for Nuclear Reactors 4th Edition, NY, McGraw Hill, 2006.
- 2. Karl Whittle *Nuclear Materials Science* 1st Edition, Bristol, IOP Publishing Ltd, 2016.
- 3. Sidney H Avner *Introduction to Physical Metallurgy* 14th Edition, NY, Glencoe/McGraw-Hill School Pub Co.

# **REFERENCE SITE**

	COURSE INFORMATION		
Course Code	: NE 252	Lecture Contact Hours	: 3.00
Course Title	: Nuclear Materials Sessional	Credit Hours	: 1.50

	PRE-REQUISITE												
	NE 251												
	CURRICULUM STRUCTURE												
	Outcome Based Education (OBE)												
	SYNOPSIS/RATIONALE												
	To learn and familiarize the basics of	different Nuclea	ar Materials a	nd the	eir app	olicatio	on.						
	OBJECTIVES												
	To verify practically the theories and concepts learned in NE 251.												
	LEARNING OUTCOMES												
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Apply experimental procedure to analyze the crystallographic /micro structure of the material.</li> <li>Analyze phase diagram as per temperature and alloy composition.</li> <li>Demonstrate various types of heat treatment process to enhance the strength of the materials</li> </ol>												
	<ol> <li>Demonstrate various types of heat treatment process to enhance the strength of the materials.</li> <li>Capable of using special methods to prepare sample specimen.</li> </ol>												
	COURSE OUTCOMES & GENERIC SKILLS												
No.	Course Learning Outcome	СР	CA	KP	Assessment Methods								
CO1	<b>Apply</b> experimental procedure to <b>analyze</b> the crystallographic/ micro structure of the material.	PO1	C3, C4	1	2	1,2	Q, R, T						
CO2	<b>Analyze</b> phase diagram as per temperature and alloy composition.	PO2, PO3	C4	3,4	1	3,4	Q, R, T						
CO3	<b>Demonstrate</b> various types of heat treatment process to enhance the strength of the materials.	PO3, PO4	C3	3,4	2	3	Q, R, T						
CO4	<b>Capable</b> of using special methods to prepare sample specimen.	PO1	C4	1,6	1	3	Q, R, T						
	(CP- Complex Problems, CA-Complex A Quiz; ASG – Assignment; Pr – Presentati	Activities, KP-Kn on; R - Report; F	owledge Profi – Final Exam,	le, T - MT- I	– Test Mid Te	; PR - erm Ex	- Project ; Q – am)						
	COURSE CONTENT												
	<ol> <li>Introduction to Metallographic an</li> <li>Study of Phase Diagrams 1</li> <li>Study of Phase Diagrams 2</li> <li>Microstudy of steels 1</li> <li>Microstudy of steels 2</li> <li>Heat treatment of steels-1</li> <li>Heat treatment of steels-2</li> <li>Heat treatment of steels-3</li> <li>Microstudy of cast irons-3</li> <li>Microstudy of cast irons-4</li> </ol>	d Metallographi	ic Sample Sp	ecime	n Prep	paratio	on.						

	SKILL MAPPING (CO-PO MAPPING)															
		, , , , , , , , , , , , , , , , , , ,		/												
		C I				F	RO	GRA	MO	DUT	COM	1ES	(PO)			
	No.	Course L	earning Outcome	1	2	3	4	5	6	7	8	9	10	11	12	
		Apply experi	mental procedure to													
	CO1	analyze the cr	ystallographic /micro	2												
		structure of th	e material.													
	CO2	temperature a	nd allow composition		2	2										
		Demonstrate	various types of heat													
	CO3	treatment pro	cess to enhance the			3	2									
		strength of the	e materials.													
	CO4	Capable of u	sing special methods	3												
	to prepare sample specimen.															
	(3 – High, 2- Medium, 1-low)															
JUSTIFICAT	CATION FOR CO-PO MAPPING															
Mapping	Corresponding Level of Matching         Justification           2         Scientific knowledge is required to analyze the microstructure of the material															
CO1-PO1	2 Scientific knowledge is required to analyze the microstructure of the material.															
CO2-PO2		2	Problem identificatio diagram.	oblem identification and finding its solution is essential to understand the phase agram.								ase				
CO2-PO3		2	It could be done by for	ormi	ng a	grou	p.									
CO3-PO3		3	Group performance /	team	wor	k is '	very	imp	ortai	nt.						
CO3-PO4		2	Usually performed or	n the	basi	s of	data	anal	yze	and i	nter	preta	tion.			
CO4-PO1		3	Scientific knowledge	is re	equire	ed to	pre	pare	sam	ple s	peci	men.				
<b>TEACHING</b>	LEARN	ING STRATE	EGY													
Teaching and I	Learning	Activities											I	Engag	gemer	ıt
														(ho	urs)	
	Face-to	-Face Learnin	ıg													
		Lecture												-	28	
		Practical / Tu	utorial / Studio												28	
		Student-Cen	tred Learning										_		-	
	Self-D	irected Learnin	ng												• •	
		Preparation of	of Lab Reports												28	
		Preparation of	of Lab Test											-	20	
		Preparation of	or presentation												14	
		Engagement	in Group Projects												-	
	Formal		in Group Frojects										+		-	
	Forma	Continuous Assessment 1														
		Final Ouiz	1000001110111												1	
		Total												1	20	
TEACHING N	METHO	DOLOGY														
Lecture and Di	scussion	, Co-operative	and Collaborative N	/leth	od, l	Prob	lem	Bas	sed I	Meth	nod					
COURSE SCI	HEDUL	E														

Weeks	Topics	Remarks
Week-1	Introduction to metallographic and metallographic sample specimen preparation	
Week-2	Study of Phase Diagrams 1	
Week-3	Study of Phase Diagrams 2	
Week-4	Microstudy of steels 1	
Week-5	Microstudy of steels 2	
Week-6	Heat treatment of steels 1	
Week-7	Heat treatment of steels 2	
Week-8	Heat treatment of steels 3	
Week-9	Microstudy of cast irons 3	
Week-10	Microstudy of cast irons 4	
Week-11	Practice lab 1	
Week-12	Quiz test, Viva	
Week-13	Lab test 1	
Week-14	Lab test 2	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
	Conduct of Lab Tests/Class Performance	25%	CO1-CO4	C1-C6
Continuous	Report Writing/ Programming	15%	CO1-CO4	C1-C6
Assessment	Mid-Term Evaluation (exam/project/assignment)	20%	CO1-CO4	C1-C6
Final	Viva Voce	10%	CO1-CO4	C1-C6
Assessment	Final Evaluation (Lab Quiz)	30%	CO1-CO4	C1-C6
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

1. RE. Fand J.K.Shultis, Radiological Assessment, Prentice Hall, 1993.

# **REFERENCE SITE**

	COURSE INFORMATION								
Course Code Course Title	: NE 261 : Numerical Methods in Nuclear Engir	neering Analysis	Lecture Co Credit Hou	ntact H rs	Iours	: 3.( : 3.(	)0 )0		
	PRE-REQUISITE					<u> </u>			
	MATH 101, Math 103 and CSE 121								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	<ol> <li>This course will emphasize the development of numerical algorithms to provide solutions to common problems formulated in nuclear engineering field.</li> <li>The course is designed to develop the basic understanding of the construction of numerical algorithms, and perhaps more importantly, the applicability and limits of their appropriate uses</li> </ol>								
	OBJECTIVES								
	<ol> <li>To know the roots of polynomia</li> <li>To able to solve differential equa</li> <li>To able to compare various n differentiation, integration</li> <li>To able to evaluate the solving e</li> </ol>	Is and transcende ations applying d nathematical ope quations by finit	ental equation lifferent nume erations and e difference r	ns. erical n tasks, nethod	nethoo such s and	ls. as in curve	nterpolation, fitting.		
	LEARNING OUTCOMES								
	<ol> <li>Upon completion of the course, the s</li> <li>Apply fundamentals of numericarelated polynomials and transcer</li> <li>Analyze the differential equation</li> <li>Compare various mathematical and integration.</li> <li>Evaluate solving equations by find</li> </ol>	students will be a al analysis in fir adental equations as by different nu operations and t nite difference m	ble to ding roots of merical methasks, such as tethods and co	f variou nods. 5 interp urve fit	us eng olatio	gineer n, dif	ing problem ferentiation,		
	COURSE OUTCOMES & GENE	RIC SKILLS	Dlaam'a				Assessment		
No.	Course Learning Outcome	POs	Taxonomy	СР	CA	KP	Methods		
CO1	<b>Apply</b> fundamentals of numerical analysis in finding roots of various engineering problem related polynomials and transcendental equations.	1	C1	1	-	2	T, Q, F		
CO2	<b>Analyze</b> the differential equations by different numerical methods.	2	C2	2	-	2	T, Q, F		

CO3	Compar operatio interpola integrati	re various ns and tas ation, differe on.	various mathematical and tasks, such as n, differentiation, and		3			(	23	1		-	3	M	Г, Q,	F
CO4	Evaluat different	e solving equation eq	ations by finite curve fitting.		3			C	24	2		-	3	Т	', Q, F	7
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)									<b>)</b> –						
	COUR	SE CONTEN	T													
	Roots of polynomials and transcendental equations: bisection method, method of false position iteration method, Newton-Raphson method, Ramanujan's method, secant method, Muller's method; Solution of linear and non-linear algebraic equations; Solution of differential equations by Taylor's series, Picard's method, Euler's method, Runge-Kutta method, predictor-corrector methods, cubic spline method, boundary value problems; Interpolation methods: finite differences method, Stirling's formula, Bessel's formula, Everett's formula, Lagrange's formula Hermite's formula; Numerical differentiation and integration; Solving equations by finite differences; Curve fitting.									on, r's ns: tor ite la, ite						
	SKILL	MAPPING	(CO-PO MAP)	PING	)											
					PROGRAM OUTCOMES (PO)									I		
	No.	Course I	earning Outcome	e	1	2	3	4	5	6 7	8	9	10	11	12	
	CO1	<b>Apply</b> funda analysis in fi engineering polynomials equations.	mentals of num nding roots of va problem re and transcence	erical arious elated lental	3											
	CO2	Analyze the by different r	differential equa numerical method	ations ls.		3										
	CO3	Compare operations a interpolation, integration.	various mathem and tasks, such differentiation,	atical h as and			3									
	CO4	<b>Evaluate</b> so finite different fitting.	olving equations	s by curve			3									
	(3 – Hig	h, 2- Medium,	1-low)													
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corro Level o	esponding of Matching					Ju	ıstifi	catio	on						
CO1-PO1		3	In order to apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex nuclear science and engineering problems finding roots of various engineering problem related polynomials and transcendental equations are required.													
CO2-PO2	3 In order undertake nuclear engineering related problem identification analysis of differential equations by different numerical methods are required					on, ms										

CO3-PO3	CO3-PO33In order to design and conduct experiments, as well as to analyze and interpret data of nuclear related problems comparison of various mathematical operations and tasks, such as interpolation, differentiation, integration are required.					
CO4-PO3	3	In order to design nuclear systems, components, or computation meet desired needs within realistic constraints, it requires to equations by finite difference methods and curve fitting.	nal processes to evaluate solving			
TEACHING	LEARNING STRAT	EGY				
Teaching and	Learning Activities		Engagement (hours)			
	Face-to-Face Learnin Lecture Practical / T	ng utorial / Studio	42			
	Student-Cerri Self-Directed Learni	ng	-			
	Non-face-to Revision	-face learning	84 21			
	Formal Assessment Continuous Mid-Term Final Exami	Assessment	2 1 3			
	Total		153			
TEACHING	METHODOLOGY					
Lecture and D	iscussion, Co-operative	e and Collaborative Method, Problem Based Method				
COURSE SC	HEDULE					
Weeks		Topics	Remarks			
Weeks Week-1	HEDULE Roots of polynomial false position, iterati	<b>Topics</b> Is and transcendental equations: bisection method, method of on method	Remarks			
Week-1 Week-2	Roots of polynomial false position, iterati Roots of polynomia Ramanujan's method	<b>Topics</b> Is and transcendental equations: bisection method, method of on method Ils and transcendental equations: Newton-Raphson method d, secant method, Muller's method	Remarks of I, Class Test 1, Final Exam			
Weeks Week-1 Week-2 Week-3	HEDULE Roots of polynomial false position, iterati Roots of polynomia Ramanujan's method Solution of linear an	<b>Topics</b> Is and transcendental equations: bisection method, method of on method Is and transcendental equations: Newton-Raphson method d, secant method, Muller's method d non-linear algebraic equations (I)	Remarks of I, Class Test 1, Final Exam			
Weeks Week-1 Week-2 Week-3 Week-4	HEDULE Roots of polynomial false position, iterati Roots of polynomia Ramanujan's method Solution of linear an Solution of linear an	Topics         Is and transcendental equations: bisection method, method of on method         als and transcendental equations: Newton-Raphson method         als and transcendental equations: Newton-Raphson method         d, secant method, Muller's method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)	Remarks f I, Class Test 1, Final Exam			
Weeks Week-1 Week-2 Week-3 Week-4 Week-5	HEDULE Roots of polynomial false position, iterati Roots of polynomia Ramanujan's method Solution of linear an Solution of linear an Interpolation method	Topics         Is and transcendental equations: bisection method, method of on method         als and transcendental equations: Newton-Raphson method         d, secant method, Muller's method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)         hs: finite differences method	Remarks       of       I,       Class Test       1, Final       Exam       Class Test       2, Final			
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6	HEDULE         Roots of polynomial false position, iterati         Roots of polynomia         Ramanujan's method         Solution of linear an         Solution of linear an         Interpolation method	Topics         Is and transcendental equations: bisection method, method of on method         als and transcendental equations: Newton-Raphson method         d, secant method, Muller's method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)         ds: finite differences method         ds: Stirling's formula, Bessel's formula, Everett's formula	Remarks         of         Class Test         1, Final         Exam         Class Test         2, Final         Exam			
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7	HEDULE         Roots of polynomial false position, iterati         Roots of polynomia         Ramanujan's method         Solution of linear an         Solution of linear an         Interpolation method         Interpolation Method	Topics         Is and transcendental equations: bisection method, method of on method         als and transcendental equations: Newton-Raphson method         d, secant method, Muller's method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)         ds: finite differences method         ds: Stirling's formula, Bessel's formula, Everett's formula         ds: Lagrange's Formula, Hermite's Formula	Remarks       of       Class Test       1, Final       Exam       Class Test       2, Final       Exam			
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-8	HEDULE         Roots of polynomial false position, iterati         Roots of polynomial false position file         Solution of linear an         Interpolation method         Interpolation Method         Solution of different	Topics         Is and transcendental equations: bisection method, method of on method         als and transcendental equations: Newton-Raphson method         d, secant method, Muller's method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)         ds: finite differences method         ds: Stirling's formula, Bessel's formula, Everett's formula         ds: Lagrange's Formula, Hermite's Formula         ial equations: by Taylor's series	Remarks         of         Class Test         1, Final         Exam         Class Test         2, Final         Exam         Mid         Test			
WeeksWeek-1Week-2Week-3Week-4Week-5Week-6Week-7Week-8Week-9	HEDULE         Roots of polynomial false position, iterati         Solution of linear an         Solution of linear an         Interpolation method         Interpolation Method         Solution of different         Solution of different         Solution of different         method	Topics         Is and transcendental equations: bisection method, method of on method         als and transcendental equations: Newton-Raphson method         als and transcendental equations: Newton-Raphson method         d, secant method, Muller's method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)         ds: finite differences method         ds: Stirling's formula, Bessel's formula, Everett's formula         ds: Lagrange's Formula, Hermite's Formula         ial equations: by Taylor's series         ial equations: Picard's method, Euler's method, Runge-Kutt	Remarks         of         I,         L,         Exam         Class Test         I,         Final         Exam         Class Test         I,         Final         Mid         Term,         Final			
Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-8 Week-9 Week-10	HEDULE         Roots of polynomial false position, iterati         Roots of polynomial false position file         Solution of linear an         Interpolation method         Interpolation Method         Solution of different         Solution of different	Topics         Is and transcendental equations: bisection method, method on method         als and transcendental equations: Newton-Raphson method         als and transcendental equations: Newton-Raphson method         d non-linear algebraic equations (I)         d non-linear algebraic equations (II)         ds: finite differences method         ds: Stirling's formula, Bessel's formula, Everett's formula         ds: Lagrange's Formula, Hermite's Formula         ial equations: by Taylor's series         ial equations: Picard's method, Euler's method, Runge-Kutt         ntial equations: predictor-corrector methods, cubic splin	Remarks         of         Class Test         1, Final         Exam         Class Test         2, Final         Exam         a         Mid         a         Final         e			

Week-12	Numerical integration	Class Tost
Week-13	Solving equations by finite differences	3, Final
Week-14	Curve fitting	Exam

	Components	Grading	СО	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2, C4
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1-CO4	C1-C4
(1070)	Mid term	10%	CO3	C3
Final Examination		60%	CO1-CO4	C1-C4
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. V.N. Vedamurthy, N. Iyengar Numerical Methods India, Vikas Publishing House Pvt Limited, 2008
- 2. E. Balagurusamy Numerical Methods 25th Reprint Edition, New Delhi, Tata MacGrawHill, 2008
- 3. S. S. Sastry Introductory Methods of Numerical Analysis 5th Edition, India, PHI Learning Pvt. Ltd., 2012
- 4. Curtis F. Gerald, Patrick O. Wheatley *Applied Numerical Analysis* 7th Edition, Boston, Addison-Wesley Publishing Company, 2004
- 5. Steven C. Chapra, Raymond P. Carale *Numerical Methods for Engineers* 8th edition, Publisher NY, Tata McGraw-Hill Publishing Company Ltd., 2020

#### **REFERENCE SITE**

	COURSE INFORMATION		
Course Code Course Title	: NE 262 : Numerical Methods in Nuclear Engineering Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
	PRE-REQUISITE		
	CSE 122 and NE 261		
	CURRICULUM STRUCTURE		

	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	To learn and familiarize the basics	of Numerical Me	ethods and its	applic	cation.				
	OBJECTIVES								
	To verify practically the theories and concepts learned in NE 261.								
	LEARNING OUTCOMES								
	Upon completion of the course, the	e students will be	able to						
	<ol> <li>Design and solve mathematica</li> <li>Develop the methodology for s</li> </ol>	l problems by nu olving complex e	merical techn quations with	ique. the he	elp of 1	numer	rical methods.		
	COURSE OUTCOMES & GEN	ERIC SKILLS	•		-				
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Design</b> and <b>solve</b> mathematical problems by numerical technique.	PO3, PO5	C6	1,2	2	2	MT, T, R, Q		
CO2	<b>Develop</b> the methodology for solving complex equations with the help of numerical methods.	PO3, PO4, PO5	C6	1,2	2	2	T, R, Q		
	(CP- Complex Problems, CA-Comple Quiz; ASG – Assignment; Pr – Presen	ex Activities, KP-K tation; R - Report;	Knowledge Pro F – Final Exar	file, T n, MT-	– Test · Mid T	; PR - Term E	– Project ; Q – Exam)		
	COURSE CONTENT								
	This course consists of two parts. practically the theories and concep simple systems using the principles	In the first part, ots learned in NE s learned in NE 2	students will 261. In the se	perfo econd	rm exj part, s	perim tuden	ents to verify ts will design		
	Exp 01: Solve an equation of $f(x) =$	= exp(-x) by Fixe	d Point Iterati	ion me	ethod.				
	Exp 02: Solve an equation of $f(x) =$	exp(-x) by New	ton Raphson	metho	od.				
	Exp 03: Solve an equation of $f(x)$ =	exp(-x) by Ram	anujan's met	hod.					
	Exp 04: Develop a short code wh preference and categorize the total	nich can receive numbers into fou	number of st ir grades as th	udents ie user	s acco 's pref	rding ferenc	to the user's se as well.		
	Exp 05: Develop a code which wil	l deliver the mean	n value of the	stude	nts' he	eights.			
	Exp 06: Prepare a curve by insertion 'hold on' option in same figure, sh and finally show the curves on diff	on of y-axis and x now those differe ferent figures.	–axis data. In nt curves by	nclude 'subpl	e more ot' op	than of the	one curves by n same figure		
	Exp 07: Prepare an algorithm and o	curves for extrapo	olation and in	terpola	ation c	of diff	erent data.		
	Exp 08: Build a code to find the re	sult of following	problem:						
	$1+2^{2}+3^{2}+\dots+N^{2}=?$								
	Exp 09: Build a code to find the re-	sult of following	problem:						
	1-2+3+N = ?								
	Exp 10: Build a code to find the re-	sult of following	problem:						

	1+3+5+7++N=?														
	Exp 11	: Obtain the so	lutions by using Gau	iss E	limir	natio	n me	thod	1.						
	Emp 12	Obtain the se	lutions by using Guu	I			41. a d	linoe	*•						
	Exp 12	: Obtain the so	lutions by using Gau	ISS-J	ordai	1 me	tnod	•							
	SKILL MAPPING (CO-PO MAPPING)														
	No.	Course Le	earning Outcome		r	F	ROC	BRAN	N OI	UTC	OM	ES (I	20)		
				1	2	3	4	5	6	7	8	9	10	11	12
	CO1	<b>Design</b> and	solve mathematical			3		3							
		<b>Develon</b> the	methodology for												
	CO2	solving compl	ex equations with the			3	2	3							
		help of numeri	cal methods.												
	(3 – Hig	h, 2- Medium, 1	-low)												
JUSTIFICAT	ION FO	R CO-PO MA	PPING												
Mapping	Corr Level	esponding of Matching				Ju	stifi	catio	on						
CO1-PO3		3	Some design problem construct and solve n	ms n nathe	eed t	to be	solv oble	red w ms by	where v nu	e stu meri	dent	s wil echni	ll be que.	requi	red to
CO1-PO5		3	Modern simulation to	ools a	and n	umer	ical t	ools erica	are r	equi	red i	for sc	olving	large	scale
CO2-PO3		3	Ability to develop	the the h	meth	iodol of dif	ogy feren	for	solv	ing	com	plex	nucl	ear r	elated
CO2-PO4		2	Design, analyze and methods to solve the	inte com	rpret plex o	nucl nucl	lear d	lata g pro	is re obler	quir ns.	ed t	he he	elp of	num	erical
CO2-PO5		3	Modern simulation methodology to solve	tools e con	and and	nun equa	nerication	al to by nu	ols umer	are ical	requ tech	ired nique	d for develop the ue.		
TEACHING	LEARNI	NG STRATE	GY			-						-			
Teaching and I	Learning	Activities											Engagement		
	n												(	hour	s)
	Face-to	-Face Learning	g												
		Lecture												28	
		Practical / Tu	torial / Studio											28	
	C If D	Student-Cent	red Learning											-	
	Self-Di	Dremention	g f Lah Dananta											20	
		Preparation of Dramonation	f Lab Reports											28	
		Preparation of	f presentation											20	
	Preparation of presentation 14														
		Engagement i	n Group Projects											_	
<u> </u>	Formal	Assessment													
		Continuous A	ssessment											1	
		Final Ouiz												1	
	Total													120	
<b>TEACHING</b> I	METHO	DOLOGY													
Lecture and Di	scussion,	Co-operative	and Collaborative M	etho	d, Pr	oble	m B	ased	Me	thod	l				

# **COURSE SCHEDULE**

Weeks	Topics						
Week-1	Solve an equation of $f(x) = exp(-x)$ by Fixed Point Iteration method						
Week-2	Solve an equation of $f(x) = exp(-x)$ by Newton Raphson method						
Week-3	Solve an equation of $f(x) = exp(-x)$ by Ramanujan's method						
Week-4	Develop a short code which can receive number of students according to the user's preference and categorize the total numbers into four grades as the user's preference as well						
Week-5	Develop a code which will deliver the mean value of the students' heights						
Week-6	Week-6Prepare a curve by insertion of y-axis and x –axis data. Include more than one curves by 'hold on' option in same figure, show those different curves by 'subplot' option in same figure and finally show the curves on different figures						
Week-7	Prepare an algorithm and curves for extrapolation and interpolation of different data						
Week-8	Build a code to find the result of following problem: $1+2^2+3^2++N^2=?$						
Week-9	Build a code to find the result of following problem: 1-2+3+N=?						
Week-10	Build a code to find the result of following problem: 1+3+5+7++N=?						
Week-11	Obtain the solutions by using Gauss Elimination method						
Week-12	Obtain the solutions by using Gauss-Jordan method						
Week-13	Practice Lab						
Week-14	Quiz test, Lab Test 1, Viva						

# ASSESSMENT STRATEGY

	Components	Grading	СО	<b>Blooms Taxonomy</b>
	Conduct of Lab Tests/Class Performance	25%	CO1 CO2	C6
	Report Writing/ Programming	15%	CO1 CO2	C6
	Mid-Term Evaluation (exam/project/assignment)	20%	CO1	C6
	Viva Voce	10%	CO1, CO2	C6
	Final Evaluation (Lab Quiz)	30%	CO1, CO2	C6
Total Mar	'ks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. John H. Mathews and Kurtis D. Fink *NUMERICAL METHODS: Using Matlab* Fourth Edition, Prentice-Hall Pub. Inc., 2004 ISBN 0-13-065248-2
- 2. E. Balagurusamy Numerical Methods -- 25th Reprint Edition, New Delhi, Tata MacGrawHill, 2008

# **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: GESL 221 : Environment, Sustainability and Lav	W	Lecture Conta Credit Hours	ct Hours	: 2. : 2.	00 00					
	PRE-REQUISITE										
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	This course is designed to learn and fa impact on environment.	amiliarize the b	basics of radiati	on energy p	henom	enon and its					
	OBJECTIVES										
	<ol> <li>To know the environmental impact of Nuclear Power Plants.</li> <li>To understand the features of radiation effect on biodiversity.</li> <li>To understand the regulatory aspects for the environment monitoring and public safety.</li> <li>To understand the IAEA guidelines for environment safety.</li> </ol>										
	LEARNING OUTCOMES										
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Define energy, energy conversion system and management.</li> <li>Explain IAEA Safety Standards and guides for environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning.</li> <li>Analyze radioactivity monitoring equipment, analytical methods and their techniques, radiation level and public awareness systems.</li> <li>Evaluate environmental monitoring program of the regulatory body and the operators, National Manitoring System of the redioactivity.</li> </ol>										
	COURSE OUTCOMES & GENER	IC SKILLS									
No.	Course Learning Outcome	Corresponding POs	g Bloom's Taxonomy	CP CA	KP	Assessment Methods					
CO1	<b>Define</b> energy, energy conversion system and management.	PO1	C1		1	T, F, ASG					
CO2	<b>Explain</b> IAEA Safety Standards and guides for environmental radiological	PO1	C2		1	T, F, ASG					

	monitori requirem	ng and surveillance nents during NPP construction,												
	and oper	ation and decommissioning.												
CO3	Analyze equipme techniqu awarene	e radioactivity monitoring ent, analytical methods and their es, radiation level and public ss systems.	PO6		(	24		-	-	1		MT, F		
CO4	Evaluate program operator of the rate	e environmental monitoring of the regulatory body and the s, National Monitoring System dioactivity.	PO7		(	25		-	-	2		T, F		
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)													
	COUR	SE CONTENT												
	<ul> <li>Sources of energy, energy consumption patterns: Life-cycle cost calculations, energy demand forecasting, energy conversion methods, energy efficiency, energy management and conservation, impacts of energy utilization on environment.</li> <li>IAEA Safety Standards and guides for environmental monitoring of NPPs, environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning.</li> <li>Introduction to radioactivity monitoring equipment, analytical methods and their techniques; Evaluation and monitoring of radiation level in air, water and soil in the vicinity (15-30 km distances) of the NPPs and public awareness systems during reactor operation, maintenance, and decommissioning periods; Environmental monitoring program of the regulatory body and the operators, National Monitoring System of the radioactivity; Environmental impact assessment methodology due to contamination of air, water and soil in case of accidents or higher level of radiation; Thermal ecological studies, biodiversity conservation studies for environment safety and</li> </ul>													
	SKILL	MAPPING (CO-PO MAPP	ING)											
	No.	Course Learning Outc	come	1		ROGR	SAM			<u>MES (</u>	PO)	12		
	CO1	<b>Define</b> energy, energy conversion management.	on system and	3	2 3	4.	5 0	/	0 9	10	11	12		
	CO2	<b>Explain</b> IAEA Safety Standard for environmental radiologica and surveillance requirements construction, and oper decommissioning.	ds and guides al monitoring during NPP ation and	3										
	CO3	<b>Analyze</b> radioactivity monitoring analytical methods and their radiation level and public aware	ng equipment, r techniques, eness systems.				2							
	CO4	<b>Evaluate</b> environmental monitor of the regulatory body and to National Monitoring Syster radioactivity.	oring program the operators, em of the					3						
JUSTIFICAT	<u>(3 – Hig</u> TION FO	h, 2- Medium, 1-low) <b>R CO-PO MAPPING</b>												

Mapping	Corresponding Level of Matching	Justification											
CO1-PO1	3	In order to define energy, energy conversion system and n knowledge of science is required	nanagement, basis										
CO2-PO1	3	In order to apply IAEA Safety Standards and guides for environmentoring and surveillance requirements during NPP construct and decommissioning, the knowledge of mathematics, natural sc fundamentals and an engineering specialization to the solution engineering problems is to applied.	mental radiological tion, and operation tience, engineering ution of complex										
CO3-PO6	2	In order to analyze energy conversion and core flow distribu- generation, temperature distributions in fuel elements and trans- reasoning informed by contextual knowledge to assess societal, H and cultural issues and the consequent responsibilities releva- engineering practice and solutions to complex engineering prob	ution, reactor heat sfer, application of health, safety, legal ant to professional lems is required.										
CO4-PO7	2	2 In order to explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer, application of ethical principles and commit to professional ethics and responsibilities and norms of engineering practice is required.											
TEACHING	LEARNING STRAT	EGY											
Teaching and	Learning Activities		Engagement (hours)										
Face-to-Face Learning Lecture Practical / Tutorial / Studio													
	Student-Cen	tred Learning	-										
	Non-face-to- Revision	face learning	56 14										
	Formal Assessment Continuous A Mid-Term Final Examin	Assessment	$\begin{array}{r} 2\\ 1\\ 3\\ \hline 104 \end{array}$										
TEACHING	METHODOLOGY		104										
Lecture and D	viscussion, Co-operativ	e and Collaborative Method, Problem Based Method											
COURSE SC	HEDULE												
Weeks		Topics	Remarks										
Week-1	Sources of energy, Energy demand forec	energy consumption patterns: Life-cycle cost calculatio	ns;										
Week-2	Energy conversion conservation; impact	methods.; energy efficiency; energy management as of energy utilization on environment	and Class Test 1, Final										
Week-3	IAEA Safety Standa	rds and guides for environmental monitoring of NPPs											
Week-4	Environmental radio construction, and ope	logical monitoring and surveillance requirements during N eration and decommissioning	PPClass Test2, Final										

Week-5	Introduction to radioactivity monitoring equipment, analytical methods and their techniques		
Week-6	Evaluation and monitoring of radiation level in air, water and soil in the vicinity (15- 30 km distances) of the NPPs		
Week-7	Public awareness systems, during reactor operation, maintenance, and decommissioning periods		
Week-8	Environmental monitoring program of the regulatory body and the operators	Mid Term,	
Week-9	National Monitoring System of the radioactivity		
Week-10	Environmental impact assessment methodology due to contamination of air, water and soil in case of accidents or higher level of radiation	Final	
Week-11	Thermal ecological studies		
Week-12	Biodiversity conservation studies for environment safety and sustainability	Class Test	
Week-13	Geomorphology, geology studies for environment safety and sustainability	3, Final	
Week-14	Seismic studies for NPP safety		

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2, C4
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C1, C2
(10,0)	Mid term	10%	CO3	C4
Final Examination		60%	CO1-CO4	C1, C2, C4, C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

- Todreas, N.E. and Kazimi, M. S. Nuclear Systems I Thermal Hydraulic Fundamentals 2nd Edition, Taylor & Francis, 2011.
- 2. Cengel Y.A. and Boles, M.A. *Thermodynamics: An Engineering Approach* 8th edition in S.I. units, McGrawHill Book Company, 2014.
- 3. Cengel, Y. A. and Cimbala, J. M. Fluid Mechanics Fundamentals and Applications McGraw-Hill, 2010.
- 4. Wakil, M. M. E. *Nuclear Energy Conversion* Revised Edition, Amer Nuclear Society, 1982
- 5. El-Wakil, M.M. Nuclear Heat Transport International Text Book, 1971.
- 6. Rust, J.H. Nuclear Power Plant Engineering Haralson, 1979.

#### **REFERENCE SITE**

# Level-3, Term-I

#### **COURSE INFORMATION**

Course Code Course Title	: NE 301 : Radiation Detection and Measurem	ient C	Lecture Contact Credit Hours	Hours		: 3.0 : 3.0	00 00				
	PRE-REQUISITE										
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)			_	_	_					
	SYNOPSIS/RATIONALE										
	This course is designed to impart know technique and develop skill on statist	owledge on th tical analysis	e operation of d of the radioactiv	ifferen ve sam	t radia ples.	tion n	neasurement				
	OBJECTIVES										
	<ol> <li>To know the nuclear instrumentation and measurement.</li> <li>To understand the operation of different radiation measurement technique.</li> <li>To understand the statistical analysis of the radioactive samples.</li> <li>To understand the radiation survey techniques.</li> </ol>										
	LEARNING OUTCOMES										
	Upon completion of the course, the students will be able to										
	<ol> <li>Apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer.</li> <li>Analyze the methods of radiation detection.</li> <li>Evaluate the process of radiation detection and measurement.</li> <li>Formulate the methodology for the design and development of detectors for radiation detection and measurement.</li> </ol>										
	COURSE OUTCOMES & GENE	RIC SKILLS	5								
No.	Course Learning Outcome	Correspondir POs	ng Bloom's Taxonomy	СР	CA	KP	Assessment Methods				
CO1	<b>Apply</b> fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer.	PO1	C3	-	-	3	T, F				
CO2	Analyze the methods of radiation detection.	PO2	C4	-	-	4	MT, F				
CO3	<b>Design</b> and <b>Evaluate</b> the process of radiation detection and measurement.	PO3	C5	-	-	5	T , F, ASG				
CO4	<b>Formulate</b> the methodology for the design and development of detectors for radiation detection and measurement.	PO2	C6	1	-	6	F, T				
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP tion; R - Repor	-Knowledge Prof rt; F – Final Exam	ile, T – , MT- 1	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)				
	COURSE CONTENT										

detector, P.M. Tubes, semiconductor detector, track etch detector hormos-luminescent dosimeter; (b) neutral particle detection, neutron detector hy activation foils; Detector efficiencies: standardization of radioactive sources, calibration of detectors, absolute counting, source geometry, source absorption, air and window effects, source dilution, measurement of very short and very long half-lives.       Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagenetic radiation, and neutron sources; Statistics of radiation counting: characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting: Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.       SKILL MAPPING (CO-PO MAPPING)       CO1       No.     Course Learning Outcome       1     2       3     1       4     6       7     8       9     10       11     12       3     1       12     3       4     5       6     7       8     10       11     2       12     3       12     3       13     1       14     1 </th <th></th> <th>Detection bubble</th> <th>on of nuclear chamber, pl</th> <th>radiation: (a) detection notographic emulsion</th> <th>n of</th> <th>cha bark</th> <th>rged cha</th> <th>l par amb</th> <th>ticler,</th> <th>es, r scir</th> <th>nucle ntilla</th> <th>ear in tion</th> <th>ntera det</th> <th>ction tector</th> <th>with s, C</th> <th>i matt erenk</th> <th>er, tov</th>		Detection bubble	on of nuclear chamber, pl	radiation: (a) detection notographic emulsion	n of	cha bark	rged cha	l par amb	ticler,	es, r scir	nucle ntilla	ear in tion	ntera det	ction tector	with s, C	i matt erenk	er, tov	
dosimeter; (b) neutral particle detection, neutron detection, detector based on boron reaction, time of flight technique, proton recoil telescope, neutron detection by activation foils; Detector efficiencies: standardization of radioactive sources, calibration of detectors, absolute counting, source geometry, source absorption, air and window effects, source dilution, measurement of very short and very long half-lives.       Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; statistics of radiation counting; characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.       SKILL MAPPING (CO-PO MAPPING)       Voing various engineering 3       detection and measurement heory CO1       in solving various engineering 3       detection and measurement for radiation detectors and detector and       anabze the methodology for the detectors for and traduate the process of energy transfer.       CO2       Anabze the methodology for the design and development of detectors for adiation detection and measurement.       (3 – High, 2- Medium, 1-low)       JUSTIFICATION FOR CO-PO MAPPING       CO2+PO2       3       CO1-PO1       3 <th></th> <th>detector</th> <th>r, P.M. Tub</th> <th>es, semiconductor a</th> <th>lete</th> <th>ctor,</th> <th>tra</th> <th>ıck</th> <th>etc</th> <th>h d</th> <th>letec</th> <th>tor,</th> <th>the</th> <th>rmos</th> <th>-lumi</th> <th>inesco</th> <th>ent</th>		detector	r, P.M. Tub	es, semiconductor a	lete	ctor,	tra	ıck	etc	h d	letec	tor,	the	rmos	-lumi	inesco	ent	
of flight technique, proton recoil telescope, neutron detection by activation folls; Detector efficiencies: standardization of radioactive sources, calibration of detectors, absolute counting, source geometry, source absorption, air and window effects, source dilution, measurement of very short and very long half-lives.         Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; statistics of radiation counting: characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fluting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         VC01       No.       Course Learning Outcome       1       2       3       4       5       6       7       8       9       10       11       12         GM       SILL MAPPING (CO-PO MAPPING)       To all all all all all all all all all al		dosime	ter; (b) neutra	l particle detection, ne	utro	n de	tecti	ion,	det	ecto	r bas	sed o	on bo	oron r	eacti	on, ti	me	
efficiencies: standardization of radioactive sources, calibration of detectors, absolute counting, source geometry, source absorption, air and window effects, source dilution, measurement of very short and very long half-lives.         Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; Statistics of radiation counting; characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       1       2       3       4       1       1       1         Apply fundamentals of radiation detection and measurement theory in solving various engineering 3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		of fligh	nt technique,	proton recoil telesco	ope,	net	itron	ı de	tect	ion	by	acti	vatio	on fo	ils; I	Detec	tor	
source geometry, source absorption, air and window effects, source dilution, measurement of very short and very long half-lives.       Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; Statistics of radiation counting: characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.       SKILL MAPPING (CO-PO MAPPING)       No.     Course Learning Outcome       No.     Course Learning Outcome       Apply fundamentals of radiation detection and measurement theory in solving various engineering 3       problem related to process of energy transfer.       CO2     Analyze the methods of radiation 3       Design and Evaluate the process of detection and measurement.       G3 – High, 2- Medium, 1-low)       JUSTIFICATION FOR CO-PO MAPPING       Mapping       Corresponding Level of Matching       Level of Matching       No.     Justification       G1-PO1       3     In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematis, natural science, engineeri		efficien	cies: standard	lization of radioactive	e so	urce	s, ca	alibr	atic	on o	f de	tecto	ors, a	absol	ute co	ountii	ng,	
short and very long half-lives.         Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; Statistics of radiation counting: characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments. limits of detectability, distribution of time intervals, and curve fitting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         Void       Course Learning Outcome         No.       Course Learning Outcome         Apply fundamentals of radiation       1         detection and measurement theory       3         CO1       in solving various engineering         3       1         CO2       Analyze the methodology for the design and development of detection and measurement.         (CO3       radiation         3       1         JUSTIFICATION FOR CO-PO MAPPING         JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching         Level of Matching       In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to proccess of energy transfer.		source g	geometry, sou	rce absorption, air and	l wii	ndov	v eff	ects	, so	urce	dilu	ition	ı, me	easure	ement	t of ve	ery	
Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; Statistics of radiation counting; characteristics and utilization of statistical models, propagation of errors, optimization of counting experiments. limits of detectability, distribution of time intervals, and curve fitting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering 3       Program (PO)       Program (PO)         C01       In solving various engineering 3       Program (PO)       Program (PO)         C02       Analyze the methods of radiation detection and measurement.       3       Program (PO)         GO3       Result the methodology for the design and development of a detectors of radiation detection and measurement.       3       Program (PO)         JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching       Justification         CO1-PO1       3       In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineeri		short an	nd very long h	alf-lives.														
electromagnetic radiation, and neutron sources; Statistics of radiation counting: characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve filting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory CO1 in solving various engineering 3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1<		Radiati	on sources:	fast electron source	es,	hea	vy	cha	rgeo	d p	artic	eles	sou	rces,	sou	rces	of	
data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting; Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation         QCO1 in solving various engineering         other colspan="2">PROGRAM OUTCOMES (PO)         Other colspan="2">Apply fundamentals of radiation         detection and measurement theory         Other colspan="2">CO2         Analyze the methods of radiation         other colspan="2">atom colspan="2">SKILL MAPPING (CO-PO MAPPING)         CO2         Apply fundamentals of radiation         other colspan="2">CO1         Other colspan="2">CO2         Apply fundamentals of radiation         Other colspan="2">CO2         CO2         Design and Evaluate the process of radiation detection and measurement.         CO3       Formulate the methodology		electror	nagnetic radia	ation, and neutron sou	rces	; Sta	atisti	cs o	f ra	diat	ion c	coun	ting	: chai	acter	istics	of	
counting experiments, limits of detectability, distribution of time intervals, and curve fitting:         Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         Very meters.         SKIL MAPPING (CO-PO MAPPING)         Very meters.         SKIL MAPPING (CO-PO MAPPING)         C01       Course Learning Outcome         1       2       3       4       5       6       7       8       9       10       11       12         C01       Apply fundamentals of radiation detection and measurement theory in solving various engineering 3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		data, sta	atistical mode	els, applications of sta	tisti	cal r	node	els,	pro	paga	ation	of	erroi	s, op	timiz	ation	of	
Characteristics and utilization of various detectors: simplified detector model, modes of detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering 3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		countin	g experiment	s, limits of detectabi	lity,	dist	tribu	tion	of	tim	e in	terv	als,	and o	curve	fittiı	ıg;	
operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering a label of the properties of the methods of radiation detection and measurement.       Justification         JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching       Justification tetes of radiation detection, identification, formulation, research literature and analysis of complex engineering problems is to be applied.         Corresponding Level of Matching <th and="" colspanet="" design="" detetemethodology="" development="" for="" o<="" td="" the=""><td></td><td>Charact</td><td>eristics and u</td><td>tilization of various d</td><td>etec</td><td>tors</td><td>sim</td><td>plif</td><td>ied</td><td>dete</td><td>ector</td><td>mo</td><td>del,</td><td>mode</td><td>es of (</td><td>detec</td><td>tor</td></th>	<td></td> <td>Charact</td> <td>eristics and u</td> <td>tilization of various d</td> <td>etec</td> <td>tors</td> <td>sim</td> <td>plif</td> <td>ied</td> <td>dete</td> <td>ector</td> <td>mo</td> <td>del,</td> <td>mode</td> <td>es of (</td> <td>detec</td> <td>tor</td>		Charact	eristics and u	tilization of various d	etec	tors	sim	plif	ied	dete	ector	mo	del,	mode	es of (	detec	tor
Tradiation dose measurements of ionization chambers, variants of the proportional counter design, G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering 3 problem related to process of energy transfer.       1       2       3       4       5       6       7       8       9       10       11       12         CO1       in solving various engineering problem related to process of energy transfer.       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		operatio	on, pulse heig	ght spectra, sensitivity	y, ei	nerg	y res	solu	tior	ı, de	etect	ion	effic	eiency	, dea	ad tin	ne;	
G-M survey meters.         SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering a problem related to process of energy transfer.       CO2       Analyze the methods of radiation and measurement theory in detection and measurement.         CO2       Analyze the methods of radiation and detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering problems is to be applied.         In order to apply fundamentals of radiation detection, identification, formula		radiatio	n dose measu	rements of ionization	cha	mbe	rs, v	aria	nts	of th	ne pr	opo	rtior	al co	unter	desig	gn,	
SKILL MAPPING (CO-PO MAPPING)         No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering       3       4       5       6       7       8       9       10       11       12         C01       Apply fundamentals of radiation detection and measurement theory energy transfer.       3       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       4       5 <td></td> <td colspan="10">G-M survey meters.</td>		G-M survey meters.																
No.       Course Learning Outcome       PROGRAM OUTCOMES (PO)         Apply fundamentals of radiation detection and measurement theory in solving various engineering 3       1       2       3       4       5       6       7       8       9       10       11       12         C01       in solving various engineering problem related to process of energy transfer.       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1 <th></th> <th colspan="12">SKILL MAPPING (CO-PO MAPPING)</th>		SKILL MAPPING (CO-PO MAPPING)																
Instruction       1       2       3       4       5       6       7       8       9       10       11       12         Apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer.       3       1       1       1       1       1       1       12       3       4       5       6       7       8       9       10       11       12         C01       in solving various engineering problem related to process of energy transfer.       3       1       1       1       1       1       10       11       12         C02       Analyze the methods of radiation detection and tection and measurement.       3       1       1       1       1       1       1       1       1       1       10       11       12         JUSTIFICATION FOR CO-PO MAPPING       In order to apply fundamentals of radiation detection and measurement.       Justification       In order to apply fundamentals of cadiation detection and engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.       1       10       11       12       1       1       1       1       1       1		No	Course I	earning Outcome			Р	ROO	GRA	AM (	DUT	CON	AES	(PO)				
CO1       in solving various engineering a problem related to process of energy transfer.         CO2       Analyze the methods of radiation detection and measurement.         CO3       Analyze the methodology for the design and development of detectors for radiation detection and measurement.         CO4       Besign and Evaluate the process of detection and measurement.         CO4       Besign and Evaluate the process of detection and measurement.         CO4       Gesign and development of detection and measurement.         Image: CO4       Gesign and development of detectors for radiation detection and measurement.         (3 - High, 2- Medium, 1-low)       Justification         JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching         Image: CO1-PO1       3       Image: Corresponding solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         CO2-PO2       3       Image: Corresponding solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering problems is to be applied.         CO2-PO2       3       Image: Corresponding solving various engineering problems as to be applied.         CO3-PO3       3       Image: Corresponding solving various engineering problems as to be applied.					1	2	3	4	5	6	7	8	9	10	11	12		
C01       detection and measurement theory in solving various engineering 3         C02       Analyze the methods of radiation 3         C03       Analyze the methods of radiation 3         C03       radiation detection and measurement.         C04       design and Evaluate the process of radiation detection and measurement.         C03       radiation detection and development of detection for radiation detection and measurement.         C04       design and development of detection for radiation detection and measurement.         C04       design and development of detections for radiation detection and measurement.         C04       design and development of detections for radiation detection and measurement.         C05       FORMULT         JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching         In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         C01-PO1       3       In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering rolation detection and measurement, it is required to design solutions for complex engineering p			Apply funda	amentals of radiation														
CO1       in solving various engineering is interviewed to process of energy transfer.         CO2       Analyze the methods of radiation       3         CO2       Analyze the methods of radiation       3         Design and Evaluate the process of radiation       3       1         CO3       reasurement.       3       1         Formulate the methodology for the design and development of detectors for radiation detection and measurement.       3       1         JUSTIFICATION FOR CO-PO MAPPING       3       1       1         Mapping       Corresponding Level of Matching       Justification         CO1-PO1       3       1       1         Solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         CO2-PO2       3       1       1         CO3-PO3       3       1       1       1         CO3-PO3       3       1       1       1         CO3-PO3       3       1       1       1		COL	in solving	various engineering	3													
CO2       Analyze the methods of radiation detection       3         CO2       Analyze the methods of radiation detection       3         Design and Evaluate the process of radiation detection and measurement.       3       1         Formulate the methodology for the design and development of detectors for radiation detection and measurement.       3       1         JUSTIFICATION FOR CO-PO MAPPING         JUSTIFICATION FOR CO-PO MAPPING         CO1-PO1       3       1       1         Scoresponding Level of Matching       Justification         CO1-PO1       3       1       1         CO2-PO2       3       1       1       1         CO3-PO3       3       3       1       1			problem rel	ated to process of	5													
CO2       Analyze the methods of radiation detection       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1			energy transf	er.														
C02       detection       3       1       1       1         Design and Evaluate the process of radiation       add ection       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		CO2	Analyze the	methods of radiation		2												
Design and Evaluate the process of radiation detection and measurement.       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1		02	detection			3												
CO3       radiation       detection       and       3       3       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1			Design and H	Evaluate the process of														
measurement.       Image: Construction of the methodology for the design and development of detectors for radiation detection and measurement.       Image: Construction of the detectors for radiation detection and measurement.         (3 - High, 2- Medium, 1-low)       JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching       Justification         CO1-PO1       3       In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         C02-PO2       3       In order to analyze the methodo of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.         C03-PO3       3       In order to design the methodology for the design and development of detectors for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, the intervent with appropriate consideration for public health and safety.		CO3	radiation	detection and			3											
C04       Formulate the methodology for the design and development of detectors for radiation detection and measurement.       3         JUSTIFICATION FOR CO-PO MAPPING       Justification         Mapping       Corresponding Level of Matching       Justification         C01-PO1       3       In order to apply fundamentals of radiation detection, and engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         C02-PO2       3       In order to analyze the methodology for the design and development of detectors for radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.         C03-PO3       3       In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, when the interval the level to the level of the level			measurement															
CO4       design and development of detectors for radiation detection and measurement.       3         JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching         JUSTIFICATION FOR CO-PO MAPPING         C01-PO1       3         In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         C02-PO2       3         C03-PO3       3			Formulate the	the methodology for the														
Interview		CO4	detectors for	radiation detection and		3												
Image: Interview Interview       Image: Interview Interview         (3 - High, 2- Medium, 1-low)       JUSTIFICATION FOR CO-PO MAPPING         Mapping       Corresponding Level of Matching       Justification         C01-PO1       3       In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.         C02-PO2       3       In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.         C03-PO3       3       In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety,			measurement															
JUSTIFICATION FOR CO-PO MAPPINGMappingCorresponding Level of MatchingJustificationC01-PO13In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, meet specified needs with appropriate consideration for public health and safety,		(3 - Hig)	h, 2- Medium,	1-low)	·	·	·	·	·	·	·	·	·	·	•	•		
MappingCorresponding Level of MatchingJustificationCO1-PO13In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, we here the provider specified needs with appropriate consideration for public health and safety,	JUSTIFICAT	ION FO	R CO-PO M	APPING														
CO1-PO13In order to apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, need engineering head with appropriate consideration for public health and safety,	Mapping	Corres Level o	ponding f Matching				Jı	ıstif	ica	tion								
CO1-PO13solving various engineering problem related to process of energy transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, uet specified needs with appropriate consideration for public health and safety,				In order to apply fund	ame	ntals	of r	adia	tion	dete	ection	n and	1 me	asurei	nent t	theory	in	
CO1-PO13knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, using the provide p				solving various engin	eerii	ng pi	roble	em r	elate	ed to	o pro	ocess	of	energy	y tran	sfer,	the	
CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, use the principle of the design for public health and safety,	COI-POI		3	knowledge of mathem	natic	s, n	atura	l sc	ienc	e, e	ngin	eerin	ig fu	ndam	entals	and .	an	
CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, use the principle problement of detection				engineering specializa	tion	to th	ne so	lutic	on o	f coi	mple	x en	ginee	ering	proble	ems 1s	to	
CO2-PO23In order to analyze the methods of radiation detection, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.CO3-PO33In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, when the principal design is a specified needs with appropriate consideration for public health and safety.				In order to analyze the	mot	hode	ofr	adia	tion	dote	oction	n ide	ntifi	cation	form	nulati	on	
CO2-PO2       3       Instantiated und undysts of complex engineering problems retering substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.         In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, where the principal solution is a statement.			2	research literature an	nd a	nalv	sis o	of c	omr	olex	eng	ineer	ing	probl	ems	reach	ing	
and engineering sciences are required.         In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety,	CO2-PO2		3	substantiated conclusi	ons	using	g firs	st pr	inci	ples	of n	nathe	emati	cs, na	atural	scien	ces	
CO3-PO3 3 In order to design the methodology for the design and development of detectors for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety,				and engineering science	ces a	re re	quire	ed.		-								
CO3-PO3 3 for radiation detection and measurement, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety,				In order to design the	met	hode	ology	for	the	desi	ign a	nd d	evel	opmei	nt of $\overline{\mathbf{c}}$	letect	ors	
complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety,			2	for radiation detection	1 an	d me	easur	eme	nt,	it is	requ	iired	to c	lesign	solu	tions	for	
meet specified needs with appropriate consideration for public health and safety,	CO3-PO3		5	complex engineering p	orobl	ems	and	desi	gn s	yste	ms, o	comp	onei	its or	proce	sses t	nat	
CHITIPAL SOCIETAL AND ENVIRONMENTAL CONSIDERATIONS				cultural, societal and	envii	appi ronm	opra	ate c 1 cor	nsid	erati	anon ons	101	puon	c nea	iui an	u saie	ιy,	

CO4-PO2	3 In order to design the methodology for the design and development of detectors for radiation detection and measurement, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.											
TEACHING I	LEARNING STRATE	EGY										
Teaching and I	Learning Activities		Engagement (hours)									
	Face-to-Face Learnin Lecture Practical / Tr Student-Cen	ng utorial / Studio tred Learning	42									
	Self-Directed Learni Non-face-to- Revision	ng -face learning	84 21									
	Formal Assessment Continuous Assessment Mid-Term Final Examination											
	Total		153									
TEACHING N	METHODOLOGY											
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method										
COURSE SCI	HEDULE											
Weeks		Topics	Remarks									
Week-1	Detection of charged photographic emulsion	d particles, nuclear interaction with matter, bubble chamb on, spark chamber, scintillation detectors, Cerenkov detector	or, Class Test									
Week-2	P.M. Tubes, semico dosimeter;	onductor detector, track etch detector, thermos-luminesco	ent 1, Final Exam									
Week-3	P.M. Tubes, semico dosimeter;	onductor detector, track etch detector, thermos-luminesc	ent									
Week-4	Neutral particle detect of flight technique, p	ction, neutron detection, detector based on boron reaction, ti proton recoil telescope, neutron detection by activation foils	me ;;									
Week-5	Detector efficiencie detectors, absolute co	es: standardization of radioactive sources, calibration ounting, source geometry	of Class Test 2, Final									
Week-6	Source absorption, a short and very long h	ir and window effects, source dilution, measurement of venalf-lives	ery Exam									
Week-7	Rrevision											
Week-8	Fast electron sources, heavy charged particles sources, sources of electromagnetic radiation and neutron sources											
Week-9	Statistics of radiation counting: characteristics of data, statistical models											
Week-10	Statistics of radiation counting: characteristics of data, statistical modelsApplications of statistical models, propagation of errors, optimization of counting											
	experiments											

Week-12	Pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers	
Week-13	Variants of the proportional counter design, G-M survey meters.	3, Final Exom
Week-14	Revision	Exam

Components		Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C3, C5, C6
Assessment (40%)	Class Participation and Class attendance	5+5= 10%	CO3	C5
	Mid term	10%	CO2	C4
Final Examination		60%	CO1-CO4	C3-C6
Total Marks		100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Knoll, Glenn F. Radiation detection and measurement, 4th edition, United Sates: John Wiley & Sons, 2010.
- 2. Cember, Herman, Thomas E. Johnson, and Parham Alaei. *Introduction to health physics*, 4th edition, New York, USA :McGraw Hill, 2008.

#### **REFERENCE SITE**

	COURSE INFORMATION									
Course Code Course Title	: NE 302 : Radiation Detection and Measurement Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75							
	PRE-REQUISITE									
	NE 301									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	To learn and familiarize the detection of radiation and	the medical applications of	of radiation.							
	OBJECTIVES									

	<ol> <li>To know the Nuclear Instrumentation and Measurement.</li> <li>To understand the operation of different radiation measurement technique.</li> <li>To understand the statistical analysis of the radioactive samples.</li> <li>To understand the radiation survey techniques.</li> </ol>															
	LEARNING OUTCOMES															
	<ol> <li>Apply the different measurement technique to detect radioactivity and follow radiation safety during experimentation.</li> <li>Design and solve real life problems adapting to the specified requirements using both simulating tools and hardware.</li> </ol>												ty th			
	COUR	SE OUTCOMES & GENEI	RIC S	KII	LS											
No.	Co	ourse Learning Outcome	Corre	espoi POs	nding	; ;	Blo Taxo	om': non	s 1y	СР	(	CA	KP	Ass M	essme ethod	ent s
CO1	Apply techniqu follow experime	the different measurement e to detect radioactivity and radiation safety during PO1, PO4 C3 - 2 1-3								R	, Q, T	,				
CO2	<b>Design</b> adapting using b hardware	and <b>solve</b> real life problems to the specified requirements both simulating tools and e.	ad <b>solve</b> real life problems to the specified requirements the simulating tools and PO5 C6 1 3								3	1- 3, 5	R, Q, T, Pr, P4			
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)															
	COUR	SE CONTENT														
	<ol> <li>Bac</li> <li>Sea spec</li> <li>Det</li> <li>Gar</li> <li>Exp</li> <li>Det</li> <li>gan</li> </ol>	kground radiation measurem rch for lost point radioactive ctrometry. ermining the Linear Absorpti nma-ray spectrometry using is perimental determination of F ermination of the efficiency nma rays.	ents. sourc ion coe NaI(TI WHM of Na	es b effic l) de l and aI(T	y us ient tecto l FW l) sc	ing of A or. /TM cinti	radia Al & Al of I illatio	atio Pb NaI on o	n su usii det dete	nrvey ng B ector	me eer' for	eter s La r diff diff	or mo w. ferent ferent	ener ener	gamn gies. rgies	na of
	SKILL	MAPPING (CO-PO MAPI	PING)	)												
	No.	Course Learning Outcome	e			Р	ROC	BRA	MC	OUTC	CON	1ES	(PO)			
	CO1	CO1 Apply the different measurem technique to detect radioactivand follow radiation safety due experimentation		3	2	3	4	5	6	7	8	9	10	11	12	
	CO2	<b>Design</b> and <b>solve</b> real life prob <b>adapting</b> to the spec requirements using both simul tools and hardware.	olems cified lating					3								
JUSTIFICAT	(5 – Hig. [ <b>ON FO</b> ]	R CO-PO MAPPING														
JUSTIFICAT	ION FOI	R CO-PO MAPPING														

Mapping	Corresponding Level of Matching	Justification					
CO1-PO1	3	In order to apply the different measurement technique to detect radioactivity and follow radiation safety during experimentation, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.					
CO1-PO4	3	In order to apply the different measurement technique to detect radioactivity and follow radiation safety during experimentation, it is required to conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.					
CO2-PO5	3	In order to apply the different measurement technique to detect radioactivity and follow radiation safety during experimentation, It is required create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations.					
<b>TEACHING I</b>	LEARNING STRATI	EGY					
Teaching and I	Learning Activities		Engagement (hours)				
	Face-to-Face Learning         Lecture         Practical / Tutorial / Studio         Student-Centred Learning         Self-Directed Learning         Preparation of Lab Reports         Preparation of Lab Test         Preparation of presentation         Preparation of Quiz         Engagement in Group Projects         Formal Assessment         Continuous Assessment         Final Quiz		14 28 - - 14 10 9 - - - - 14 1				
	Total						
TEACHING N	TEACHING METHODOLOGY						
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method					
COURSE SCI	COURSE SCHEDULE						
Weeks		Topics	Remarks				
Week-1	Background radiation	n measurements					
Week-2	Search for lost poin mobile gamma spect	t radioactive sources by using radiation survey meter or rometry					
Week-3	Determining the Line	ear Absorption coefficient of Al & Pb using Beer's Law					
Week-4	Gamma-ray spectron	netry using NaI(Tl) detector					
Week-5	Experimental determ energies	ination of FWHM and FWTM of NaI detector for different					
Week-6	Determination of the energies of gamma ra	e efficiency of NaI(Tl) scintillation detector for different ays					

Week-7	Quiz test Lab Test Viva						
ASSESSMENT STRATEGY							
	Components	Grading	СО	Blooms Taxonomy			
Continuous Assessment (40%)	Lab participation and Report	20%	CO 1, CO2	C3, C6 A1, A2, A5, P1, P4			
	Labtest-1, Labtest-2	40%	CO 1, CO2	C3, C6 A1, A2, A5, P1, P4			
	Project/ Presentation	15%	CO2	C6, P4			
Lab Quiz		25%	CO1, CO2	C3, C6 A1, A2, A5, P1, P4			
Total Marks		100%					

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

1. Ahmed, Syed Naeem. *Physics and engineering of radiation detection.*,1st edition, San Diago, USA: Academic Press, 2007.

### **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: NE 305 : Nuclear Reactor Thermal Hydraulics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00								
	PRE-REQUISITE										
	NE 243										
	CURRICULUM STRUCTURE         Outcome Based Education (OBE)         SYNOPSIS/RATIONALE										
	This course is designed to provide a general intermediation mechanics in fluids and analogies in solving variable energy transfer. It will introduce the important of distribution, reactor heat generation, temperate multi-phase flow, convective boiling to react transfer. Apart from these, this course will also thermal design, nuclear and thermal-hydraulic of the set of the	e is designed to provide a general introduction to heat transfer mechanisms and fluid in fluids and analogies in solving various engineering problem related to process of sfer. It will introduce the important concepts such as energy conversion and core flow i, reactor heat generation, temperature distributions in fuel elements and transfer, e flow, convective boiling to reactor coolant channel process and radiative heat part from these, this course will also introduce the important topics including core sign, nuclear and thermal-hydraulic operational and accident transient sequences.									
	OBJECTIVES										
	<ol> <li>To understand the fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer.</li> <li>To know energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer.</li> <li>To apply multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.</li> <li>To evaluate core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.</li> </ol>										
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	LEARNING OUTCOMES										
	Upon completion of the course, the students will be able to										
	<ol> <li>Apply fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer.</li> <li>Analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer.</li> <li>Explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.</li> <li>Evaluate core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.</li> </ol>										
	COURSE OUTCOMES & GENERIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods				
CO1	<b>Apply</b> fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer.	PO1, PO2	C3	1	-	3	T, Q, F				
CO2	<b>Analyze</b> energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer.	PO1, PO2, PO3	C4	2	-	4, 5	ASG, F				
CO3	<b>Explain</b> multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.	PO1, PO2, PO3	C2	1	-	4	MT, F				
CO4	<b>Evaluate</b> core thermal design, nuclear and thermal hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.	ear nd nd tor PO1, PO2, PO3 C5 2 1 3 T, F									
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kı tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT- 1	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)				
	COURSE CONTENT										

Fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies. Energy and core flow distribution, Reactor heat generation and transfer; radial and axial temperature distributions in fuel elements, Applications of single-phase, two-phase flow and convective boiling to reactor coolant channel analysis, core thermal design and safety analysis, Two-phase flow patterns, Critical heat flux, DNBR, AOOs, Void coefficient, Radiative heat transfer, Thermal-hydraulic safety limits and conditions, Current research topics of the nuclear thermalhydraulics concerned with safe and effective heat removal from the reactor core for power production. Analysis of operational and accident transient sequences, nuclear and thermalhydraulic transient, and engineering aspects of nuclear reactor safety.

#### SKILL MAPPING (CO-PO MAPPING)

	No	Course I	comina Outcoma			Р	ROC	GRA	M (	A OUTCOMES (PO)							
	INO.	Course I	Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12		
	CO1	Apply fun transfer me mechanics in solving v problem rel energy transf	damentals of heat chanisms and fluid fluids and analogies in arious engineering ated to process of er.	3	3												
	CO2	CO2 Analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer.		2	2	2											
	CO3	<b>Explain</b> convective coolant char radiative heat	multi-phase flow, boiling to reactor annel process and t transfer	2	2	2											
	CO4	Evaluatecorethermaldesign,nuclearandthermal-hydraulicCO4operationalandaccidenttransientsequences, and engineering aspectsofnuclearreactor safety.		2	2	2											
	(3 – Hig	h, 2- Medium,	1-low)										_				
JUSTIFICAT	ION FO	к со-ро М	APPING														
Mapping	Corro Level o	esponding of Matching	Justification														
CO1-PO1	In order to apply fundation in fluids and analogies 3 of energy transfer, the			ame s in s e kno	ntals solvii swle	of h ng va dge (	eat t ariou of m	rans is ei iath	sfer i ngine emat	mech eerin tics.	nanis g pro natu	ms a obler ral s	nd flu n rela cience	uid me ted to e. eng	echar proc ineer		

		fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO1-PO2	3	In order to apply fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.
CO2-PO1	2	In order to analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.

CO2-PO2	2	2 In order to analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.							
CO2-PO3	2	In order to analyze energy conversion and core flow distrib generation, temperature distributions in fuel elements and trans design solutions for complex engineering problems and components or processes that meet specified needs with approp for public health and safety, cultural, societal, and environmen	ution, reactor heat fer, it is required to design systems, oriate consideration tal considerations.						
CO3-PO1	2	In order to explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.							
CO3-PO2	2	In order to explain multi-phase flow, convective boiling to reac process and radiative heat transfer, identification, formulation, and analysis of complex engineering problems reaching substa using first principles of mathematics, natural sciences and en are required.	tor coolant channel research literature ntiated conclusions gineering sciences						
CO3-PO3	2	In order to explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.							
CO4-PO1	2	In order to evaluate core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.							
CO4-PO2	2	In order to evaluate core thermal design, nuclear and thermal-hy and accident transient sequences, and engineering aspects of nu- identification, formulation, research literature and anal engineering problems reaching substantiated conclusions using mathematics, natural sciences and engineering sciences are required.	draulic operational clear reactor safety, ysis of complex g first principles of uired.						
CO4-PO3	2	In order to evaluate core thermal design, nuclear and thermal-hy and accident transient sequences, and engineering aspects of nu- it is required to design solutions for complex engineering pr systems, components or processes that meet specified need consideration for public health and safety, cultural, societal, considerations.	draulic operational clear reactor safety, oblems and design s with appropriate and environmental						
TEACHING I	LEARNING STRAT	EGY							
Teaching and I	Learning Activities		Engagement (hours)						
	Face-to-Face Learnin	ng	42						
	Practical / Tutorial / Studio								
	Student-Cen	tred Learning	-						
	Self-Directed Learni Non-face-to	ng -face learning	84						
	Revision		21						
	Formal Assessment								
	Continuous	2							

Total153Total153Total153Total153Teachning wethod, Problem Based MethodLecture and Discussion, Co-operative and Collaborative Method, Problem Based MethodCOURSE SCHEDULEWeeksTopicsRemarksWeek-1Fundamentals of heat transfer mechanisms (I)Class TestWeek-2Fundamentals of heat transfer mechanisms (II)Class TestWeek-3Fluid mechanics in fluids and analogiesClass TestWeek-4Energy and core flow distributionClass TestWeek-5Reactor heat generation and transferClass TestWeek-6Radial temperature distributions in fuel elementsMidWeek-7Axial temperature distributions in fuel elementsMidWeek-8Applications of single-phaseMidWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisKamWeek-11Two-phase flow patternsClass TestWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass TestWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsClass Test		Mid-Term Final Examination	1						
TEACHING UETHODOLOGYLecture and Distribution and Collaborative Method, Problem Based MethodCOURSE SUFFUEWeeksImage and Sofe at transfer mechanisms (I)RemarksWeek-10Fundamentals of heat transfer mechanisms (II)Agas Test 1, Final ExamWeek-3Fluid mechanics in fluids and analogiesClass Test 2, Final 		Total	153						
Lecture and Discission, Co-operative and Collaborative Method, Problem Based MethodCOURSE SUPPORT Set Support Set Set Set Set Set Set Set Set Set Se	TEACHING METHODOLOGY								
COURSE SCHEDULEWeeksTopicsRemarksWeek-1Fundamentals of heat transfer mechanisms (I)Class Test 1, Final ExamWeek-2Fundamentals of heat transfer mechanisms (II)Class Test 1, Final ExamWeek-3Fluid mechanics in fluids and analogiesExamWeek-4Energy and core flow distributionClass Test 2, Final ExamWeek-5Reactor heat generation and transferClass Test 2, Final ExamWeek-6Radial temperature distributions in fuel elementsMid Term, Final ExamWeek-7Axial temperature distributions in fuel elementsMid Term, Final ExamWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisFinal ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final Exam	Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method							
WeeksTopicsRemarksWeek-1Fundamentals of heat transfer mechanisms (I)Class Test 1, Final ExamWeek-2Fundamentals of heat transfer mechanisms (II)Class Test 1, Final ExamWeek-3Fluid mechanics in fluids and analogiesClass Test 2, Final ExamWeek-4Energy and core flow distributionClass Test 2, Final ExamWeek-5Reactor heat generation and transferClass Test 2, Final ExamWeek-6Radial temperature distributions in fuel elementsMid Term, Final ExamWeek-7Axial temperature distributions in fuel elementsMid Term, Final ExamWeek-8Applications of single-phaseMid Term, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final ExamWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsClass Test 3, Final Exam	COURSE SCHEDULE								
Week-1Fundamentals of heat transfer mechanisms (I)Class Test 1, Final ExamWeek-2Fundamentals of heat transfer mechanisms (II)I, Final ExamWeek-3Fluid mechanics in fluids and analogiesExamWeek-4Energy and core flow distributionClass Test 2, Final ExamWeek-5Reactor heat generation and transferClass Test 2, Final ExamWeek-6Radial temperature distributions in fuel elementsClass Test 2, Final ExamWeek-7Axial temperature distributions in fuel elementsMid Term, Final ExamWeek-8Applications of single-phaseMid Term, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final ExamWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsClass Test 3, Final Exam	Weeks	Topics	Remarks						
Week-2Fundamentals of heat transfer mechanisms (II)Charse Text 1, Final ExamWeek-3Fluid mechanics in fluids and analogiesExamWeek-4Energy and core flow distributionClass Test 2, Final ExamWeek-5Reactor heat generation and transferClass Test 2, Final ExamWeek-6Radial temperature distributions in fuel elementsKeachorWeek-7Axial temperature distributions in fuel elementsMid Term, Final ExamWeek-8Applications of single-phaseMid Term, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final Exam	Week-1	Fundamentals of heat transfer mechanisms (I)	Class Test						
Week-3Fluid mechanics in fluids and analogiesExamWeek-4Energy and core flow distribution	Week-2	Week-2 Fundamentals of heat transfer mechanisms (II)							
Week-4Energy and core flow distributionClass Test 2, Final ExamWeek-5Reactor heat generation and transferClass Test 2, Final ExamWeek-6Radial temperature distributions in fuel elementsMid Term, Final ExamWeek-8Applications of single-phaseMid Term, Final ExamWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisFinal ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final Exam	Week-3	Fluid mechanics in fluids and analogies	Exam						
Week-5Reactor heat generation and transferClass Test 2, Final ExamWeek-6Radial temperature distributions in fuel elementsExamWeek-7Axial temperature distributions in fuel elementsMid Term, Final ExamWeek-8Applications of single-phaseMid Term, Final ExamWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisFinal ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final Exam	Week-4	Energy and core flow distribution							
Week-6Radial temperature distributions in fuel elementsZ, Final ExamWeek-7Axial temperature distributions in fuel elementsMidWeek-8Applications of single-phaseMid Term, Final ExamWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisTerm, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final Exam	Week-5         Reactor heat generation and transfer								
Week-7Axial temperature distributions in fuel elementsMidWeek-8Applications of single-phaseMidWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisTerm, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final ExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final Exam	Week-6	Week-6 Radial temperature distributions in fuel elements							
Week-8Applications of single-phaseMid Term, Final ExamWeek-9Two-phase flow and convective boiling to reactor coolant channel analysisTerm, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsCritical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final ExamWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsExam	Week-7	Axial temperature distributions in fuel elements							
Week-9Two-phase flow and convective boiling to reactor coolant channel analysisTerm, Final ExamWeek-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsClass Test 3, Final BrinalWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final ExamWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsExam	Week-8	Applications of single-phase	Mid						
Week-10Core thermal design and safety analysisExamWeek-11Two-phase flow patternsExamWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass Test 3, Final ExamWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsExam	Week-9	Two-phase flow and convective boiling to reactor coolant channel analysis	Term, Final						
Week-11Two-phase flow patternsClass TestWeek-12Critical heat flux, DNBR, AOOs, Void coefficientClass TestWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditionsSince the second seco	Week-10	Core thermal design and safety analysis	Exam						
Week-12Critical heat flux, DNBR, AOOs, Void coefficientClass TestWeek-13Radiative heat transfer, Thermal-hydraulic safety limits and conditions <b>Class TestExam</b>	Week-11	Two-phase flow patterns							
Week-13Radiative heat transfer, Thermal-hydraulic safety limits and conditions5, Final Exam	Week-12	Critical heat flux, DNBR, AOOs, Void coefficient	Class Test						
	Week-13	3 Radiative heat transfer, Thermal-hydraulic safety limits and conditions							
Week-14 Reactor heat generation and transfer	Week-14	Reactor heat generation and transfer							

	Components	Grading	СО	<b>Blooms Taxonomy</b>		
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO4	C3, C5		
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C3, C4		
	Mid term	10%	CO3	C2		
Final Examination		60%	CO1-CO4	C2-C5		
	Total Marks	100%				

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. Neil E., and Mujid Kazimi. *Nuclear systems volume I: Thermal hydraulic fundamentals*, 2nd edition, Boca Raton, USA: CRC press, 2011.
- 2. Cengel Y.A. and Boles, M.A., *Thermodynamics: An Engineering Approach*, 8th edition, Europe: McGraw-Hill Education, 2014.
- 3. Cengel, Y. A. and Cimbala, J. M., *Fluid Mechanics: Fundamentals and Applications*, 3rd edition, United States: McGraw-Hill, 2010.

## **REFERENCE SITE**

	COURSE INFORMATION											
Course Code Course Title	: NE 306 : Nuclear Reactor Thermal Hydrauli	cs Sessional	Lecture C Credit Ho	ontact H urs	Hours	:	3.00 1.50					
	PRE-REQUISITE											
	NE 305											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/RATIONALE											
	This course is designed to provide a general introduction to heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer.											
	OBJECTIVES											
	To verify practically the theories and	l concepts learne	d in NE 305.									
	LEARNING OUTCOMES											
	Upon completion of the course, the s	students will be a	ble to									
	<ol> <li>Analyze energy conversion and distributions in fuel elements.</li> <li>Explain multi-phase flow, conve heat transfer.</li> </ol>	core flow distrib	oution, reacto	r heat g t channe	enerationel proce	on, t ss ai	temperature nd radiative					
	COURSE OUTCOMES & GENE	RIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA R		Assessment Methods					
CO1	<b>Analyze</b> energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements.	PO2, PO3	C4	1	2 1		R, Q, T					

CO2	Explain boiling process	multi-phase flo to reactor coc and radiative hea	w, convective lant channel t transfer.	PC	02, P	04		(	25		3		3	4 , 5	R, 2	MT, T	'	
	(CP- Co Quiz; As	mplex Problems SG – Assignmen	, CA-Complex t; Pr – Presenta	Activi tion; R	ties, Re	KP-l eport	Kno ; F –	wled - Fina	ge I al Ez	Profi xam,	le, T , MT	` – Т `- М	fest ; id Te	PR – erm E	- Proje xam)	ect ; Ç	<u>)</u> –	
	COUR	SE CONTENT	[															
	Study o Demons Investig Determ Study o Study o Determ Demons Investig	of heat exchange stration of the l gation of the eff ination of therm of force convect of forced convect of heat transfer l ination of heat stration of film- gation of the air	er. aw of partial p fect of pressur- nal conductivi ion heat transi- ction of fin/fla by radiation an flow and surfa- wise condens effect in a co	oressure e on ca ity of a fer in a the plate nd con ace hea sation ndense	res. ritica a me a cire /pip vent at tra and r er.	al the tal b cular e bur ion. ansfe meas	erm y st r tub ndle er co sure	al flo eady be. e. beffic emen	ow. ⁷ sta cier t of	te m at at	con con	od. stan hea	t pre t trai	essure	e. coeff	icient	t.	
	SKILL MAPPING (CO-PO MAPPING)																	
					PROGRAM OUTCOMES (PO)													
	No.	Course Le	Course Learning Outcome <b>Analyze</b> energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements		1	2	<u>Р</u> 3	4 4	jRA	<u>мс</u> 6	7	<u>CON</u> 8	<u>1ES</u>	(PO) 10	11	12		
	CO1	Analyze ener core flow distr generation, distributions in				3	3											
	CO2	Explain m convective b coolant chan radiative heat t h. 2- Medium, 1-	ulti-phase oiling to re nel process ransfer. -low)	flow, eactor and		3		3										
JUSTIFICAT	ION FO	R CO-PO MA	PPING															
Mapping	Corr Level	responding of Matching						Just	tific	atio	n							
CO1-PO2		3	In order to a generation, te research liter substantiated and engineeri	malyze mpera rature conclu ng scie	ene ture and ision	rgy d distri anal s usi are i	conv buti lysis ng f requ	versions in one of of first fired.	on a n fu con prin	nd c el el nple ciple	core leme x e es of	flov ents, ngin f ma	v dis iden eerin them	tribut tificat g pro atics,	ion, r ion, f oblem natur	reactor ormul s rea cal sci	heat ation, ching ences	
CO1-PO3	3 In order to analyze energy conversion and core flow distribution, reactor generation, temperature distributions in fuel elements, it is required to d solutions for complex engineering problems and design systems, componer processes that meet specified needs with appropriate consideration for public h and safety cultural societal and environmental considerations					heat lesign nts or nealth												
CO2-PO2		3	In order to ex process and r and analysis o using first pri required.	plain n adiativ of com nciples	nulti e hea plex of n	-phas at tra engin nathe	se flo insfe neer mat	ow, c er, id ring p ics, r	enti orob natur	ectiv ficat lems ral so	ve bo ion, s rea cienc	oiling form chin ces a	g to r nulat g sub nd er	eacto ion, r ostant nginee	r cool esearc iated ering	ant ch ch liter conclu science	annel rature isions es are	

CO2-PO4         3         complex problems using research-based knowledge ar including design of experiments, analysis and interpretation of information to provide valid conclusions.	ad research method of data, and synthesi
TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning         Lecture         Practical / Tutorial / Studio         Student-Centred Learning         Self-Directed Learning         Preparation of Lab Reports         Properation of Lab Test	28 28 - 28 20
Preparation of presentation Preparation of Quiz Engagement in Group Projects	14 - -
Formal Assessment Continuous Assessment Final Quiz Total	- 1 1 120
TEACHING METHODOLOGY	120
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method	
COURSE SCHEDULE	
Weeks Topics	Remarks
Week-1 Introduction	
Week-2 Study of heat exchanger	
Week-3 Demonstration of the law of partial pressures	
Week-4 Investigation of the effect of pressure on critical thermal flow	Mid-term
Week-5 Determination of thermal conductivity of a metal by steady state method	
Week-6 Study of force convection heat transfer in a circular tube	
Week-7 Mid-term	
Week-8 Study of forced convection of fin/flat plate/pipe bundle	
Week-9 Study of heat transfer by radiation and convention	
Week-10 Determination of heat flow and surface heat transfer coefficient at constant press	sure
Week-11         Demonstration of film-wise condensation and measurement of overall heat tran coefficient	sfer <b>Final</b> Exam
Week-12 Investigation of the air effect in a condenser	
Week-13 Lab practice	

	Components	Grading	СО	Blooms Taxonomy
Continuous Assessment (60%)	Class Participation + Attendance	5+5=10%	CO1	C4
	Conduct of Lab Test	20%	CO1, CO2	C4, C5
	Report Writing	15%	CO1, CO2	C4, C5
	Mid term	15%	CO2	C4, C5
Final	Exam	30%	CO1, CO2	C4, C5
Evaluation (40%)	Viva Voce/ Presentation	10%	CO1, CO2	C4, C5
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. Todreas, N.E. and Kazimi, M. S. *Nuclear Systems I Thermal Hydraulic Fundamentals*, Taylor & Francis, 2nd edition, 2011.
- 2. Cengel Y.A. and Boles, M.A., *Thermodynamics: An Engineering Approach*, 8th edition in S.I. units, McGrawHill Book Company, 2014.
- 3. Cengel, Y. A. and Cimbala, J. M. Fluid Mechanics: Fundamentals and Applications, McGraw-Hill, 2010.
- 4. Wakil, M. M. E.; *Nuclear Energy Conversion*.
- 5. El-Wakil, M.M., Nuclear Heat Transport, International Text Book, 1971.
- 6. Rust, J.H., Nuclear Power Plant Engineering, Haralson, 1979.

#### **REFERENCE SITE**

	COURSE INFORMATION								
Course Code Course Title	: NE 307 : Reactor Theory and Analysis – II	Lecture Contact Hours Credit Hours	: 3.00 : 3.00						
	PRE-REQUISITE								
	NE 207								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								

	This course is designed to develop understanding on the reactor kinetics and transfer function in reactor engineering and develop analyzing capability on propagation of a neutron beam.										
	OBJECTIVES										
	<ol> <li>To understand reactor kinetics and transfer function in nuclear engineering.</li> <li>To understand the propagation of a neutron beam in a passive medium.</li> <li>To know the analysis of criticality of heterogeneous and homogeneous reactors and reactivity worth of partially inserted control rod.</li> <li>To understand the perturbation theory and its application.</li> <li>To calculate multi neutron diffusion equation in passive media with an external source.</li> </ol>										
	Upon completion of the course, the students will be able to										
	<ol> <li>Apply reactor kinetics and transfer function in nuclear reactor engineering.</li> <li>Analyze the criticality of heterogeneous and homogeneous reactors and also analyze reactivity worth of partially inserted control rod.</li> <li>Explain scalar neutron flux and neutron current, perturbation theory and its application.</li> <li>Evaluate multi neutron diffusion equation in passive media with an external source, Fermi age calculation, and neutron migration length.</li> </ol>										
	COURSE OUTCOMES & GENERIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods				
CO1	<b>Apply</b> reactor kinetics and transfer function in nuclear reactor engineering.	PO1, PO2	C3	-	-	3	T, Q, F				
CO2	Analyze       the       criticality       of         heterogeneous       and       homogeneous       PO3       C4       -       -       4       ASG, F         worth of partially inserted control rod       point       PO3       C4       -       -       4       ASG, F										
CO3	<b>Explain</b> scalar neutron flux and neutron current, perturbation theory and its application.	PO3	C5	-	-	5	MT, F				
CO4	<b>Evaluate</b> multi neutron diffusion equation in passive media with an external source, Fermi age calculation, and neutron migration length.	PO3	C5	1	-	6	T, F				
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentar	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT-	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)				
	COURSE CONTENT										
	<b>COURSE CONTENT</b> Reactor kinetics and transfer function, Propagation of a neutron beam in a passive medium. Scalar neutron flux and neutron current. The multi neutron diffusion equation. Solution of the neutron diffusion equation for passive media with an external neutron source. Reactor criticality calculations, criticality analysis of heterogeneous and homogeneous reactors. Nodal Analysis, Sn method, Dn method, Perturbation Theory and its applications: Reactivity worth of Partially Inserted Control Rod, Elastic scattering kinematics, Fermi age calculation, and neutron migration length.										
	SKILL MAPPING (CO-PO MAPI	PING)									

						D	ROO	3P /	M		<u></u>	/FS	$(\mathbf{PO})$			1
	No.	Course I	earning Outcome	1	2	2 r	4	5	6	7	8	9	10	11	12	
	CO1	<b>Apply</b> reactor function in engineering.	r kinetics and transfer n nuclear reactor	3	3				0	,		,	10		12	
	CO2	Analyze the criticality of heterogeneous and homogeneous reactors and also analyze reactivity worth of partially inserted control rod.				2										
	CO3	<b>Explain</b> scalar neutron flux and neutron current, perturbation theory and its application.				3										
	CO4	<b>Evaluate</b> me equation in p external so calculation, a length.			3											
	(3 – Hig	3 – High, 2- Medium, 1-low)												_		
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corre Level o	esponding of Matching				Ju	ıstif	ica	tion							
CO1-PO1		3	In order to apply re- engineering, the kno fundamentals and an engineering problems	eacto owle eng is to	or ki dge ginee be a	netic of ring pplie	s ar matl spe ed.	nd t hem cial	rans atics izati	fer s, na on t	funct atura to th	tion 1 sc e sc	in nu cience olutior	uclear , eng 1 of (	reac ineer comp	tor ing lex
CO1-PO2		3	In order to apply re engineering, identific complex engineering principles of mathema	eacto ation prol	or ki n, fo blem natu	netic ormu s rea	s ar latio achii	nd f n, ng s	rans resea subst and e	fer arch tantia	funct liter ated	tion ratur con	in nu e and clusio	uclear 1 ana ns us s are 1	reac lysis ing f	tor of irst red
CO2-PO3		2	In order to analyze the also analyze reactivity design solutions for components or process for public health and s	criti y wo con ses tl	icalit orth mple hat n y, cu	y of of pa ex en neet s ltural	heter artial ngin speci	roge lly i eeri fiec cieta	neo nser ng nee l nee	us ar ted o prob ds w id en	nd ho contr lems vith a iviror	mog ol ro an ppro	geneou od, it d des priate ntal co	is reactions is reactions is reactions is reactions is reaction in the second s	ctors a juired system derat	ind to ns, ion ns.
CO3-PO3		3	In order to explain scal its application, it is req and design systems, appropriate considera environmental consider	lar no uireo comp tion eratio	eutro d to o pone for ons.	on flu lesig nts o publ	x an n so or pi ic h	d ne lutio roce ealt	eutro ons f sses h ar	n cu or co that id sa	rrent omple t me afety	, per ex er et sj , cul	turbat nginee pecific ltural,	ion the ring p ed nee socie	eory a proble eds w etal, a	ind ms /ith ind
CO4-PO3		3	In order to evaluate multi neutron diffusion equation in passive media with an external source, Fermi age calculation, and neutron migration length, it is required to design solutions for complex engineering problems and design systems components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.										an red ns, ion 1s.			
<b>TEACHING I</b>	LEARNI	NG STRATI	EGY													
Teaching and I	Learning .	Activities											E	ngag (hou	emen urs)	ıt
	Face-to	-Face Learnir Lecture	ıg											42	2	

	Practical / Tutorial / St Student-Centred Learn	udio ing			-			
	Self-Directed Learning							
	Non-face-to-face learn	ing			84			
	Revision				21			
	Formal Assessment				2			
	Mid-Term	11			2			
	Final Examination				3			
	Total				153			
TEACHING N	METHODOLOGY							
Lecture and Di	scussion, Co-operative and Colla	borative Metho	od, Problem Based Meth	od				
COURSE SCI	HEDULE							
Weeks		Topics			Remarks			
Week-1	Reactor kinetics and transfer fu	inction			Class Test			
Week-2	Propagation of a neutron beam	in a passive me	edium		1, Final			
Week-3	Scalar neutron flux and neutron	n current			Exam			
Week-4	The multi neutron diffusion equ	uation						
Week-5	Solution of the neutron diffus neutron source	sion equation f	or passive media with	an external	Class Test 2. Final			
Week-6	Reactor criticality calculations				Exam			
Week-7	Criticality analysis of heterogen	neous and home	ogeneous reactors					
Week-8	Reactivity worth of partially in	serted control r	od		Mid			
Week-9	Nodal Analysis				Term, Final			
Week-10	Sn method				Exam			
Week-11	Dn method							
Week-12	Perturbation Theory and its app	olications			Class Test			
Week-13	Elastic scattering kinematics				Exam			
Week-14	Fermi age calculation, and neut	tron migration l	ength					
ASSESSMEN	T STRATEGY							
	Components	Grading	CO	Blooms Te	axonomy			
	Class Test/ Assignment (1-3)	20%	CO1. CO2. CO4	C3. C4	4. C5			
Continuous Assessment	Class Participation and Class		,,					
(40%)	attendance	5+5=10%	CO1, CO2	CO1, CO2 C3, C4				
	Mid term	10%	CO3	C	5			
	Final Examination	60%	CO1-CO4	C3-	C5			
	Total Marks	100%						

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. E.E. Lewis, *Fundamentals of Nuclear Reactor Physics*, 1st edition, Massachusetts, USA: Academic Press, 2008.
- 2. Waltar, Alan, and Donald Todd. *Fuel Pin Thermal Performance: Fast Spectrum Reactors*. Boston, USA: Springer, 2012.
- 3. Lamarsh, J.R. and Baratta, A.J., Introduction to Nuclear Reactor Theory, 3rd edition, USA: Pearson, 2001.

# **REFERENCE SITE**

	COURSE INFORMATION		
Course Code Course Title	: NE 317 : Nuclear Security and Safeguard Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	This course is designed to provide a general into on nuclear sector. It will introduce the important layers, graded approach, category of nuclear mat for protection of nuclear material, radiation an Threat (DBT) on boarder, airport, sea port. Apa important topics including inspection guidance cultures, insider threats analysis, cyber se neutralization.	troduction to nuclear security a t concepts such as physical proto aterial, Physical Protection Syste d associated facilities and analy art from these, this course will a e, assessment methodology for curity, nuclear security even	nd safeguard acts ection regime and em (PPS) designs yze Design Basis also introduce the nuclear security nt response and
	OBJECTIVES		
	<ol> <li>To understand the fundamentals of physica defence in depth, Physical Protection Sys nuclear material and radioactive sources du</li> <li>To study on national legislative and regulate instruments.</li> <li>To know risk, threat characteristics, and thr</li> </ol>	l protection regime and layers, tem (PPS) design architecture ring use, storage, and transport. ory frameworks and internationa eat assessments.	graded approach, for protection of al nuclear security
	4. To know NPT, IAEA safeguards systems, agreements, additional protocol agreement	evolving safeguards implement s. national regulatory framewo	tation, safeguards

	<ul> <li>policy and regulation.</li> <li>5. To understand the nuclear security and safeguard interfacing.</li> <li>6. To acquire knowledge on safeguards information system, safeguards verification systems, and SSAC.</li> </ul>											
	LEARNING OUTCOMES											
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Apply nuclear security and safeguard acts on nuclear sector.</li> <li>Explain safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation.</li> <li>Analyze physical protection regime, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities .</li> <li>Evaluate safeguards information system, safeguards verification systems, enrichment and reprocessing facilities, safeguards R&amp;D for advanced nuclear fuel cvcles.</li> </ol>											
	COURSE OUTCOMES & GENERIC SKILLS											
No.	Course Learning OutcomeCorresponding POsBloom's TaxonomyCPCAKPAssessment Methods											
CO1	<b>Apply</b> nuclear security and safeguard acts on nuclear sector.	PO1	C3	-	-	3	T, Q, F					
CO2	<b>Explain</b> safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation.	PO2	C5	-	-	4	ASG, F					
CO3	<b>Analyze</b> physical protection regime, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities.	PO2	C4	-	-	5	MT, F					
CO4	Evaluatesafeguardsinformationsystem,safeguardsverificationsystems, enrichment and reprocessingPO3C51facilities,safeguardsR&Dforadvanced nuclear fuel cycles											
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)											
	COURSE CONTENT											

Definition of nuclear security; threat, theft, sabotage, nuclear attacks, historical developments, international protocols, UNSCR-1373, 1540, IAEA nuclear security document series and hierarchy, member state's obligations towards nuclear security, legal and non-legal binding instruments for member states, legislative and regulatory framework for nuclear security, physical protection regime and layers, graded approach, category of nuclear material, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities, Design Basis Threat (DBT) analysis, detection architecture (boarder, airport, sea port), regulation for nuclear material and radioactive sources in storage and transport, export and import control, assessment methodology for nuclear security cultures, insider threats analysis, cyber security, nuclear security event response and neutralization.

NPT, IAEA safeguards systems, evolving safeguards implementation, safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation, nuclear material facility inspection guidance, state-level and integrated safeguards concepts, State Systems Accounting for and Control (SSAC) of nuclear material, safeguards reporting system, safeguards information system, safeguards verification systems, NDAS and DAS, safeguards challenges for fuel fabrication, enrichment and reprocessing facilities, safeguards R&D for advanced nuclear fuel cycles.

#### SKILL MAPPING(CO-PO MAPPING)

	No	Course I	anning Outcome	PROGRAM OUTCOMES (PO)											
	NO.	Course I	Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12
	CO1	Apply nuc safeguard act	clear security and s on nuclear sector.	3											
	CO2	Explain sat additional p national regu safeguards po	feguards agreements, protocol agreements, ilatory framework for blicy and regulation.		3										
	CO3	Analyze regime, Phys (PPS) desig nuclear mat associated fa	physical protection ical Protection System ns for protection of terial, radiation and cilities.		3										
	CO4	Evaluate sa system, sat systems, reprocessing R&D for a cycles.	feguards information feguards verification enrichment and facilities, safeguards dvanced nuclear fuel			3									
	(3 - Hig)	h, 2- Medium,	1-low)												
JUSTIFICAT	ION FO	R CO-PO M	APPING												
Mapping	Corre Level o	esponding of Matching	Justification												
CO1-PO1		3	In order to apply nuclear security and safeguard acts on nuclear sec knowledge of mathematics, natural science, engineering fundamentals engineering specialization to the solution of complex engineering proble be applied.								otor, t and other and set of the				
CO2-PO2		3	In order to explain safeguards agreements, additional protocol agree national regulatory framework for safeguards policy and regulation, identifi formulation, research literature and analysis of complex engineering pr									emen ficatio probler			

reaching substantiated conclusions using first principles of mathematics, natural

sciences and engineering sciences are required.

CO3-PO2	2	In order to analyze physical protection regime, Physical Protection of nuclear material, radiation and as identification, formulation, research literature and analysengineering problems reaching substantiated conclusions using mathematics, natural sciences and engineering sciences are required.	tion System (PPS) sociated facilities, ysis of complex g first principles of uired.
CO4-PO3	2	In order to evaluate safeguards information system, safeg systems, enrichment and reprocessing facilities, safeguards R nuclear fuel cycles, it is required to conduct investigations of using research-based knowledge and research methods inc experiments, analysis and interpretation of data, and synthesis provide valid conclusions.	uards verification &D for advanced complex problems cluding design of of information to
<b>TEACHING I</b>	LEARNING STRATI	EGY	
Teaching and I	Learning Activities		Engagement (hours)
TEACHING N Lecture and Di COURSE SCI	Face-to-Face Learnin Lecture Practical / T Student-Cen Self-Directed Learni Non-face-to Revision Formal Assessment Continuous Mid-Term Final Exami Total METHODOLOGY scussion, Co-operative	ng utorial / Studio tred Learning ng -face learning Assessment nation e and Collaborative Method, Problem Based Method	42 - - 84 21 2 1 3 153
Weeks		Topics	Remarks
Week-1 Week-2	Definition of nuclea developments, intern UNSCR-1373, 1540 member state's oblig	r security; threat, theft, sabotage, nuclear attacks, histori ational protocols ), IAEA nuclear security document series and hierarch ations towards nuclear security	cal Class Test 1, Final
Week-3	Legal and non-lega regulatory framewor	I binding instruments for member states, legislative a k for nuclear security, physical protection regime and layer	Exam and s
Week-4	Graded approach, ca designs for protection	tegory of nuclear material, Physical Protection System (PI n of nuclear material	PS)
Week-5	Detection architectur and radioactive source	re (boarder, airport, sea port), regulation for nuclear mater ces in storage and transport	rial Class Test 2, Final
Week-6	Export and import co	ontrol, assessment methodology for nuclear security culture	es Exam
Week-7	Radiation and associ	ated facilities, Design Basis Threat (DBT) analysis	
Week-8	Safeguards informati	on system, safeguards verification systems	Mid Term
Week-9	Nuclear security even	nt response and neutralization, NPT, IAEA safeguards syste	ms Final
Week-10	Safeguards challenge	es for fuel fabrication	Exam

Week-11	Enrichment and reprocessing facilities	
Week-12	Nuclear material facility inspection guidance, state-level and integrated safeguards concepts	Class Test 3. Final
Week-13	Safeguards R&D for advanced nuclear fuel cycles	Exam
Week-14	Syllabus and previous year question analysis	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C3, C5
	Mid term	10%	CO3	C4
	Final Examination	60%	CO1-CO4	C3-C5
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

1. Maiani Luciano, Abousahl, Said, Plastino, Wolfango, *International Cooperation for Enhancing Nuclear Safety, Security, Safeguards and Non-proliferation*, 1st edition, Rome, Italy: Springer International Publishing 2015.

2. Doyle, James, *Nuclear safeguards, security and nonproliferation: achieving security with technology and policy*, 2nd edition, USA: Butterworth-Heinemann, 2011.

3. International Atomic Energy Agency, *Nuclear Material Accounting Handbook*, services series no. 15, IAEA, Vienna (2008).

4. International Atomic Energy Agency, *Objective and Essential Elements of a State's Nuclear Security Regime*, IAEA Nuclear Security Series No. 20, IAEA, Vienna (2013).

# **REFERENCE SITE**

	COURSE INFORMATION		
Course Code Course Title	: NE 318 : Nuclear Security and Safeguard Engineering Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
	PRE-REQUISITE		
	NE 317		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		

	SYNOPSIS/RATIONALE										
	This course is designed to provide a general idea on simulation and practical based application on nuclear security and safeguard. This course will also introduce the practical part of several important topics including inspection guidance, assessment methodology for nuclear security cultures, insider threats analysis, cyber security, nuclear security event response.										
	OBJECTIVES										
	<ol> <li>To enable the students to design and analyze the Physical Physical Protection System (PPS) to secure nuclear materials.</li> <li>To make students acquainted with IAEA safeguards system and its application.</li> <li>To be familiar with different procedure in practical to ensure safeguard act.</li> <li>To impart into students the safeguards with verification systems, enrichment and reprocessing facilities.</li> </ol>										
	LEARNING OUTCOMES										
	<ol> <li>Apply safeguard knowledge to prevent nuclear proliferation.</li> <li>Analyze Physical Protection System (PPS) and adapt to the specified requirements using both simulating tools and hardware.</li> <li>Design simula Physical Protection System (PPS) to suppress product to the specified requirements using both simulating tools and hardware.</li> </ol>										
	5. Design simple Physical Protection System (PPS) to secure nuclear materials.										
	COURSE OUTCOMES & GENERIC SKILLS										
No.	Course Learning Outcome	POs	Taxonomy	СР	CA	KP	Methods				
CO1	<b>Apply</b> safeguard knowledge to prevent nuclear proliferation.	PO1	C3	1	2	3	R, Q, T				
CO2	<b>Analyze</b> Physical Protection System (PPS) and <b>adapt</b> to the specified requirements using both simulating tools and hardware.	PO2	C4	2	1	4	MT, R, Q, T				
CO3	<b>Design</b> a simple Physical Protection System (PPS) to secure nuclear materials.	PO4	C6	1	1	7	R, Q, T, PR				
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT-	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)				
	COURSE CONTENT										
	<ol> <li>Analysis of Probabilistic Risk Assessment (PSA) inside the Pressurized Water Reactor (PWR).</li> <li>Application of malicious software in order to ensure cyber security of the NPP.</li> <li>Practice of emergency preparedness and activities for NPP workers and employees on transient situation.</li> <li>Analysis of emergency mode operation in case of any transient situation inside the reactor.</li> <li>Analysis of Physical Protection System (PPS) to prevent any kind of sabotage and removal of nuclear materials.</li> <li>Design a Physical Protection System (PPS) to prevent any kind of sabotage and removal of nuclear materials.</li> </ol>										

	SKILL	MAPPING(	CO-PO MAPPING)													
	No.	Course L	earning Outcome	1		P	ROC	GRA	M (	DUT	CON	1ES	(PO)	11	10	1
		Apply safes	uard knowledge to	1	2	3	4	5	6	1	8	9	10	11	12	
	CO1	prevent nucle	ar proliferation.	3												1
		Analyze I	Physical Protection													
	CO2	specified rea	b) and <b>adapt</b> to the uirements using both		3											
		simulating to	ols and hardware.													
		Design a sim	ple Physical Physical													1
	CO3	nuclear materials.													1	
	(3 – Hig	h, 2- Medium,	1-low)	1												
JUSTIFICAT	TION FOR CO-PO MAPPING															
	Corre	esponding														
Mapping	Level of Matching Justification															
CO1-PO1	3 Knowledge of both scientific and safeguard fundamentals are requir PPS.										ared to design					
CO2-PO2	3 Security will be ensured by finding relevant problems and its consolution.										corres	pondi	ng			
CO3-PO4		2	Designing a PPS by fo	ollow	ing p	prope	er IA	EA	guio	dance	e.					
<b>TEACHING I</b>	LEARNI	NG STRATE	EGY													
Teaching and L	Learning .	Activities												Eng nt (	agen hours	ie s)
	Face-to	-Face Learnin	ıg													
		Lecture													14	
		Practical / Tu	itorial / Studio												28	
	Self-Di	rected Learni	ng												-	
		Preparation of	of Lab Reports												14	
		Preparation of	of Lab Test												10	
		Preparation of Preparation of Preparation	of presentation												9	
	Engage	ment in Grou	p Projects													
	881	Formal Asse	ssment													
	-	Continuous A	Assessment												1	
	Final Quiz 1															
TEACHINC	I OTAI														90	
Lecture and Di	scussion.	Co-operative	and Collaborative M	etho	d. P	robl	em l	Bas	ed N	Лeth	od					
COURSE SCHEDULE																
Weeks		-	Торі	cs										Re	mark	KS

Week-1	Analysis of Probabilistic Risk Assessment (PSA) inside the Pressurized Water Reactor (PWR)	
Week-2	Application of malicious software in order to ensure cyber security of the NPP	
Week-3	Practice of emergency preparedness and activities for NPP workers and employees on transient situation	
Week-4	Analysis of emergency mode operation in case of any transient situation inside the reactor	
Week-5	Analysis of Physical Protection System (PPS) to prevent any kind of sabotage and removal of nuclear materials	
Week-6	Design a Physical Protection System (PPS) to prevent any kind of sabotage and removal of nuclear materials	
Week-7	Lab test, Quiz	

Components	Grading	СО	<b>Blooms Taxonomy</b>
Conduct of Lab Tests/Class Performance	25%	CO1, CO2, CO3	C3, C4, C6
Report Writing/ Programming	15%	CO1, CO2, CO3	C3, C4, C6
Mid-Term Evaluation (exam/project/assignment)	20%	CO2	C4
Viva Voce	10%	CO1, CO2, CO3	C3, C4, C6
Final Evaluation (Lab Quiz)	30%	CO1, CO2, CO3	C3, C4, C6
Total Marks	100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. International Cooperation for Enhancing Nuclear Safety, Security, Safeguards and Non-proliferation, Maiani Luciano, Abousahl, Said, Plastino, Wolfango (Eds.), 2015.
- 2. James Doyle Nuclear Safeguards, Security and Nonproliferation: Achieving Security with Technology and Policy, ISBN 978, 2008
- 3. Nuclear Security Series #11, #13, #20

#### **REFERENCE SITE**

	COURSE INFORMATION		
Course Code Course Title	: NE 320 : Industrial Training	Lecture Contact Hours Credit Hours	: 5 weeks : 1.5
	PRE-REQUISITE		
	None		

	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/RATIONALE											
	Industrial training helps learners to acquire the latest techniques, skills, methodologies and to build a strong foundation for their career growth. In a nutshell, it helps in boosting career of students, since by the end of this training; students are turned into professionals in their specialized area.											
	OBJECTIVES											
	<ol> <li>To provide comprehensive learning platform to students where they can enhance their employ ability skills and become job ready along with real corporate exposure.</li> <li>To provide learners hands on practice within a real job situation.</li> </ol>											
	LEARNING OUTCOMES											
	<ol> <li>Interview the people involved in design, construction of NPP.</li> <li>Identify required skills for reactor operation and maintenance.</li> <li>Utilize management tools to handle different categories reactor control systems.</li> <li>Plan the crisis management and resolve the conflicts amongst subordinates.</li> <li>Understand management and operation and maintenance of radiological equipment in medical sector.</li> <li>Take part in decision making process.</li> </ol>											
	COURSE OUTCOMES & GENERIC SKILLS											
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
CO1	<b>Interview</b> the people involved in <b>design</b> , <b>construction</b> of NPP.	PO1	C3	1		4-6	Rp, Pr, WS					
CO2	<b>Identify</b> required skills for reactor operation and maintenance.	PO1	C3	1		6	Rp, Pr, WS					
CO3	<b>Utilize</b> management tools to handle different categories reactor control systems.	PO5	C3	7		5-6	Rp, Pr, WS					
CO4	<b>Plan</b> the crisis management and resolve the conflicts amongst subordinates.	PO9	C6	7		5-6	Rp, Pr, WS					
CO5	<b>Understand</b> management and operation and maintenance of radiological equipment in medical sector.	PO3	C2	1		4-6	Rp, Pr, WS					
CO 6	Take part in decision making process.	PO12	C4	1		4-6	Rp, Pr, WS					
	(CP – Complex Problems, CA – Comple Attendance, KS – Knowledge Skill, WS Test; PR – Project ; Q – Quiz; ASG – A	x Activities, KP – 5 – Working Skill ssignment; Rp - R	Knowledge Pi and Work Per eport; F – Fina	rofile, I forman al Exan	R – Reg ice , Pr n)	gularity – Pres	r in Work and sentation, T –					
	COURSE CONTENT Content is prepared by the specified	l industries Stu	dent has to a	nnlv t	heoret	ical a	nd technical					
	knowledge to perform or execute the	given task by th	ie specified in	ndustri	les.	icui al						

	SKILL	MAPPING	(CO-PO MAPPING)	)												
		1														
	No.	Course I	earning Outcome	1	2	P 3	ROC	GRA	M (	DUT 7	CON	1ES	(PO)	11	12	1
	CO1	Interview the	e people involved in truction of NPP	3	2	5	+	5	0	/	0	,	10	11	12	
	CO2	<b>Identify</b> requirements	uired skills for reactor l maintenance.	3												
	CO3	Utilize mana different cate systems.	gement tools to handle egories reactor control					3								
	CO4	Plan the cr resolve the subordinates.	<b>Plan</b> the crisis management and resolve the conflicts amongst subordinates.									3				
	CO5	Understand operation a radiological sector.	erstand management and ation and maintenance of blogical equipment in medical br.													
	CO 6	CO 6 Take part in decision making process.										2	1			
	(3 - High)	(3 – High, 2- Medium, 1-low)														
JUSTIFICAT	ION FOI	R CO-PO M	APPING													
Mapping	Corre Level o	esponding f Matching				Ju	istif	icat	tion							
CO1-PO1		3	In order to interview knowledge of mathem engineering specializa be applied.	the natic tion	peop s, na to th	ole in atura ie so	nvol 1 sci lutio	ved lenc n oi	in d e, ei f con	lesig ngine nple:	n, co eerin x eng	onstr g fu ginee	uctior ndam ering p	n of N entals proble	NPP, t and ems is	he an to
CO2-PO1		3	In order to identify re knowledge of mathem engineering specializa be applied.	equir natic tion	ed sl s, na to th	kills atura ie so	for a l sci lutio	reac ienc n oi	tor o e, ei f con	opera ngine nple:	ation eerin x en	and g fu ginee	main ndam ering j	tenan entals proble	ce, , 1 and ems is	the an to
CO3-PO5		3	In order to utilize man systems, it is required t and modern engineer complex engineering p	ager to cre ing probl	nent eate, and ems,	tools selec IT to with	s to h et and pols, n an	nanc d ap inc und	lle di ply a ludi ersta	iffere appro ng p andin	ent c opria oredio ng of	atego te teo ction the l	ories r chniqu and limita	eactor ues, re mode tions.	r cont esourc lling,	rol es, to
CO4-PO9		3	In order to plan the subordinates, it is need or leader in diverse tea	cri led to ums a	sis r o fun and i	nana ctior n mu	igem 1 effe 1lti-d	ent ectiv lisci	and vely a plina	res as an ary s	olve i indi ettin	the ividu gs.	conf al, an	licts d as a	amon; meml	gst ber
CO5-PO3		3	In order to understand management and operation and maintenance of radiological equipment in medical sector, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural societal and environmental considerations							cal lex eet ty,						
CO 6-PO12		2	In order to take part in decision making process which will help to achieve life- long learning in professional life													
TEACHING I	LEARNI	NG STRATH	EGY													
		Teaching a	nd Learning Activiti	ies							]	Eng	agem	ent (	week	s)
Face-to-Face L	earning											A	s per	indus	stries	
Self-Directed L	Self-Directed Learning									As per industries						
Formal Assess	nent		Totol							As per industries						
			Total											3		

## **TEACHING METHODOLOGY**

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

#### **COURSE SCHEDULE**

As per industries.

## ASSESSMENT STRATEGY

Students have to complete this course within 4 weeks. Schedule is prepared by different industries.

Components	Grading (%)	СО	Blooms Taxonomy
Regularity in work	10	CO1-CO6	C2, C3, C4, C6
Report Writing	20	CO1-CO6	C2, C3, C4, C6
Working Skill and Work Performance	50	CO1-CO6	C2, C3, C4, C6
Final Presentation	20	CO1-CO6	C2, C3, C4, C6
Total Marks	100		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

N/A

#### **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: NE 321 : Reactor Operation and Safety	Lecture Contact Hours Credit Hours	: 3.00 : 3.00								
	PRE-REQUISITE										
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	This course is designed to provide a general intr It will introduce the important concepts such as cooling systems of research and power reactor, reactor, operation limits and conditions, safety sy response and safety culture concept. Apart fro standards for nuclear facilities available in the principles and safety criteria. From this cou- deterministic and probabilistic safety analysis for	roduction to nuclear reactor ope s research and power reactor op piping and instrumentation dia ystems of research and power re om these, this course will also e IAEA and other countries, fu urse students will also learn or nuclear installations.	ration and safety. peration, different agrams of nuclear eactor, emergency introduce safety ndamental safety fundamentals of								

	OBJECTIVES											
	<ol> <li>To understand the general concepts and issues behind nuclear reactor operation and safety.</li> <li>To able to explain and analyze the elements of Deterministic Safety Analysis (DSA) and Probabilistic Safety Analysis (PSA).</li> <li>To able to explain the principles of reactor operation, reactor start-up sequence &amp; operation at power; pre-nuclear commissioning.</li> <li>To able to hypothesize and classify the operation transients and sever accidents, accident phenomena, general problems of reactor operation.</li> </ol>											
	LEARNING OUTCOMES											
	Upon completion of the course, the students will be able to											
	<ol> <li>Define the nuclear reactor safety features, safety principles, safety systems and safety culture concept.</li> <li>Explain and analyze the elements of deterministic and probabilistic safety analysis.</li> <li>Explain the principles of reactor operation, reactor start-up sequence &amp; operation at power, pre-nuclear commissioning.</li> <li>Analyze the operation transients &amp; severe accidents, accident phenomena, general problems of reactor operation</li> </ol>											
	COURSE OUTCOMES & GENERIC SKILLS											
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
CO1	<b>Define</b> the nuclear reactor safety features, safety principles, safety systems and Safety culture concept.	PO1	C1	-	-	6	T, Q, F					
CO2	<b>Explain</b> and <b>analyze</b> the elements of deterministic and probabilistic safety analysis.	PO3	C2, C4	-	-	2,3	ASG, F					
CO3	<b>Explain</b> the principles of reactor operation, reactor start-up sequence and operation at power, pre-nuclear commissioning.	PO1	C2	-	-	6	MT, F					
CO4	<b>Analyze</b> the operation transients and severe accidents, accident phenomena, general problems of reactor operation.	PO2	C4	1	-	4	T, F					
	(CP- Complex Problems, CA-Complex Ouiz: ASG – Assignment: Pr – Presenta	Activities, KP-Kr	nowledge Prof F – Final Exam	ile, T - MT-	- Test ; Mid Te	PR – erm Ex	Project ; Q –					
	COURSE CONTENT			, .,		נות						
	Safety characterization and safety fe criteria, Design-Basis and Beyo performance, safety issues and saf elements), regulation and safety of operating experience of Research Reso operation; principles of control and of operators; layout of control desks; nuclear commissioning; mechanical reactivity balance at power operation Analysis of operation transients, acc severe accidents.	atures of nuclear and-Design-Basis ety issue resolu- culture; Determ actor and Power operation; metho warnings and er and electrical teon; accident mar idents and sever	r power plant s events, s ution, Probab inistic Safety Reactor (PW) ods of control mergencies; r ests; coolant f nagement, en e accidents; a	s, reac afety illistic y Ana R), gen ; range eactor flow te hergen accider	tor saf syste Safet ilysis neral p e of co start- ests; op cy ope nt pher	ety pr ms, y Ana (basic robler ntrol; up sec peration pomen	inciples and containment dysis (basic e elements); ns of reactor functions of quence; pre- on at power; n procedure; na, including					

	SKILL	MAPPING (	CO-PO MAPPING	)												
		1														
	No	Course Le	earning Outcome			Р	ROC	GRA	AM (	DUT	CON	AES	(PO)			
	110.			1	2	3	4	5	6	7	8	9	10	11	12	
	CO1	<b>Define</b> the n	uclear reactor safety	2												
		systems and s	afety culture concept	3												
		Explain and a	analyze the elements													
	CO2	of determinis	tic and probabilistic			3										
		safety analysis	S.													
		Explain the	principles of reactor													
	CO3	operation, read	ctor start-up sequence	3												
		and operation	at power, pre-nuclear													
		Analyze the operation transients														
		and severe	accidents. accident													
	CO4	phenomena,	general problems of		2											
		reactor operation	ion.													
	(3 - Hig)	h, 2- Medium, 1	l-low)													
JUSTIFICAT	ION FO	ON FOR CO-PO MAPPING														
Manning	Corr	esponding				Ъ	nstif	fica	tion	1						
	Level	of Matching														
			In order to apply the knowledge of engineering fundamentals and an engineering specialization to the solution of complex nuclear science and engineering													
CO1-PO1		3	specialization to the	e sol	utioi	1 Of	cor ar r	nple	ex n	ucles	$ar so \frac{1}{2}$	cienc	te and	d eng	ineeri	ng
	safety systems and s				cult	ure o	an n	ent:	or s are r	ennii	red	luies	s, said	ay pi	merpi	<b>C</b> 5,
		In order to design nu				ty sy	stem	is, a	nd a	nalys	sis, c	omp	onent	s, or p	rocess	ses
CO2-PO3		3	to meet desired needs	ired needs within realistic constraints, explanation and analysis of the											the	
		elements of determin				prob	abili	stic	safe	ty ar	nalys	is ar	e requ	ired.		
			In order to apply the knowledge of engineering fundamentals and an engineering													
CO3-PO1		3	specialization to the	e sol	ution	1 of	cor	nple	ex n	uclea	ar s	cienc	ce and	d eng	ineeri	ng
			sequence and operation	on u on at	ne p	orinci	pies		rea	omm	ope	oning	n, re	actor	start-	up
			In order to undertake	prol	olem	iden	tific	atio	n. fc	ormu	latio	n. re	search	the 1	iteratı	ire
CO4 DO2		2	and analyze complex	eng	inee	ring	prob	lem	is, ai	nalyz	ze of	the	opera	tion ti	ansie	nts
C04-P02		3	and severe accidents,	acci	dent	pher	iome	ena,	gen	eral p	probl	lems	of rea	ctor o	perati	on
			are required.													
TEACHING I	LEARNI	NG STRATE	GY											_		
Teaching and I	Learning	Activities											E	ngag	emen	t
	Easa ta	Easa Laamin	~											(not	irs)	
	Face-to	-Face Learning	g											1'	2	
		Practical / Tu	torial / Studio											4.	2	
		Student-Cent	red Learning											_		
	Self-Di	rected Learnin	σ													
	ben bi	Non-face-to-f	face learning											84	4	
													2	1		
	Formal Assessment									1						
		Continuous A	Assessment											2		
		Mid-Term														
		Final Examin	ation										3			
	Total												1	15	3	

# **TEACHING METHODOLOGY**

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

# **COURSE SCHEDULE**

coensister		
Weeks	Topics	Remarks
Week-1	Safety characterization and safety features of nuclear power plants	Class Test
Week-2	Reactor safety principles and criteria, design-basis and beyond-design-basis events	1, Final
Week-3	Safety systems, containment performance, safety issues and safety issue resolution	Exam
Week-4	Probabilistic Safety Analysis (basic elements), regulation and safety culture	
Week-5	Deterministic Safety Analysis (basic elements)	Class Test
Week-6	Operating experience of Research Reactor and Power Reactor (PWR), general problems of reactor operation	2, Final Exam
Week-7	Principles of control and operation; methods of control; range of control	
Week-8	Functions of operators; layout of control desks; warnings and emergencies	Mid
Week-9	Reactor start-up sequence; pre-nuclear commissioning	Term, Final
Week-10	Mechanical and electrical tests; coolant flow tests	Exam
Week-11	Operation at power; reactivity balance at power operation	
Week-12	Accident management, emergency operation procedure	Class Test
Week-13	Analysis of operation transients, accidents and severe accidents	S, r mai Exam
Week-14	Accident phenomena, including severe accidents	<u> </u>

## ASSESSMENT STRATEGY

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2, C4
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C1, C2, C4
	Mid term	10%	CO3	C2
Final Examination		60%	CO1-CO4	C1, C2, C4
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Pershagen, Bengt, and M. Bowen. *Light Water Reactor Safety*,1st edition, Oxford, United Kingdom:Parmagon Press, 2013.
- 2. Farmer, F. ed. Nuclear Reactor Safety, Chicago, USA: Academic Press, 2012.
- 3. Petrangeli, Gianni. *Nuclear safety*, 2nd edition. Oxford, United Kingdom: Butterworth-Heinemann, 2006.
- 4. Shaw, J., Reactor operation. Oxford, United Kingdom: Pergamon Press, 2013.

## **REFERENCE SITE**

# Level 3 Term I

	COURSE INFORMATION												
Course Code Course Title	: NE 331 : Automation, Robotics and Liner Co	ontrol System	Lecture Con Credit Hours	tact Hours s	: 3. : 3.	00 00							
	PRE-REQUISITE												
	None												
	CURRICULUM STRUCTURE												
	Outcome Based Education (OBE)												
	SYNOPSIS/RATIONALE												
	Control Systems is the study of the analysis and regulation of the output behaviours of dynamical systems subject to input signals. The concepts and tools discussed in this course can be applicable in a wide spectrum of engineering disciplines such as mechanical, electrical, aerospace, manufacturing, and biomedical engineering. The emphasis of this course will be on the basic theories and feedback controller design methods of linear time-invariant systems.												
	OBJECTIVES												
	<ol> <li>To infordate the statems with Diagram/ Signal Flow Graph (SI</li> <li>To impart the basic knowledge including with their inter-conver</li> <li>To use Routh's stability criteria, to analyse the system stability.</li> <li>To impart in-depth theoretical practical controlling algorithm.</li> <li>LEARNING OUTCOMES</li> </ol>	FG) and reduction of electrical, r rsion and system root locus technic knowledge of	n of complica nechanical an transfer func ique, Bode plo control syste	ted system ad electro- tion. ot and Nyqu m enginee	to a sir mechai iist stal	plified one. nical system pility criteria o design the							
	Upon completion of the course, the s	students will be a	able to										
	<ol> <li>Define Automation, Kinematics, Manipulators and Explain automation strategy</li> <li>Translate the pneumatic, hydraulic, and even heat transfer systems to its equivalent electrical circuit model and evaluate the output characteristics with the specified input.</li> <li>Interpret the basic concepts of stability for various control systems from both the classical and the state-space viewpoints.</li> <li>Design control systems using different automation tools.</li> </ol>												
	COURSE OUTCOMES & GENE	RIC SKILLS											
No.	Course Learning OutcomeCorresponding POsBloom's TaxonomyCPCAKPAssessmer Methods												
CO1	<b>Define</b> Automation, Kinematics, Manipulators and Explain automation strategy	PO1	C1	1 -	3	T, Q, F							
CO2	<b>Translate</b> the pneumatic, hydraulic, and even heat transfer systems to its equivalent electrical circuit model and	PO1	C2, C5	1 -	1, 3	ASG, F							

	evaluate	e the output characteristics												
	with the	specified input.												
CO3	Interpression stability from bo space vie	et the basic concepts of for various control systems th the classical and the state- ewpoints.	Р	PO1		(	22		2	-	3	N	⁄ΙΤ, F	
CO4	Design automat	control systems using different ion tools	Р	<b>PO</b> 3		(	C6		3	3	2, 5		T, F	
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)													
	COURSE CONTENT													
	Automation strategy, role of automation in industries, benefits of automation, introduction to automation tools programmable logic control, microcontroller, relay etc. Elements of pneumatic and electrical control systems; valves and actuators; stepper motors; case studies of industrial automation systems. Basic concepts: System, control system, input, output, open-loop and closed loop control systems, elements of a general control system, examples of control system. Transfer functions and systems response: Review of Laplace transform, impulse, step and Ramp functions, concept of transfer functions of common components, block diagram algebra, signal flow graphs, impulse, step, and ramp response of first and second order systems, characterization of response (time constant, gain, overshoot, rise time, setting time, steady state error, etc.) relation of system response to location of system poles and zeros. Manipulators: Classification of robot; example of robot application, identification of manipulator components and terminology; joints classification. Kinematics: Kinematic description of multi-degree of freedom manipulators, joint coordinates, task coordinates, transformation coordinate system, kinematic model, dynamic equation of six degree of freedom robot arm, introduction to Jacobians and dynamic performance. Automation strategy, role of automation in industries, benefits of automation, introduction to automation tools													
	SKILL	MAPPING(CO-PO MAPP	ING)											
	No.	Course Learning Outcome	e –			PROC	GRAN	MOU	JTCC	<u>MES</u>	(PO)		10	
		Dafina Automation Kinam	atics	1	2 3	5 4	5	6 7	/ 8	5 9	10	11	12	
	CO1	Manipulators and Ex automation strategy	plain	3										
	CO2	Translate the pneum hydraulic, and even heat tra systems to its equivalent elec circuit model and evaluate output characteristics with specified input.	natic, nsfer trical the the	3										
	CO3	<b>Interpret</b> the basic concept stability for various control sys from both the classical and the space viewpoints.	ts of stems state-	3										

	CO4 Design con different auto (3 – High, 2- Medium,	ntrol systems usi omation tools 1-low)	l systems using 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2										
JUSTIFICAT	ION FOR CO-PO M	APPING											
Mapping	Corresponding Level of Matching				Ju	stifica	tion						
CO1-PO1	3	The knowledge of be applied to defi minimize a compli- function.	nathen ne and cated s	natics class ysten	, scie ify d 1 intc	nce and ifferen a moi	d elec t typ e sin	ctrica es of nplifi	l engin f contr ied for	neering ol sys m wit	g sci tem h si	iences s as v ngle ti	has to well as ransfer
CO2-PO1	3	In order to translate evaluate the output electrical engineer	a order to translate different systems to its equivalent electrical circuit model and valuate the output characteristics, the knowledge of mathematics, science an ectrical engineering science is needed.										lel and ce and
CO3-PO1	3	To interpret the ba the classical and the and electrical scien	interpret the basic concepts of stability for various control systems from both e classical and the state-space viewpoints the knowledge of mathematics, scienc d electrical science is required.										
CO4-PO3	3	To design a practic or processes that r health and safety w	al feedl neet spo ith env	oack o ecifie ironn	contro d nee nenta	ol syste ds wit l consi	em, it h app derat	is re propr ions.	quired	l to des onsider	sign ratic	comp on for	onents public
TEACHING I	LEARNING STRATI	EGY											
Teaching and I	Learning Activities										En	gager (hour:	nent s)
	Face-to-Face Learnin	ng										10	
	Lecture Practical / T	utorial / Studio									42		
	Student-Cer	tred Learning									-		
	Self-Directed Learni	ng											
	Non-face-to	-face learning									84		
	Revision											21	
	Formal Assessment	Assessment										2	
	Mid-Term	Assessment										1	
	Final Exami	nation										3	
	Total										_	153	
<b>TEACHING</b>	METHODOLOGY												
Lecture and Di	iscussion, Co-operative	e and Collaborative	Meth	od, P	roble	em Ba	sed N	Meth	od				
COURSE SCI	HEDULE												
Weeks		Т	opics									Rem	arks
Week-1	Introduction to contr	ol system										Class	Test
Week-2	Transfer functions of	f translational and	otatio	nal m	echa	nical s	syste	m			1, Final		
Week-3	Mathematical proble	m related to analog	ous co	nver	sion							Exan	1
Week-4	Mathematical proble	ms related to trans	er fun	ction	and	space	state	e rep	resent	tation	Class Test		
Week-5	Mason's rule and dea	signing problems r	elated	to M	ason	's rule						2, Fin	nal
Week-6	Introduction to root locus technique for system stability Exam									1			

Week-7	Introduction to Frequency Response method				
Week-8	Automation strategy, role of automation in industries, benefits of automation, introduction to automation tools programmable logic control, microcontroller, relay etc.	Mid Term.			
Week-9	Elements of pneumatic and electrical control systems; valves and actuators; stepper motors; case studies of industrial automation systems.	Final Exam			
Week-10	Manipulators: Classification of robot; example of robot application				
Week-11	Identification of manipulator components and terminology; joints classification.				
Week-12	Kinematics: Kinematic description of multi-degree of freedom manipulators, joint coordinates, task coordinates, transformation coordinate system, kinematic model, dynamic equation of six degree of freedom robot arm,	Class Test 3. Final			
Week-13	Introduction to Jacobians and dynamic performance. Automation strategy, role of automation in industries, benefits of automation	Exam			
Week-14	Introduction to automation tools Programmable Logic Control (PLC), microcontroller, relay etc.				

	Components	Grading	СО	Blooms Taxonomy
Continuous Assessment	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2C6
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C1, C2, C5, C6
(40%)	Mid term	10%	CO3	C2
Final Examination		60%	CO1-CO4	C1, C2, C5, C6
	Total Marks	100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

1. Nise, Norman S. Control Systems Engineering, 5th edition, USA: John Wiley & Sons, 2020.

- 2. Ogata, Katsuhiko, and Yanjuan Yang. Modern Control Engineering.5th edition, India: Prentice hall, 2002.
- 3. Dorf, Richard C., and Robert H. Bishop. *Modern Control Systems*, 12th edition, Florida, USA: Addison-Wesley, 1998.
- 4. S Hassan Saeed , *Automatic Control Systems*, 1st edition, , India: Arihant, 2013.

#### **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: NE 333 : Reactor Instrumentation and Control	IE 333       Lecture Contact Hours         Leactor Instrumentation and Control       Credit Hours									
	PRE-REQUISITE										
	None	None									
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										

	SYNOPSIS/RATIONALE												
	This course is designed to devel- measurements of reactor instrument behaviour of instrumentation on norr during accidental condition in nuclea	op the capabili ation system wh nal condition as ar power plants.	ty on basic nich will enal well as to and	princ ble stu alyse i	iples Idents nstrum	of de to une nentati	tection and derstand the on response						
	OBJECTIVES												
	<ol> <li>To understand the reactor systems, sensor performance and reliability test.</li> <li>To understand the details of instrumentation response on nuclear accidents.</li> <li>To acquire the knowledge on the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics.</li> <li>To know the process of data acquisition, data analysis and basic principles of measurements.</li> </ol>												
	LEARNING OUTCOMES												
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Evaluate sensor performance and reliability test of reactor systems.</li> <li>Analyse the instrumentation response on nuclear accidents.</li> <li>Formulate the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics.</li> <li>Apply the data acquisition process and measurements technique to calculate the temperature, flow pressure and heat flux</li> </ol>												
	COURSE OUTCOMES & GENERIC SKILLS												
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	<b>Evaluate</b> sensor performance and reliability test of reactor systems.	PO1	C5	-	-	3	T, Q, F						
CO2	<b>Analyse</b> the instrumentation response on nuclear accidents.	PO1, PO2	C4	-	-	4	ASG, F						
CO3	<b>Formulate</b> the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics.	PO2, PO3	C6	-	-	5	MT, F						
CO4	<b>Apply</b> the data acquisition process and measurements technique to calculate the temperature, flow, pressure and heat flux.	PO1, PO2	C3	1	-	6	T, F						
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT-	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)						
	COURSE CONTENT												

	basic principles of measurements, characteristics and behaviour of typical measuring systems; transfer function measurement systems; basic I&C loop and major loop elements including transmitters, signal conditioner, controllers, actuators and final control elements, instrumentation systems used in NPPs for measurement of temperature, flow, pressure, liquid level, neutron flux, ex-core and in-core nuclear instrumentations; sensor performance and reliability test,; protection systems; calibration; control rod drives and rod position indication system, power supplies; NPP I&C system architecture, classification of I&C systems; Microprocessor, micro controller and nuclear electronics, analytical nuclear instrumentation, data acquisition and data analysis; Piping & Instrumentation Diagram (P&ID); process instrumentation, instrumentation failure in nuclear accidents.															
	SKILL	MAPPING	(CO-PO MAPPING	)												
	No	Course I	earning Outcome			P	ROC	GRA	M (	DUT	CON	1ES	(PO)			]
		Evaluate ser	sor performance and	1	2	3	4	5	6	7	8	9	10	11	12	-
	CO1	reliability test of reactor systems. Analyse the instrumentation														
	CO2	response on r	esponse on nuclear accidents.													
	CO3	systems of including m	Formulate the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics.			3										
	CO4	<b>Apply</b> the date and measured calculate the pressure and	<b>Apply</b> the data acquisition process and measurements technique to calculate the temperature, flow, pressure and heat flux													
	(3 – Hig	h, 2- Medium,	1-low)													
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corre Level o	esponding of Matching				Ju	stif	icat	tion							
CO1-PO1		3	In order to evaluate se knowledge of mather engineering specializa applied.	sensor performance and reliability test of reactor systems, the ematics, natural science, engineering fundamentals and an zation to the solution of complex engineering problems is be											the an be	
CO2-PO1		3	In order to analyse knowledge of mather engineering specializa be applied.	the instrumentation response on nuclear accidents, the ematics, natural science, engineering fundamentals and an zation to the solution of complex engineering problems is to											the an s to	
CO2-PO2		3	In order to analyse identification, formu engineering problems mathematics, natural s	the	e in n, r hing ces a	strur esea subs nd ei	nent rch tanti ngin	atio lite iateo eeri	n r eratu d coi ng s	espo re nclus cient	nse and sions ces a	on ana usin re re	nucle lysis g firs quirec	ar ac of of tprino 1.	cider comp ciples	nts, olex s of
CO3-PO2		3	In order to formulati including microprocess formulation, research reaching substantiated sciences and engineeri	e th sor, liter con ng s	e ins micr ature clusi cienc	strun o cor e and ons ces ai	nenta ntrol l ana using re re	ation ler a alys g fin quir	n sy and r is of rst p red.	vstem nucle f con rinci	ns of ear el nple: ples	f nue ectro x en of n	clear onics, gineer nather	powe identi ring p natics	r pla ficati roble , natu	ants on, ems aral
CO3-PO3		3	In order to formulat including microproces to design solutions f components or process for public health and s	e th sor, for c ses th afety	e ins micr comp nat m 7, cul	strun o co lex leet s tural	nenta ntrol engi peci	ation ller nee fied cieta	n sy and ring nee d, ar	vstem nucl pro eds w nd en	ns of ear e blem vith a viron	f nu lectr is ar ppro nmer	clear onics nd de priate ntal co	powe , it is sign consi onside	r pla requi syste derat ratio	ants red ms, tion ns.

CO4-PO1	3 In order to calculate mathemati specializa In order to	o apply the data acquisition process and measurem the temperature, flow, pressure and heat flux, th ics, natural science, engineering fundamentals and tion to the solution of complex engineering problems o apply the data acquisition process and measurem	ents technique to ne knowledge of d an engineering is to be applied. ents technique to							
CO4-PO2	3 research substantia and engin	literature and analysis of complex engineering p ted conclusions using first principles of mathematics eering sciences are required.	roblems reaching , natural sciences							
<b>TEACHING I</b>	LEARNING STRATEGY									
Teaching and I	earning Activities		Engagement (hours)							
	Face-to-Face Learning		40							
	Practical / Tutorial / St	udio	42							
	Student-Centred Learn	Student-Centred Learning								
	Self-Directed Learning									
	Non-face-to-face learn	Non-face-to-face learning								
	Formal Assessment		21							
	Continuous Assessment	2								
	Mid-Term		1							
	Final Examination		3							
TEACHINC			155							
IEACHING	METHODOLOGI									
Lecture and Di	scussion, Co-operative and Colla	borative Method, Problem Based Method								
COURSE SCI										
Weeks		Topics	Remarks							
Week-1	Overview of reactor I&C syste I&C systems	m, NPP I&C system architecture, classification	of Class Test							
Week-2	Basic principles of measurement	nts	1, Final							
Week-3	Characteristics and behaviour measurement systems	of typical measuring systems; transfer functi	on Exam							
Week-4	Basic I&C loop and major loop	elements including transmitters								
Week-5	Signal conditioner, controllers		Class Test							
Week-6	Actuators and final control eler	nents	Exam							
Week-7	Temperature, flow, pressure, lie	quid level sensors								
Week-8	Neutron flux, ex-core and in-co	re nuclear instrumentations	Mid							
Week-9	Sensor performance and reliabi	lity test,; protection systems; calibration	Term,							
Week-10	control rod drives and rod pos system architecture	ition indication system, power supplies; NPP I&	C Final Exam							
Week-11	Classification of I&C system electronics	s; Microprocessor, micro controller and nucle	ear Class Test 3, Final							
Week-12	Measurements of temperature		Exam							

Week-13	Analytical nuclear instrumentation, data acquisition and data analysis; Piping & Instrumentation Diagram (P&ID)
Week-14	Process instrumentation, instrumentation failure in nuclear accidents

	Components	Grading	СО	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C4, C5
	Mid term	10%	CO3	C6
Final Examination		60%	CO1-CO4	C3-C6
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

 Harrer, Joseph M., and James G. Beckerley. *Nuclear power Reactor Instrumentation Systems Handbook*, vol 2. US Atomic Energy Commission National Technical Information Services, Springfield, Virginia 22151 USA, 1975.
 Ahmed, S. N. Physics and Engineering of Radiation Detection, 2nd Edition. APA, USA:Academic Press, 2007.
 Holman, Jack Philip. Experimental methods for engineers, 6th Edition New York, United States:Mc-Graw Hill 2001.

4. Beckwith, Thomas G., Roy D. Marangoni, and John H. Lienhard. *Mechanical Measurements*. New Jarsey, USA: Prentice Hall, 1995.

5. Schultz, Mortimer A. *Control of Nuclear Reactors and Power Plants*, 6th Edition New York, United States McGraw-Hill, 1961.

**REFERENCE SITE** 

	COURSE INFORMATION	COURSE INFORMATION											
Course Code Course Title	: NE 334 : Reactor Instrumentation and Control Sessional	NE 334Lecture Contact HoursReactor Instrumentation and Control SessionalCredit Hours											
	PRE-REQUISITE												
	NE 333												
	CURRICULUM STRUCTURE												
	Outcome Based Education (OBE)												
	SYNOPSIS/RATIONALE												

	This course is designed to provide a general concept regarding practical application of reactor instrumentation and control. Students will be acquainted with the important concepts such as working principle of thermocouple, temperature resistor, pressure gauge and flow meter. Apart from these, this course will also introduce the practical part of several important topics including voltage, current and power measurement by ammeter and voltmeter.												
	OBJECTIVES												
	<ol> <li>To enable the students to analyze and demonstrate the process instrumentation.</li> <li>To make students acquainted with voltage, current and power measurement by ammeter and voltmeter.</li> <li>To verify the measured value with calculated results.</li> <li>To design a simple temperature and pressure measurement system for reactor.</li> </ol>												
	LEARNING OUTCOMES												
	<ol> <li>Analyze and demonstrate the process instrumentation.</li> <li>Measuring voltage, current and power measurement device such as ammeter and voltmeter.</li> <li>Analyzing measured value with calculated results.</li> <li>Design a simple temperature and pressure measurement system for reactor.</li> </ol>												
	COURSE OUTCOMES & GENERIC SKILLS												
No.	Course Learning Outcome	Bloom's Taxonomy	СР	CA	KP	Assessment Methods							
CO1	Analyze and demonstrate the process instrumentation.	C2, C4	1	2	1,2	Q, R, T							
CO2	<b>Measure</b> voltage, current and power measurement device such as ammeter and voltmeter.	PO2, PO5	C5	2	1	6	Q, R, T						
CO3	<b>Analyzing</b> measured value with calculated results.	PO1, PO4	C4	2	3	2	Q, R, MT						
CO4	<b>Design</b> a simple temperature and pressure measurement system for reactor.	PO4	C6	1	1	5	Q, R, Pr						
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T – , MT- 1	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)						
	COURSE CONTENT												
	<ol> <li>COURSE CONTENT</li> <li>Errors in measurement and basic statistical sampling.</li> <li>Measurement of medium resistance using wheatstone bridge.</li> <li>Range Extension of Ammeter and Voltmeter.</li> <li>Measurement of Power by         <ul> <li>a) 3 Voltmeter Method</li> <li>b) 3 Ammeter Method</li> </ul> </li> </ol>												
	SKILL MAPPING (CO-PO MAP)	PING)											

		~ ~				P	ROO	GRA	AM (	DUT	CON	<b>IES</b>	(PO)				
	No.	Course L	earning Outcome	1	2	3	4	5	6	7	8	9	10	11	12		
	CO1	Analyze an	d <b>demonstrate</b> the	2			3										
	CO2	Measuring power measu	voltage, current and rement device such as		2			2									
		ammeter and <b>Analyzing</b> r	voltmeter. neasured value with														
	CO3	calculated res	sults.	2			2										
	CO4	pressure mea reactor.	ressure measurement system for eactor.				3										
	(3 – Hig	h, 2- Medium,	1-low)														
JUSTIFICAT	ION FO	R CO-PO MA	APPING														
Monning	Corre	esponding				т.			tion								
wiapping	Level o	of Matching				J	isui	ica	uon								
CO1-PO1		2	Knowledge of both sc analyze and demonstr	Knowledge of both scientific and reactor fundamental knowledge is required to <b>analyze</b> and <b>demonstrate</b> the process instrumentation.									to				
CO1-PO4		3	Design basis knowled	ge a ess i	nd da	ata ii imen	iterp tatio	reta n	tion	is ve	ery ii	npor	tant t	o <b>ana</b>	lyze a	nd	
CO2-PO2		2	Proper measurement n	nust	be e	nsure	ed by	to	find	the s	soluti	ion o	f the	proble	em.		
CO3-PO1		2	Knowledge of both scientific and reactor fundamental knowledge is required								to						
CO3-PO4		2	Design basis knowled	lge	and	data	inte	rpre	etatic	on is	ver	y im	porta	nt to	analy	ze	
			measured value with c	alcu	lated	l resu	ilts.								1 .		
CO4-PO4		3	simple temperature an	ige a d pre	and	data e mé	inte	rpre eme	tatio	n 18 Vster	very n for	reac	portai	nt to	aesigi	ia	
<b>TEACHING I</b>	LEARNI	NG STRATH	EGY	a pro	200 <b>01</b>	<u>e inc</u>	Jubul		Jile 5	, 5001	11 101	Teac					
Teaching and I	earning	Activities	-											Eng	gagen	ne	
														nt (	hour	5)	
	Face-to	-Face Learnin	ıg														
		Lecture													14		
		Practical / Tu	utorial / Studio												28		
		Student-Cen	tred Learning												-		
	Self-Di	rected Learnii	ng														
		Preparation of	of Lab Reports												14		
		Preparation of	of Lab Test												10		
		Preparation of	of presentation												0		
		Preparation of	of Quiz												9		
		Engagement	in Group Projects														
		Formal Asse															
		Continuous A	Assessment											1			
		Final Quiz	al Quiz											1			
	Total														90		
<b>TEACHING</b> N	METHO	DOLOGY															
Lecture and Di	scussion,	Co-operative	and Collaborative M	ethc	od, P	robl	em	Bas	ed N	/leth	od						

COURSE SCHEDULE				
Weeks	Topics	Remarks		
Week-1	Errors in measurement and basic statistical sampling			
Week-2	Measurement of medium resistance using Wheatstone Bridge			
Week-3	Range Extension of Ammeter and Voltmeter			
Week-4	Measurement of Power by a) 3 Voltmeter Method b) 3 Ammeter Method			
Week-5	Study of PLC Based Control system			
Week-6	Lab Test, Viva			
Week-7	Quiz			

Components	Grading	СО	<b>Blooms Taxonomy</b>
Conduct of Lab Tests/Class Performance/ Attendance	30%	CO1, CO2	C2, C4, C5
Report Writing/ Programming	15%	CO1, CO2, CO3, CO4	C2, C4, C5, C6
Mid-Term Evaluation (exam/project/assignment)	15%	CO3	C4
Viva Voce	10%	CO1, CO2, CO3, CO4	C2, C4, C5, C6
Final Evaluation (Lab Quiz)	30%	CO1, CO2, CO3, CO4	C2, C4, C5, C6
Total Marks	100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

1. Nuclear Power Reactor Instrumentation System Handbook-Joseph M. Harrer and James G.Beckerley

2. Electrical Machines Fundamentals – Stephan J. Chapman.

3. Mechanical Measurements (5th edition) Thomas G. Beckwith, Roy D. Marangoni, John H. Lientard.

# **REFERENCE SITE**

	COURSE INFORMATION									
Course Code Course Title	: NE 355 : Fluid Mechanics and Machinery	Lecture Contact Hours Credit Hours	: 3.00 : 3.00							
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
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	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	This course is designed to understand the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces and understand the functions of various types of pumps and turbines.									
	OBJECTIVES									
	<ol> <li>To understand the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces.</li> <li>To know the momentum and energy equation in fluid body and engineering fluid mechanics systems using the dimensional analysis and various losses in piping networks.</li> <li>To identify various types of pumps and turbines and their functions.</li> <li>To evaluate various types of pumps and turbines using dimensional and vector analysis</li> </ol>									
	LEARNING OUTCOMES									
	Upon completion of the course, the s	tudents will be a	able to							
	<ol> <li>Apply the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces.</li> <li>Analyze the momentum and energy equation in fluid body and engineering fluid mechanics systems using the dimensional analysis and various losses in piping networks.</li> <li>Compare the various types of pumps and turbines and their functions.</li> <li>Evaluate the various types of pumps and turbines using dimensional and vector analysis</li> </ol>									
	COURSE OUTCOMES & GENER	RIC SKILLS								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods			
CO1	<b>Apply</b> the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces.	PO1	C3	1	1	1	T, Q, F			
CO2	<b>Analyze</b> the momentum and energy equation in fluid body and engineering fluid mechanics systems using the dimensional analysis and various losses in piping networks.	PO1	C4	1	1	2	ASG, F			
CO3	<b>Compare</b> the various types of pumps and turbines and their functions.	PO2	C5	2	1	3	MT, F			
CO4	<b>Evaluate</b> the various types of pumps and turbines using dimensional and vector analysis.	PO3	C6	3	1	3	T, F			
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT-	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)			

Fundamental concept of fluid as a continuum; fluid statics: basic hydrostatic equation, pressure variation in static incompressible and compressible fluids; manometers; forces on plane and curved surfaces; buoyant force; stability of floating and submerged bodies; pressure distribution of a fluid in a rotating system. Relation between system approach and control volume approach; continuity, momentum and energy equations; special forms of energy and momentum equations and their applications; pressure, velocity and flow measurement devices.

Dimensional analysis and similitude; fundamental relations of compressible flow; speed of sound wave; stagnation states for the flow of and ideal gas; flow through converging-diverging nozzles; normal shock; real fluid flow; frictional losses in pipes and fittings.

Types of fluid machinery; rotodynamic and positive displacement machines; velocity diagrams and Euler pump/turbine equation; impulse and reaction turbines; centrifugal and axial flow pumps; deep well turbine pumps; dimensional analysis applied to fluid machinery: specific speed, unit power, unit speed, unit discharge; performance and characteristics of turbines and pumps; design of pumps; cavitation; reciprocating pump, gear and screw pumps; fans, blowers and compressors; hydraulic transmission: fluid coupling and torque converter; system analysis and selection of fluid machine.

#### SKILL MAPPING (CO-PO MAPPING)

No	Course Learning Outcome PROGRAM OUTCOMES (PO)												
INO.	Course Learning Outcome		2	3	4	5	6	7	8	9	10	11	12
CO1	<b>Apply</b> the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces.	3											
CO2	<b>Analyze</b> the momentum and energy equation in fluid body and engineering fluid mechanics systems using the dimensional analysis and various losses in piping networks.	3											
CO3	<b>Compare</b> the various types of pumps and turbines and their functions.		3										
CO4	<b>Evaluate</b> the various types of pumps and turbines using dimensional and vector analysis.			3									

#### JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The knowledge of mathematics, science, engineering fundamentals is required to apply fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces.
CO2-PO1	3	The knowledge of mathematics, science, engineering fundamentals is required to analyze the momentum and energy equation in fluid body and engineering fluid mechanics.
CO3-PO2	3	In order to explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.

CO4-PO3	3	In order to evaluate the various types of pumps and turbines and vector analysis, it is required to design solutions for con- problems and design systems, components or processes that mo- with appropriate consideration for public health and safety, cul- environmental considerations.	using dimensional mplex engineering eet specified needs ltural, societal, and
<b>TEACHING I</b>	LEARNING STRATI	EGY	
Teaching and I	Learning Activities		Engagement (hours)
	Face-to-Face Learnin	ng	
	Lecture		42
	Practical / T	utorial / Studio	-
	Student-Cen	tred Learning	-
	Self-Directed Learni	ng	0.4
	Non-face-to	-face learning	84
	Revision		21
	Formal Assessment	Assessment	2
	Mid Torm	Assessment	2
	Final Exami	nation	3
	Total	nation	153
TEACHING N	METHODOLOGY		
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method	
COURSE SCH	HEDULE		
Weeks		Topics	Remarks
Weeks Week-1	Fundamental conception incompressible and conception of the second secon	<b>Topics</b> pt of fluid as a continuum; Pressure variation in sta compressible fluids; Manometers	Remarks
Weeks Week-1 Week-2	Fundamental conce incompressible and c Fluid statics: basic Buoyant force; Stabi	<b>Topics</b> pt of fluid as a continuum; Pressure variation in sta compressible fluids; Manometers hydrostatic equation; Forces on plane and curved surfac lity of floating and submerged bodies	Remarks       atic       ces;       I, Final       Example
Weeks Week-1 Week-2 Week-3	Fundamental concer incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control	<b>Topics</b> pt of fluid as a continuum; Pressure variation in sta compressible fluids; Manometers hydrostatic equation; Forces on plane and curved surfac lity of floating and submerged bodies n of a fluid in a rotating system; Relation between syst l volume approach	Remarksaticres;Class Test1, FinalExam
Weeks Week-1 Week-2 Week-3 Week-4	Fundamental concer incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement device	Topics         pt of fluid as a continuum; Pressure variation in state         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between system         l volume approach         tum and energy equations; Special forms of energy and their applications; Pressure, velocity and flast	Remarks       atic       ces;       I, Final       Exam
Weeks Week-1 Week-2 Week-3 Week-4 Week-5	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement device Dimensional analysi	Topics         pt of fluid as a continuum; Pressure variation in state         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between system         l volume approach         tum and energy equations; Special forms of energy and their applications; Pressure, velocity and flast         s and similitude	Remarks       atic       ces;       I, Final       em       Exam       and       ow       Class Test       2 Final
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement device Dimensional analysi Fundamental relation states for the flow o Normal shock	Topics         pt of fluid as a continuum; Pressure variation in state         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between system         l volume approach         tum and energy equations; Special forms of energy and their applications; Pressure, velocity and fles         s and similitude         ns of compressible flow; Speed of sound wave; Stagnat         f and ideal gas; Flow through converging-diverging nozzl	Remarksaticres;Class Test1, FinalExamandowclass Test2, FinalExam
Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement devices Dimensional analysis Fundamental relation states for the flow o Normal shock Real fluid flow; Fric	Topics         pt of fluid as a continuum; Pressure variation in stace         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between system         l volume approach         tum and energy equations; Special forms of energy and their applications; Pressure, velocity and fles         s and similitude         ns of compressible flow; Speed of sound wave; Stagnat         f and ideal gas; Flow through converging-diverging nozzl         tional losses in pipes and fittings	Remarksaticees;Class Test1, FinalExamandowclass Test2, FinalExam
WeeksWeek-1Week-2Week-3Week-4Week-5Week-6Week-7Week-8	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement devices Dimensional analysi Fundamental relation states for the flow o Normal shock Real fluid flow; Fric Types of fluid machi	Topics         pt of fluid as a continuum; Pressure variation in stace         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between syst         l volume approach         tum and energy equations; Special forms of energy a         ns and their applications; Pressure, velocity and fl         s         s and similitude         ns of compressible flow; Speed of sound wave; Stagnat         f and ideal gas; Flow through converging-diverging nozzl         tional losses in pipes and fittings         inery; Rotodynamic and positive displacement machines	Remarks         atic         ces;         Class Test         1, Final         Exam         and         ow         class Test         2, Final         Exam         Mid         Total
WeeksWeek-1Week-2Week-3Week-4Week-4Week-5Week-6Week-7Week-8Week-9	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement device Dimensional analysi Fundamental relatio states for the flow o Normal shock Real fluid flow; Fric Types of fluid machi	Topics         pt of fluid as a continuum; Pressure variation in stace         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between systed         l volume approach         tum and energy equations; Special forms of energy a         ns and their applications; Pressure, velocity and flas         s and similitude         ns of compressible flow; Speed of sound wave; Stagnat         f and ideal gas; Flow through converging-diverging nozza         tional losses in pipes and fittings         inery; Rotodynamic and positive displacement machines         nd Euler pump/turbine equation; Impulse and reaction turbin	Remarks         atic         ces;         I, Final         Exam         and         ow         Class Test         and         ow         Class Test         I, Final         Exam         Class Test         2, Final         Exam         Mid         Term,         Final
WeeksWeek-1Week-2Week-3Week-3Week-4Week-5Week-5Week-6Week-7Week-8Week-9Week-10	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement device Dimensional analysi Fundamental relatio states for the flow o Normal shock Real fluid flow; Fric Types of fluid machi Velocity diagrams an Centrifugal and axia	Topics         pt of fluid as a continuum; Pressure variation in stace         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between system         l volume approach         tum and energy equations; Special forms of energy and their applications; Pressure, velocity and flass         s and similitude         ns of compressible flow; Speed of sound wave; Stagnat         f and ideal gas; Flow through converging-diverging nozzl         tional losses in pipes and fittings         mery; Rotodynamic and positive displacement machines         nd Euler pump/turbine equation; Impulse and reaction turbin         l flow pumps; Deep well turbine pumps	Remarksaticres;class Test1, FinalExamandowclass Testclass Testclass Test2, FinalExamenMidTerm,FinalExam
WeeksWeek-1Week-2Week-3Week-4Week-4Week-5Week-6Week-7Week-8Week-9Week-10Week-11	Fundamental conce- incompressible and c Fluid statics: basic Buoyant force; Stabi Pressure distribution approach and control Continuity, moment momentum equatio measurement device. Dimensional analysi Fundamental relation states for the flow o Normal shock Real fluid flow; Fric Types of fluid machi Velocity diagrams an Centrifugal and axia Dimensional analysi speed, unit discharge	Topics         pt of fluid as a continuum; Pressure variation in stace         compressible fluids; Manometers         hydrostatic equation; Forces on plane and curved surface         lity of floating and submerged bodies         n of a fluid in a rotating system; Relation between system         l volume approach         tum and energy equations; Special forms of energy at and their applications; Pressure, velocity and flags         s and similitude         ns of compressible flow; Speed of sound wave; Stagnat f and ideal gas; Flow through converging-diverging nozzlational losses in pipes and fittings         inery; Rotodynamic and positive displacement machines         nd Euler pump/turbine equation; Impulse and reaction turbin         l flow pumps; Deep well turbine pumps         s applied to fluid machinery: specific speed, unit power, upper specific speed, upper specific speed specific specific speed specific speed specific specific	Remarks         atic         ees;         Class Test         1, Final         Exam         and         ow         Class Test         and         ow         Class Test         2, Final         Exam         ion         los;         Mid         Term,         Final         Exam         imit         Class Test         3, Final

Week-13	Cavitation; Reciprocating pump, gear and screw pumps; Fans, blowers and
	compressors
Week 14	Hydraulic transmission: fluid coupling and torque converter; System analysis and
WEEK-14	selection of fluid machine

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C6
Assessment (40%)	Class Participation and Class attendance	5+5= 10%	CO1, CO2	C3, C4
	Mid term	10%	CO3	C5
Final Examination		60%	CO1-CO4	C3-C6
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

- 1. Cengel, Y. A. and Cimbala, J. M. Fluid Mechanics: Fundamentals and Applications, McGraw-Hill, 2010.
- 2. Franzini, Joseph B., E. John Finnemore, and Robert Long Daugherty. *Fluid Mechanics with Engineering Applications*. McGraw-Hill College, 1997.
- 3. Fox, Robert W., and Alan T. Mc Donald. Introduction to fluid mechanics, John wiley and sons, 2003.
- 4. White, Frank M. *Fluid mechanics*.USA: Tata McGraw-Hill Education, 1979.
- 5. Rao, NS Govinda. Fluid flow machines.USA: Tata McGraw-Hill, 1983..
- 6. Dixon, S. Larry, and Cesare Hall. Fluid mechanics and thermodynamics of turbomachinery, 7th edition. Butterworth-Heinemann, 2013.

# **REFERENCE SITE**

	COURSE INFORMATION							
Course Code Course Title	: NE 356 : Fluid Mechanics and Machinery Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75					
	PRE-REQUISITE							
	NE 351							
	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	This course is designed to learn and familiarize with the basics of fluid mechanics and machinery.							

	OBJEC	CTIVES								
	To veri	fy practically	the theories and	l concepts learne	ed in NE 351.					
	LEARNING OUTCOMES									
	Upon co	ompletion of	the course, the s	students will be a	able to					
	1. Exa	amine the flui	d characteristics	5.						
	2. Eva	aluate fluid m	achineries chara	cteristics.						
	COUR	SE OUTCON	MES & GENE	RIC SKILLS						
No.	Co	ourse Learning	Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods	
CO1	Examin	e the fluid cha	acteristics.	PO3, PO4	C4	2	2	4	R, Q, T	
CO2	Evaluat characte	e fluid ristics.	machineries	PO3, PO9	C6	3	3	5	R, MT, T	
	(CP- Co Quiz; As	mplex Problen SG – Assignme	ns, CA-Complex ent; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Prof F – Final Exam	ile, T - , MT-	- Test : Mid Te	; PR – erm Ex	Project ; Q – (am)	
	COUR	SE CONTEN	T							
	<ol> <li>Ver</li> <li>Stud</li> <li>Stud</li> <li>Intr</li> <li>Stud</li> </ol>	dy of flow the dy of fluid fri oduction to C dy of Propelle	ough a Venturi ction in a pipe. entrifugal Pum er Turbine chara	meter. p characteristics. acteristics.						
	SKILL	MAPPING	(CO-PO MAP	PING)						
	No.		Course Learning	g Outcome	PR 1 2	COGRA	AM OU 5 6	TCON 78	AES (PO) 9 10 11 12	
	CO1	Examine the	fluid characteris	tics.		3 3				
	CO2	Evaluate flu	id machineries ch	naracteristics.		3			2	
	(3 – H1g	n, 2- Medium,	1-low)			_				
JUSTIFICAT	ION FO	R CO-PO M	APPING							
Mapping	Corre Level o	esponding of Matching			Justification					
CO1-PO3		3	Upon formulati made to meet devices within t	on, mathematical selection and desired technology constraints	analysis and ired performat s for serving p	reason nce nee ractical	ing, væ eds of l purpo	ilid co new h ses.	nclusions are neterojunction	
CO1-PO4		3	Though any ex interpret the da that, it is require based knowledg	Though any experimental investigation is out of the scope of this course, but to interpret the data obtained from researches and making valid conclusions about that, it is required to be familiarized with the similar type of experimental research-based knowledge and the results obtained by these investigations.						
CO2-PO3		3	Upon formulation made to meet devices within the	on, mathematical selection and desi realistic constraint	analysis and ired performat s for serving p	reason nce nee ractica	ing, væ eds of l purpo	lid co new h ses.	nclusions are leterojunction	
CO2-PO9		2	The design prol as a whole in a	plems involve disc group. Thus, the a	cussions and bibility to work	rainsto in a tea	rming a m is de	as an in evelop	ndividual and ed.	

TEACHING	LEARNING STRATEGY	
Teaching and	Learning Activities	Engagement (hours)
	Face-to-Face Learning	
	Lecture	14
	Practical / Tutorial / Studio	28
	Student-Centred Learning	-
	Self-Directed Learning	
	Preparation of Lab Reports	14
	Preparation of Lab Test	10
	Preparation of presentation	9
	Formal Assessment	
	Continuous Assessment	14
	Final Quiz	1
	Total	90
TEACHING	METHODOLOGY	
Lecture and D	Discussion, Co-operative and Collaborative Method, Problem Based Method	
COURSE SC	CHEDULE	
Weeks	Topics	Remarks
Week-1	Verification of Bernoulli's Equation	
Week-2	Study of flow through a Venturimeter	
Week-3	Study of fluid friction in a pipe	
Week-4	Introduction to Centrifugal Pump characteristics	
Week-5	Study of Propeller Turbine characteristics	
Week-6	Practice Lab, Quiz test, Project submission	
Week-7	Lab Test, Viva	
ASSESSMEN	NT STRATEGY	

Cor	Grading	СО	<b>Blooms Taxonomy</b>	
	Class Participation + Attendance	15%	CO1	C4
$\begin{array}{c} \text{Continuous} \\ \text{Assessment} (600()) \end{array}$	Conduct of Lab Test	20%	CO1, CO2	C4, C6
Assessment (00%)	Report Writing	15%	CO1, CO2	C4, C6
	Mid term	15%	CO2	C6
Einst Evolution $(400/)$	Exam	30%	CO1, CO2	C4, C6
Final Evaluation (40%)	Viva Voce/ Presentation	10%	CO1, CO2	C4, C6
Tot	100%			

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. Cengel, Y. A. and Cimbala, J. M. Fluid Mechanics: Fundamentals and Applications, McGraw-Hill, 2010.
- 2. Fluid Mechanics with Engineering Applications Robert L. Daugherty, Joseph B. Franzini, E. John Finnemore, Mc Graw-Hill companies, 8th edition, 1985.

# **REFERENCE SITE**

	COURSE INFORMATION							
Course Code Course Title	: NE 353 : Mechanics of Materials	Lecture Contact Hours Credit Hours	: 3.00 : 3.00					
	PRE-REQUISITE							
	ME 253							
	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	This course introduces to the calculations conce as they relate to the strength and stability of struct and knowledge required to develop analytical stress/strain problems.	rned with the mechanical prope ctures and mechanical compone techniques used to solve a wid	erties of materials nts, and the skills le range of linear					
	OBJECTIVES							
	<ol> <li>To know the basic concepts and principles, and stability of structures and mechanical co</li> <li>To learn the characteristics and calculate th members and complete structures.</li> <li>To calculate the deflection at any point on a</li> <li>To illustrate science/engineering data graph data analysis.</li> </ol>	and perform calculations, relation omponents. The magnitude of combined strest beam subjected to a combinatinically and interpret the role of	ve to the strength sses in individual on of loads. Such displays in					
	LEARNING OUTCOMES							
	Upon completion of the course, the students wil	l be able to						
	<ol> <li>Define the concepts and principles, and perf stability of structures and mechanical composition</li> <li>Explain the characteristics and calculate the members and complete structures.</li> </ol>	Form calculations, relative to the onents. magnitude of combined stresse	e strength and es in individual					
	<ol> <li>Analyze various situations involving structural application of Mohr's circle of stress and carsubjected to a combination of loads.</li> <li>Construct graphical displays of science/englished application.</li> </ol>	ral members subjected to comb lculate the deflection at any po-	ined stresses by int on a beam					
	displays in data analysis.	meeting data and interpret the						

	COURSE OUTCOMES & GENERIC SKILLS										
No.	Co	ourse Learning Outcome	Corresponding POs	Bloon Taxono	n's omy	СР	CA	K	Р	Asses Met	sment hods
CO1	<b>Define</b> to perform strength mechani	he concepts and principles, and calculations, relative to the and stability of structures and cal components.	PO1	C1		1	1	1	l	Т, О	Q, F
CO2	Explain calculat stresses complete	the characteristics and e the magnitude of combined in individual members and e structures.	PO2	C2, C	25	2	1	2	2	AS	G, F
CO3	Analyze structura combine Mohr's the defle subjecte	e various situations involving al members subjected to ad stresses by application of circle of stress and <b>calculate</b> ection at any point on a beam d to a combination of loads.	C4, C	C5	2	1		3	M	Г, F	
CO4	Constru science/ interpre data ana	et graphical displays of engineering data and et the role of such displays in lysis.	PO3	C2, C	C6	2	2	2	1	Т	, F
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q - Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)										t;Q-
	COUR	SE CONTENT									
	Stress a and cen Beams: formula Torsion principa Secant : Introdu	nalysis: statically indetermin trifugal stresses; Stresses in t Shear force and bending mo ; Deflection of beams: integr formula; Angle of twist; I al stress, Mohr's Circle; Col formula; Flexure formula of c ction to experimental stress a	ate axially loade hin and thick wa ment diagrams; ation and area m Modulus of rup umns: Euler's fo curved beams. nalysis technique	d memb illed cyli Various ioment ri ture; He ormula, es; Strai	ber, and inder types netho elical inter n ene	xially s and s of st ods; l sprin media ergy; <b>l</b>	loade spher resse ngs; ( te co Failur	d m es. s in l Com lumr e the	emb bear bine n fo orie	per, th ms; Fl ed str rmula es.	ermal exure esses: us, the
	SKILL	MAPPING (CO-PO MAP	PING)								
					05.5			<b>a</b> a -	(T) -	(7.5.)	
	No.	Course Learning (	Dutcome	1	$\frac{PROC}{2}$	JRAM			<u>1ES</u>	(PO) 10 11	12
	CO1	<b>Define</b> the concepts and princalculations, relative to the structures and mechanical com-	nciples, and perfo ength and stability aponents.	rm of 3							12
	CO2	<b>Explain</b> the characteristics magnitude of combined str members and complete structu	and <b>calculate</b> esses in individu rres.	the ual	3						
	CO3	<b>Analyze</b> various situations members subjected to con application of Mohr's circle of the deflection at any point on a combination of loads.	<b>Analyze</b> various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress and <b>calculate</b> the deflection at any point on a beam subjected to a combination of loads.								
	CO4	<b>Construct</b> graphical disp engineering data and <b>interp</b> displays in data analysis.	lays of scienter o	ce/ ich	3						

	(3 – High, 2- Medium,	1-low)						
JUSTIFICATION FOR CO-PO MAPPING								
Mapping	Corresponding Level of Matching	Justification	Justification					
CO1-PO1	3	In order to define the concepts and principles, and perform cal to the strength and stability of structures and mechanical knowledge of mathematics, natural science, engineering fund engineering specialization to the solution of complex engineering be applied.	culations, relative components, the lamentals and an ng problems is to					
CO2-PO1	3	In order to explain the characteristics and calculate the magni stresses in individual members and complete structures, the mathematics, natural science, engineering fundamentals and specialization to the solution of complex engineering problems	tude of combined ne knowledge of an engineering is to be applied.					
CO3-PO3	2	In order to analyze various situations involving structural men combined stresses by application of Mohr's circle of stress deflection at any point on a beam subjected to a combination of 1 to design solutions for complex engineering problems and components or processes that meet specified needs with appropri- for public health and safety, cultural, societal, and environmenta	bers subjected to and calculate the bads, it is required design systems, iate consideration al considerations.					
CO4-PO3	3	In order to construct graphical displays of science/ engineering the role of such displays in data analysis, it is required to de complex engineering problems and design systems, components meet specified needs with appropriate consideration for public cultural societal and environmental considerations	data and interpret sign solutions for s or processes that health and safety,					
<b>TEACHING I</b>	LEARNING STRATI	EGY						
Teaching and I	Learning Activities		Engagement (hours)					
	Face-to-Face Learnin	ng						
	Lecture		42					
	Practical / T	utorial / Studio	-					
	Salf Directed Learni	ng						
	Non-face-to-	face learning	84					
	Revision		21					
	Formal Assessment							
	Continuous	Assessment	2					
	Mid-Term		1					
	Final Exami	nation	3					
TEACHING N	METHODOLOGY		155					
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method						
COURSE SCI	HEDULE							
Weeks		Topics	Remarks					
Week-1	Stress analysis: stat	ically indeterminate axially loaded member, axially load	ed					

Week-2 Week-3	Stress analysis: statically indeterminate axially loaded member, axially loaded member, thermal and centrifugal stresses (II) Stress analysis: statically indeterminate axially loaded member, axially loaded member, thermal and centrifugal stresses (III)	Class Test 1, Final Exam
Week-4	Stresses in thin and thick walled cylinders and spheres	
Week-5	Beams: Shear force and bending moment diagrams; various types of stresses in beams	Class Test 2, Final
Week-6	Flexure formula; Deflection of beams: integration and area moment methods (I)	Exam
Week-7	Flexure formula; Deflection of beams: integration and area moment methods (II)	
Week-8	Torsion formula; Angle of twist; Modulus of rupture; Helical springs; Combined stresses: principal stress (I)	Mid
Week-9	Torsion formula; Angle of twist; Modulus of rupture; Helical springs; Combined stresses: principal stress (II)	Term, Final
Week-10	Mohr's Circle (I)	Exam
Week-11	Mohr's Circle (II)	
Week-12	Euler's formula, intermediate column formulas, the Secant formula; Flexure formula of curved beams (I)	Class Test
Week-13	Euler's formula, intermediate column formulas, the Secant formula; Flexure formula of curved beams (II)	3, Final Exam
Week-14	Introduction to experimental stress analysis techniques; Strain energy; Failure theories	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2, C5, C6
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C1, C2, C5
	Mid term	10%	CO3	C4, C5
	Final Examination	60%	CO1-CO4	C1, C2, C4, C5, C6
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. W. Nash, Strength of materials, 6th edition, USA: Mcgraw-Hill International Editions, 2013.
- 2. Andrew Pytel, Ferdinand L. Singer, Strength of Materials, 4th edition ,New York,USA: Harpercollins. 2009.
- 3. Ferdinand P. Beer, E. Russell Johnston Jr., *Mechanics of Materials*, 7th Edition.USA: McGraw-Hill Education, 2014.
- 4. E. P. Popov, *Mechanics of Materials*, Oxford, UK: Prentice-Hall, 1958.

## **REFERENCE SITE**

	COURSE INFORMATION								
Course Code Course Title	: NE 354 : Mechanics of Materials Sessional		Lecture Contact	Hours	: 1 : (	50 ).75			
	PRE-REQUISITE								
	NE 353								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	This is the foundation unit in the study of structures. By applying the knowledge gained in Statics and combining it with the concepts gained in Materials Technology the students are introduced to fundamental theories and techniques required to analyze the state of stress and strain to meet strength, stiffness and stability requirements in structural members subjected to external loads.								
	OBJECTIVES								
	<ol> <li>To learn a basic knowledge of the statistical aspects of mechanics of materials.</li> <li>To understand the formal theory of solid mechanics: the equilibrium, kinematic, and constitutive equations.</li> <li>To introduce the atomistic mechanisms underlying the mechanical behavior of materials.</li> <li>To evaluate the process-structure-property-performance relationships in materials engineering.</li> </ol>								
	LEARNING OUTCOMES								
	<ol> <li>Upon completion of the course, the s</li> <li>Demonstrate the fundamentals of</li> <li>Construct graphical displays to its structural members subjected to deflection at any point on a beam</li> </ol>	tudents will f stresses an nterpret the combined st n.	be able to d strains. engineering data a resses by Mohr's	as well as circle and	analyz l calcul	e various ate the			
	COURSE OUTCOMES & GENEI	RIC SKILL	S						
No.	Course Learning Outcome	Correspond POs	ing Bloom's Taxonomy	CP C	A KF	Assessment Methods			
CO1	<b>Demonstrate</b> the fundamentals of stresses and strains.	PO1	C2	1 2	1	R, Q, T			
CO2	<b>Construct</b> graphical displays to interpret the engineering data as well as <b>analyze</b> various structural members subjected to combined stresses by Mohr's circle and <b>calculate</b> the deflection at any point on a beam.	PO2, PO4 C4, C6 3 3 4 R, MT,							
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentar	Activities, K tion; R - Repo	P-Knowledge Profi ort; F – Final Exam	ile, T – Te , MT- Mic	st ; PR Term I	– Project ; Q – Exam)			

	COUR	COURSE CONTENT														
	<ol> <li>Street</li> <li>Street</li> <li>Study</li> <li>Study</li> <li>Study</li> <li>Study</li> <li>Study</li> <li>Explored</li> </ol>	ess analysis: s esses in thin a dy of various dy of deflecti dy of Mohr's perimental str	statically indeterminat and thick-walled cyline types of stresses in be on of beams. circle. ess analysis technique	e ax ders eams	ially and s. d fa	' loa sph ilure	ded eres	me orie	mbe es.	er.						
	SKILL	MAPPING	(CO-PO MAPPING	)												
	No.	Course I	Learning Outcome	-		P	ROO	GR/	AM (	DUT	CON	AES	(PO)	1.1	10	]
		Demonstrat	<b>Demonstrate</b> the fundamentals of			3	4	5	6	7	8	9	10	11	12	-
	COI	stresses and s	strains.	3												-
	CO2	<b>Construct</b> g interpret the well as <b>anal</b> members su stresses by <b>calculate</b> the	<b>Construct</b> graphical displays to interpret the engineering data as well as <b>analyze</b> various structural members subjected to combined stresses by Mohr's circle and <b>calculate</b> the deflection at any point				3									
	(3 – Hig	(3 – High, 2- Medium, 1-low)								]						
																_
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Level o	of Matching				Jı	ıstif	ica	tion							
CO1-PO1		3	The knowledge of mathematics, science and engineering drawing fundamentals is required to demonstrate the fundamentals of stresses and strains.								s is					
CO2-PO2		3	Identification, formu engineering problems engineering data as combined stresses by beam.	latio are 1 well Moh	n, i requi as a r's c	resea red t analy ircle	irch to co ze v and	lite Instr Vario Cal	eratu ruct g ous culat	re grapl struc te the	and hical tural e def	ana disp me lecti	llysis blays t mbers on at a	of o inte s subj any po	comp rpret ected pint o	lex the to n a
CO2-PO4		3 Beam. In order to construct graphical displays to interpret the engineering data as well analyze various structural members subjected to combined stresses by Mohr circle and calculate the deflection at any point on a beam, it is required to condu investigations of complex problems using engineering drawing knowledge ar methods including design of experiments, analysis and interpretation of data, ar sumthesis of information to provide valid complusions					l as ir's uct and and									
TEACHING	LEARNI	NG STRATI	EGY													
Teaching and I	Learning	Activities											E	ngag (hou	emen ırs)	ıt
	Face-to	-Face Learnin Lecture Practical / T Student-Cen	ng utorial / Studio tred Learning										14 28			
	Sudent-Centred Learning Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test Preparation of presentation					14 19 9	4 )									

Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	90

## **TEACHING METHODOLOGY**

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

### COURSE SCHEDULE

Weeks	Topics	Remarks				
Week-1	Stress analysis: statically indeterminate axially loaded member					
Week-2	Stresses in thin and thick walled cylinders and spheres					
Week-3	Study of various types of stresses in beams					
Week-4	Study of deflection of beams					
Week-5	Study of Mohr's circle					
Week-6	Week-6 Experimental stress analysis techniques and failure theories					
Week-7	Final Exam					

### ASSESSMENT STRATEGY

Cor	nponents	Grading	СО	Blooms Taxonomy
	Class Participation/ Attendance	5+5=10%	CO1	C2
Continuous Assessment (60%)	Conduct of Lab Test	20%	CO1, CO2	C2, C4, C6
	Report Writing	15%	CO1, CO2	C2, C4, C6
	Mid term	15%	CO2	C4, C6
Final Evaluation	Exam	30%	CO1, CO2	C2, C4, C6
(40%)	Viva Voce/ Presentation	10%	CO1, CO2	C2, C4, C6
Tot	al Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

1. *Strength of materials* (4th edition) William Nash, Publisher Mcgraw-hill International Editions, Schaum's Outline Series.

# **REFERENCE SITE**

	COURSE INFORMATION									
Course Code Course Title	: GEEM 351 : Engineering Ethics and Moral Philo	osophy C	Lecture Contact ] Credit Hours	Hours		: 2.0 : 2.0	)0 )0			
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	It is essential for professionals in any field to have an understanding of the ethical problems and principles in their field. But anyone, no matter what their job, must deal with many other professions as well. Part of professional ethics is the understanding of the ethics of other professions: how they interact and what can be expected from them as correct ethical behaviour. In turn, any professional will benefit from a critical scrutiny of their own ethics by those from other professions. The general principles of professional ethics will be examined, as well as the distinctive problems of the different fields. This course will help the nuclear engineering students to conceptualize the dynamics of the ethical practice in nuclear domain									
	OBJECTIVES									
	<ol> <li>To inculcate the sense of social responsibility.</li> <li>To develop a firm ethical base.</li> <li>To make the students realize the significance of ethics in nuclear professional environment.</li> </ol>									
	LEARNING OUTCOMES									
	<ol> <li>Upon completion of the course, the s</li> <li>Understand the theoretical aspec</li> <li>Identify practical and legal p professional field/industry.</li> <li>Develop foundation knowledge of Critically assess the codes of engineering life.</li> </ol>	students will b ts of ethics an problems com of ethics to be professional	e able to d moral philoso nmonly encoun applied in profe conduct and t	phy in p tered by essional : their im	orofes y en field aplica	ssiona nginee s. ntions	ll fields. ers in their in nuclear			
	COURSE OUTCOMES & GENEI	RIC SKILLS								
No.	Course Learning Outcome	Correspondin POs	g Bloom's Taxonomy	CP (	CA	KP	Assessment Methods			
CO1	<b>Understand</b> the theoretical aspects of ethics and moral philosophy in professional fields.	PO1	C2	-	-	1	T, Q, F			
CO2	<b>Identify</b> practical and legal problems commonly encountered by engineers in their professional field/industry.	PO2, PO6	C3	-	-	1	ASG, F			
CO3	<b>Develop</b> foundation knowledge of ethics to be applied in professional fields.	PO8	C6	-	-	1	MT, F			

CO4	Critical profession implicat life.	<b>ly assess</b> t onal conduc ions in nucle	he codes of t and their ear engineering	]	PO1:	2		(	25		-		-	1		T, F	
	(CP- Co Quiz; A	mplex Problem SG – Assignme	ns, CA-Complex ent; Pr – Presenta	Activi tion; R	ties,	KP-I	Knov ; F –	wled Fina	ge l al E	Profi xam	ile, T , MT	– Т - М	ſest ; id Te	PR – erm Ex	Proje (am)	ect;(	2 -
	COUR	SE CONTEN	T														
	Introductechnologics scope, r Codes of solving Respon Energy	ction to ethic ogy, ethical to nethods etc. I of Ethics (IEI techniques; sibilities of E Technology;	s, history, evolu erminology; In ntroduction to I 3); Code of Eth Case study Engineers; Ethic Safety, Risk an	ution, f troduc Philoso ics (B metho al Issu d Liab	need tion ophy AE odolo ues ility	l and to t of E RA & ogy, in Er ; Tru	l im the Engi & IA dif ngin ist a	port Eng neen AEA fere eeri ind r	anc ine ring ); V nt ng relia	e of erin ;; Pr Whis cas Prac abili	f ethi g Eth ofess stle I e st ctice; ty.	cs i hics sion Blov udi Etl	in nu : pu al E wing es; hics	iclear rpose ngine ; Ethi The Issue	engi , obj ering ical I Righ s in	neeri ectiv Cod proble nts a Nucle	ng es, es, em ind ear
	SKILL	MAPPING	(CO-PO MAP	PING	)												
					1		D		א מי		ידי ור		100	$(\mathbf{DO})$			1
	No.	Course I	Course Learning Outcome		1	2	3	<u>4</u>	JK P	6	7	8	9	10	11	12	
	CO1	<b>Understand</b> of ethics and professional	the theoretical as l moral philosop fields.	spects hy in	1		_			-		-		-			
	CO2	<b>Identify</b> p problems co by engineers field/industry	ractical and mmonly encour in their profess	legal ntered sional		2				3							
	CO3	<b>Develop</b> fou ethics to be a fields.	ndation knowled applied in profess	ge of sional								3					
	CO4	Critically a professional implications life.	ssess the code conduct and in nuclear engine	es of their eering												1	
JUSTIFICAT	[(3 – Ing [ON FO]	R CO-PO M	APPING														
Mapping	Corre	esponding of Matching					Ju	istif	icat	tion							
CO1-PO1		3	In order to und professional fie fundamentals a engineering pro	erstand lds, the and an blems	l the e kn eng is to	theo owleo gineer be ar	retic dge ring oplie	al as of m spe	spec nath cial	ets o ema izati	f ethi tics, 1 on to	ics a natu o th	and r iral s ie so	noral j cience lution	philos e, eng	sophy ineer comp	in ing lex
CO2-PO2		2	In order to be able to identify practical and legal problems commonly encountered by engineers in their professional field/industry identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering galaxies are required.						red on, ing ces								
CO2-PO6		3	In order to be all by engineers in by contextual kn and the consequence and solutions to	ole to id their p nowled uent re compl	denti rofes lge to spor lex e	fy pra ssiona asse sibili ngine	actic al fie ess so ties eerin	cal an eld/in ociet rele ^s ig pr	nd le ndus al, l vant oble	egal stry a nealt t to j ems	probl applic h, saf profe is req	ems catic čety, ssio uire	s com on of , lega nal e ed.	reason reason l and congined	y enco ning i cultur ering	ounter nform al issu pract	red 1ed ues ice

CO3-PO8	3	In order to develop foundation knowledge of ethics to be appli fields, application of ethical principles and commit to profes responsibilities and norms of engineering practice is required.	ed in professional ssional ethics and	
CO4-PO12	1	In order to engage in lifelong learning through acquiring knowl ethical aspects of professions of Nuclear Engineering, it is req the need for, and have the preparation and ability to engage in life-long learning in the broadest context of technological change	edge on legal and uired to recognize in independent and ge.	
<b>TEACHING I</b>	LEARNING STRATI	EGY		
Teaching and I	Learning Activities		Engagement (hours)	
	Face-to-Face Learnin Lecture Practical / T Student-Cen	ng utorial / Studio utred Learning	28	
	Self-Directed Learni Non-face-to- Revision	ng -face learning	56 14	
	Formal Assessment Continuous Mid-Term Final Exami	Assessment	2 1 3	
	Total		104	
<b>TEACHING N</b>	METHODOLOGY			
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method		
COURSE SCI	HEDULE			
Weeks		Topics	Remarks	
Week-1	Introduction to ethics engineering technolo	s, history, evolution, need and importance of ethics in nucle	or	
Week-2	Introduction to the Engineering Ethics: purpose, objectives, scope, methods etc.			
Week-3	Introduction to the E	Ingineering Ethics: purpose, objectives, scope, methods etc.	Class Test I, Final Exam	
Week 5	Introduction to the E Introduction to Philo	Engineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering	Class Test 1, Final Exam	
Week-4	Introduction to the E Introduction to Philo Professional Enginee	Engineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB)	Class Test I, Final Exam	
Week-4 Week-5	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE	Engineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A)	Class Test	
Week-4 Week-5 Week-6	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE Code of Ethics ( BA)	Engineering Ethics: purpose, objectives, scope, methods etc. poophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA)	Class Test Class Test Class Test Class Test Class Test Class Test Exam	
Week-4 Week-5 Week-6 Week-7	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE Code of Ethics ( BA) Ethical Problem Solv	Angineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) ving Techniques	Class Test  Class Test  Class Test  Class Test  Class Test  Class Test  Exam	
Week-4 Week-5 Week-6 Week-7 Week-8	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE, Code of Ethics ( BA) Ethical Problem Solv Whistle Blowing.	Engineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) ving Techniques	Class Test I, Final Exam Class Test Class Test 2, Final Exam Mid	
Week-4 Week-5 Week-6 Week-7 Week-8 Week-9	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE Code of Ethics ( BA) Ethical Problem Solv Whistle Blowing. Case study methodol	Angineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) ving Techniques logy, different case studies	Class Test 1, Final Exam Class Test 2, Final Exam Mid Term, Final	
Week-4 Week-5 Week-6 Week-7 Week-8 Week-9 Week-10	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE, Code of Ethics ( BA) Ethical Problem Solv Whistle Blowing. Case study methodol The Rights and Resp	Angineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) ving Techniques logy, different case studies ponsibilities of Engineers	Class Test 1, Final Exam Class Test 2, Final Exam Mid Term, Final Exam	
Week-4 Week-5 Week-6 Week-7 Week-8 Week-9 Week-10 Week-11	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE Code of Ethics ( BA) Ethical Problem Solv Whistle Blowing. Case study methodol The Rights and Resp Ethical Issues in Eng	Angineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) wing Techniques logy, different case studies ponsibilities of Engineers gineering Practice	Class Test 1, Final Exam Class Test 2, Final Exam Mid Term, Final Exam	
Week-4 Week-5 Week-6 Week-7 Week-7 Week-8 Week-9 Week-10 Week-11 Week-12	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE. Code of Ethics ( BA) Ethical Problem Solv Whistle Blowing. Case study methodol The Rights and Resp Ethical Issues in Eng Ethics Issues in Nucl	Angineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) ving Techniques logy, different case studies ponsibilities of Engineers gineering Practice lear Energy Technology	Class Test Class Test Class Test Class Test Class Test Class Test Mid Mid Term, Final Exam Class Test Class Test Class Test	
Week-4 Week-5 Week-6 Week-7 Week-7 Week-8 Week-9 Week-10 Week-11 Week-12 Week-13	Introduction to the E Introduction to Philo Professional Enginee Code of Ethics (IAE, Code of Ethics ( BA) Ethical Problem Solv Whistle Blowing. Case study methodol The Rights and Resp Ethical Issues in Eng Ethics Issues in Nucl Safety, Risk and Lial	Angineering Ethics: purpose, objectives, scope, methods etc. psophy of Engineering ering Codes, Codes of Ethics (IEB) A) ERA) ving Techniques logy, different case studies ponsibilities of Engineers gineering Practice lear Energy Technology bility	Class Test 1, Final Exam Class Test 2, Final Exam Mid Term, Final Exam Class Test 3, Final Exam	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C3, C5
Assessment (40%)	Class Participation and Class attendance	5+5= 10%	CO1, CO2	C2, C3
	Mid term	10%	CO3	C6
	Final Examination	60%	CO1-CO4	C2, C3, C5, C6
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

1. Charles E. Harris, et el. *Engineering Ethics: Concepts and Cases*, Cengage Learning Boston, USA: 4th Edition, 2009.

2. Charles B. Fleddermann, Engineering Ethics, 4th Edition, NewYork, USA: Mc-Grawhill: 2012.

3. Davis, M., ed. Engineering Ethics. Farnham, United Kingdom Ashgate Publishing Co, 2005.

## **REFERENCE SITE**

## Level-3, Term-II

COURSE INFORMATION								
urse Code urse Title: GERM 352 : Fundamentals of Research MethodologyLecture Contact Hours Credit Hours: 4.0 : 2.0								
PRE-REQUISITE								
A STRUCTURE								
Education (OBE)								
SYNOPSIS/RATIONALE								
	<b>DRMATION</b> : GERM 352         : Fundamentals of Research Methodology <b>TE M STRUCTURE</b> Education (OBE) <b>TIONALE</b>	DRMATION         : GERM 352       Lecture Contact Hours Credit Hours         : Fundamentals of Research Methodology       Credit Hours         TE       Image: Credit Hours         M STRUCTURE       Image: Credit Hours         Education (OBE)       Image: Credit Hours         TIONALE       Image: Credit Hours						

The Fundamentals of Research Methodology is a hands-on course designed to impart education in the foundational methods and techniques of academic research in Science and Engineering context. UG students would examine and be practically exposed to the main components of a research framework i.e., problem definition, research design, data collection, ethical issues in research, time management, report writing, and presentation. Once equipped with this knowledge, participants would be well-placed to conduct disciplined research under supervision in an area of their choosing. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments.

## **OBJECTIVES**

- 1. To evaluate/review related extant literature, form a variety of sources, pertinent to the research objectives/questions.
- 2. To expose students to various research methodologies (design), relevant to the research problem needing to be addressed.
- 3. To explain and justify how researchers will collect and analyze research data.
- 4. To educate students in the common mistakes, research misconduct, and ethical considerations in the field of research methodology.

#### **LEARNING OUTCOMES**

Upon completion of the course, the students will be able to

- 1. Understand the research fundamentals and formulate problem statement and research questions/objectives.
- 2. Formulate and compose a research proposal considering research activities/design, background studies, and following standard guidelines.
- 3. Develop writing and presentation skill, and demonstrate ethical considerations in conducting research.

#### COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POS	Bloom's Taxonomy	СР	CA	KP	Assessment Methods
CO1	<b>Understand</b> the research fundamentals and <b>formulate</b> problem statement and research questions/objectives.	PO2	C2, C6	-			ASG, Q
CO2	<b>Formulate</b> and <b>compose</b> a research proposal considering research activities/design, background studies, and following standard guidelines.	PO3, PO12	C6	-			R, Pr, ASG, Q
CO3	<b>Develop</b> writing and presentation skill, and <b>demonstrate</b> ethical considerations in conducting research.	PO8, PO10	C2, C6	-			R, Pr, ASG

(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test, PR – Project, Q – Quiz, ASG – Assignment, Pr – Presentation, R – Report, F – Final Exam, MT- Mid Term Exam;

C1 – Remember, C2 – Understand, C3 – Apply, C4 – Analyze, C5 – Evaluate, and C6 – Create)

#### **COURSE CONTENT**

1. Foundations of Research: meaning of research; definitions of research; objectives of research; motivation in research; general characteristics of research; criteria of good research; types of research; concept of theory, empiricism, deductive and inductive theory; characteristics of scientific method.

2. Problem Identification and Formulation: meaning and need of review of literature; how to conduct the review of literature; research question – investigation question – measurement issues – hypothesis – qualities of a good hypothesis –Null hypothesis & Alternative hypothesis. Hypothesis testing – logic & importance.

3. Research Design: concept and importance in research – features of a good research design – exploratory research design – concept, types and uses, descriptive research designs – concept, types and uses, experimental/ computational design: concept of independent & dependent variables.

4. Data Analysis: Data Preparation – Univariate Analysis (frequency tables, bar charts, pie charts, percentages), Bivariate Analysis – Cross Tabulations and Chi-square test including testing hypothesis of association.

5. Research Misconduct and Ethics: understand the research misconduct; type of research misconduct; ethical issues in conducting research; ethical issues related to publishing, plagiarism and self-plagiarism.

6. Use of Tools / Techniques for Research: layout of a research paper; methods to search required information effectively; reference management software like Zotero/ Mendeley; software for paper formatting like LaTeX/MS Office; software for detection of Plagiarism, time management and developing Gantt Charts.

#### **SKILL MAPPING**

No. Course Learning Outcome		PROGRAM OUTCOMES (PO)											
INO.	Course Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12
	Understand the research fundamentals and												
CO1	formulate problem statement and research		3										
questions/objectives.													
	Formulate and compose a Research proposal												
CO2	considering research activities, background			1									2
	studies, and following standard guidelines.												
	Develop writing and presentation skill, and												
CO3	demonstrate ethical considerations in								1		3		
	conducting research.												

(3 – High, 2- Medium, 1-low)

PO1 – Engineering knowledge, PO2 – Problem analysis, PO3 – Design/development of solutions, PO4 - Investigation, PO5 – Modern tool usage, PO6 – Engineer and society, PO7 – Environment and sustainability, PO8 - Ethics, PO9 – Individual and teamwork, PO10 - Communication, PO11 – Project management and finance, PO12 – Life-long learning

#### **TEACHING LEARNING STRATEGY**

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	48
Lecture	24
Practical / Tutorial / Studio	12
Student-Centred Learning	12
Self-Directed Learning	30
Non-face-to-face learning	12
Report Preparation	18
Formal Assessment	
Continuous Assessment	3
Report Submission (2)	-
Presentation (2)	1
Total	160

### **TEACHING METHODOLOGY**

Lecture and Discussion, Mini-Seminars by Experts, Co-operative and Collaborative Method, Problem Based Method

#### **COURSE SCHEDULE**

Week	Topics	Assessment			
1	Foundations of Research: Meaning of Research; Definitions of Research; Objectives of Research; Motivation in Research; General Characteristics of Research; Criteria of Good Research; Types of Research; Concept of theory, empiricism, deductive and inductive theory; Characteristics of scientific method				
2	Practice session on Foundations of Research	Continuous			
3	Problem Identification & Formulation: Meaning & need of Review of Literature; How to Conduct the Review of literature; Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.	Assessment (presentation/ quiz/other assignment)			
4	Practice session on Problem Identification & Formulation				
5	Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs –	Assignment 1			

		concept, types and uses. Experimental Design: Concept of Independent & Dependent variables	Assignment has to provide			
	6	Practice session on Research Design	before, here			
	7	<ul> <li>Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association</li> </ul>				
	8	Practice session on Data Analysis				
	9	Research Misconduct and Ethics: Understand the research misconduct; type of research misconduct; Ethical issues in conducting research; Ethical issues related to publishing, Plagiarism and Self-Plagiarism				
	10	Practice session on Research misconduct and Ethics	Continuous			
	11	11 Use of Tools / Techniques for Research: Layout of a Research Paper; Methods to search required information effectively; Reference Management Software like Zotero/ Mendeley; Software for paper formatting like LaTeX/MS Office; Software for detection of Plagiarism. Time management and developing Gantt Charts				
	12	Practice session on Use of tools/ techniques for Research	ussignment)			
Ī	13	Review Session (Theory) – I/ Final Presentation	Assignment 2			
	14	Review Session (Practice) – II/ Final Presentation	Assignment has to provide before, here students will submit report and give PPT			

Assessment Crit	teria	00	Dia ang Tananang
Components	Grading	CO	Blooms Taxonomy
Assignment I	20%	CO1, CO3	C2, C6
Assignment II	50%	CO2, CO3	C2, C6
Continuous Assessment	30%	CO1, CO2	C2,C6
Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

- 1. Deb, Dipankar, Rajeeb Dey, and Valentina E. Balas. *Engineering research methodology: a practical insight for researchers*.1 edition, Singapore: Springer, 2018.
- 2. David V. Thiel, *Research Methods for Engineers*, 1st Edition, UK: Cambridge University Press, 2014.
- 3. Flick. *Introducing research methodology: A beginner's guide to doing a research project*, 2nd edition New York, USA:Sage Publications Ltd;, 2015.
- 4. Blessing, Lucienne TM, and Amaresh Chakrabarti. *DRM: A design reseach methodology*, London, UK: Springer-Verlag, 2009.
- 5. Wolske, Martin. Research Methods: Information, systems and contexts, *The Journal of Community Informatics*, Mornington, Australia: Tilde University Press, 2013.
- 6. Dillman, Don A., Jolene D. Smyth, and Leah Melani Christian. *Internet, phone, mail, and mixed-mode surveys: the tailored design method*, New Jarsey, United States: John Wiley & Sons, 2014.

#### **REFERENCE SITE**

# Level-4, Term-I and Term-II

	COURSE INFORMATION								
Course Code Course Title	: NE 400 : Final Year Design and Research Project Lecture Contact Hours : 12.00 : 6.00								
	PRE-REQUISITE								
	None								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	This course motivates to go neck-deep in research, synthesize it, and make a point or look at something in a different way after going through all of it. It provides descriptions, analyses and suggested solutions to problems in relation to practical nuclear engineering problem. It will emphasis to gather knowledge on a specific topic and to relate theory to empirical observations. Apart from these, this course will also introduce the students to write a thesis book and represent their ideas.								
	OBJECTIVES								
	<ol> <li>To learn more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work.</li> <li>To study, analyze and provide solutions for the problems related to Nuclear Engineering.</li> <li>To contribute to research and development work.</li> <li>To use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.</li> <li>To plan and use adequate methods to conduct qualified tasks in given frameworks and to evaluate this work.</li> <li>To create, analyse and critically evaluate different technical/architectural solutions.</li> <li>To critically and systematically integrate knowledge.</li> </ol>								
	LEARNING OUTCOMES								
	<ol> <li>Upon completion of the course, the students will achieve the</li> <li>Ability to conduct literature review to justify the importance of research and to support development of coherent methodology using standard references including journals, policie field data, etc.</li> <li>Ability to analyze scenario and compose the problem statements and the research objective of the project along with time-cost estimation and ethical values.</li> <li>Ability to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate relife problem.</li> <li>Ability to communicate through clear research writing conform to standard thesis format an performs verbal presentation along with visibility of the proposed system.</li> </ol>								

	COURSE OUTCOMES & GENERIC SKILLS															
No.	C	Course Learning Outcome	Correspondi ng POs	Blo Taxe	oom' onor	's ny	СР		CA		KP		As N	ses ⁄Ietl	sme 10d	ent s
CO1	Conduction important develops using s journals	t literature review to justify the nce of research and to support ment of coherent methodology standard references including , policies, field data, etc.	PO4, PO5	C1-0	C4, A	42	1		1		1			PR	, R	
CO2	Analyze problem objectiv time-cos	e scenario and compose the statements and the research es of the project along with st estimation and ethical values.	PO2, PO6, PO8	C1 C5, 4	, C3 A3, A P1	- \4,	3		2		1, 3,4			Pr,	R	
CO3	<b>Formul</b> incorport theories standard research life prob	ate research methodology rating clear fundamentals, and benchmarked against l practices governing the project which incorporate real blem.	PO1, PO3, PO7, PO9, PO12	C3-0	C6, A P5	4,	2		3		1, 2, 5	,		Pr,	R	
CO4	Commu writing, format with visi	<b>inicate</b> through clear research conform to standard thesis and verbal presentation along ibility of the proposed system.	PO7, PO10	C4 A3	I, C6 5, P7	, ,	7		5		1,8			PR	, R	
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)															
	COUR	SE CONTENT														
	Student	s may choose to write alone of	r in groups of	up to 3	3 stu	ıden	ts.									
	SKILL	MAPPING (CO-PO MAPP	ING)													
l					1		GPA	M		TC	OM	FC	( <b>P</b> (	<u>))</u>		
l	No.	Course Learning C	Outcome		1	2 3	3 4	5	6	7	8	9	10	11	12	
	CO1	Conduct literature review to ju of research and to support deve methodology using standard in journals, policies, field data, etc	stify the impor elopment of coh references inclu c.	tance erent uding			3	2								
	CO2	<b>Analyze</b> scenario and compose the problem statements and the research objectives of the project along with time-cost estimation and ethical values.				3			2		3					
	CO3	<b>Formulate</b> research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem.				3	3			2		1			2	
	CO4	Communicate       through       clear       research       writing,         conform       to       standard       thesis       format       and       verbal         presentation       along       with       visibility       of       the       proposed       gradient       gradient														
	(3 – High, 2- Medium, 1-low)															
JUSTIFICA	TION FO	OR CO-PO MAPPING														

Mapping	Corresponding Level of Matching	Justification
CO1-PO4	3	In order to conduct literature review to justify the importance of research and to support development of coherent methodology using standard references including journals, policies, field data, etc., it is required to conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
CO1-PO5	2	In order to conduct literature review to justify the importance of research and to support development of coherent methodology using standard references including journals, policies, field data, etc., it is required to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations.
CO2-PO2	3	In order to analyze scenario and compose the problem statements and the research objectives of the project along with time-cost estimation and ethical values, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.
CO2-PO6	2	In order to analyze scenario and compose the problem statements and the research objectives of the project along with time-cost estimation and ethical values, application of reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems is required.
CO2-PO8	3	In order to analyze scenario and compose the problem statements and the research objectives of the project along with time-cost estimation and ethical values, application of ethical principles and commit to professional ethics and responsibilities and norms of engineering practice is required.
CO3-PO1	3	In order to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO3-PO3	3	In order to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
CO3-PO7	2	In order to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem, it is required to understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.
CO3-PO9	1	In order to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem, it is needed to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
CO3-PO12	2	In order to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem, it is required to recognize the need

	for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.						
CO4-PO7	3 In the pr im pr	In order to communicate through clear research writing conform to standard thesis format and performs verbal presentation along with visibility of the proposed system, it is required to understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.					
CO4-PO10	In the pr 3 en su do in	In order to communicate through clear research writing conform to standard thesis format and performs verbal presentation along with visibility of the proposed system, it is required to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions					
TEACHING	LEARNING STRATEGY	7					
Teaching and	Learning Activities			Eng (	gagement hours)		
	Face-to-Face Learning Lecture Practical / Tutorial / Studio						
	Self-Directed Learning Non-face-to-face learning Revision						
	Formal Assessment Continuous Assessment Research project Report Mid-Term						
	Final Presentation	l		1			
TEACHING	METHODOLOGY				233		
Lecture and D	Discussion. Co-operative and	l Collaborative Metho	od. Problem Based Method				
COURSE SC	CHEDULE		,				
Weeks	Activitie	es	Log Book		Remarks		
Week-1	Discussion with students,	Topics selection (I)	-				
Week-2	Discussion with students, 7	Topics selection (II)	-				
Week-3	Analysis selected topics		Introduction section (Chapter 1)				
Week-4	Review of Literature (I)		Writing literature review (Chapt	er 2)			
Week-5	Review of Literature (II)		Writing literature review (Chapter 2)				
Week-6	Work on methodology sec	tion	Starting of methodology section (Chapter 3)				
Week-7	Presentation on proposed r	research work	k Sample report				

Week-8	Work on Proposal and Presentation coveringIntroduction,LiteratureMethodology	Related update					
Week-9	Related data collection, data analysis (I)	Include analysed result, result and discussion					
Week-10	Related data collection, data analysis (II)	Include analysed result, result and discussion					
Week-11	Related data collection, data analysis (III)	Include analysed result, result and discussion					
Week-12	Final update on proposed work	Submission of Draft Research Proposal to Supervisor					
Week-13	Research proposal and report evaluation considering rubrics	Submission of Final Research Proposal					
Week-14	Proposal Defence (Oral) Evaluation	-					
ASSESSMEN	ASSESSMENT STRATEGY						

Evaluator	Component	Grading (%)	Total (%)	CO	Bloom Taxonomy
	Problem statement and Research objective report	20		CO1	C1-C4, A2
Supervisor	Literature review report	30	60	CO2	C1, C3-C5, A3, A4, P1
	Methodology report	10		CO3	C3-C6, A4, P5
	Proposal raport	20		CO1	C1-C4, A2
Internal	Proposal report	20	25	CO4	C4, C6, A5, P7
Examiner	<b>Proposal presentation</b>	15	55	CO2	C1, C3-C5, A3, A4, P1
	r toposar presentation	15		CO3	C3-C6, A4, P5
Coordinator	Log book	5	5	CO4	C4, C6, A5, P7
<b>Total Marks</b>		100	100		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

N/A

**REFERENCE SITE** 

	COURSE INFORMATION		
Course Code Course Title	: NE 409 : Nuclear Fuel Cycle and Radioactive Waste Management	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	None		

	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	This course is designed to provide emerging field of nuclear fuel sys conditioning and disposal management	a general introc stem and the c ent.	luction to the lassification	e vario of rac	ous op lioacti	portu ve wa	nities in the aste and its	
	OBJECTIVES							
	<ol> <li>To understand the process of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.</li> <li>To acquiring the skill of fuel designing, fuel performance analysis, burn-up analysis and spent fuel reprocessing methods.</li> <li>To understand the classification of radioactive waste and its conditioning and develop safety cases and assessments for repositories.</li> <li>To acquire the knowledge of different waste treatment procedures and demonstrate both and radiological active in case of radioactive methods.</li> </ol>							
	LEARNING OUTCOMES							
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Understand the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management.</li> <li>Explain the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.</li> <li>Analyze the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories.</li> <li>Evaluate the fuel design and performance analysis and demonstrate both environmental and</li> </ol>							
	COURSE OUTCOMES & GENEI	RIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods	
CO1	<b>Understand</b> the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management.	PO1, PO2	C2	-	-	1	T, Q, F	
CO2	<b>Explain</b> the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.	PO2	C4	-	-	3	ASG, F	
CO3	<b>Analyze</b> the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories.	PO3	C4	-	-	3	MT, F	
CO4	<b>Evaluate</b> the fuel design and performance analysis and demonstrate both environmental and radiological safety in case of radioactive waste disposals to save environment	PO7	C5	-	-	5	T, F	

	(CP- Co Quiz; AS	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)												
	COUR	SE CONTENT												
	Nuclean An over purifica rod and of irradi econom	<b>Nuclear Fuel Cycle</b> An overview of the fuel cycle, different fuels and fuel utilization, mining and milling of uranium, purification and conversion to UF ₆ , enrichment of uranium, Separative Work Unit (SWU), fuel rod and fuel assembly designs, In core fuel management, different refuelling methods, properties of irradiated fuel, spent fuel management, nuclear fuel reprocessing, fusion fuel cycle, fuel cycle economy.												
	<b>Radioactive Waste Management</b> Radioactive waste definition and classification, LLW, ILW and HLW; principles to manage radioactive waste, wastes from the 'front end' and 'back end' of the fuel cycle, decommissioning waste, transuranic waste; different separation techniques of nuclear wastes; the Purex process, conversion of radioactive wastes, decontamination of radioactive element, treatment process of gaseous, aqueous and solid wastes, conditioning process of HLW, ILW, LLW and spent fuels, treatment and conditioning processes - incineration, compaction, cementation, bituminization, calcination, vitrification, synroc and composite waste forms, glass-ceramic composites, engineered encapsulation, transportation and storage systems of nuclear waste, disposal; different disposal techniques, shallow disposal, deep disposal, dry cask storage and spent fuel pool, policy, governance, social and political issues, environmental impact assessment.													
	SKILL	MAPPING (CO-PO MAPPING)												
							an		~ * ***	<u></u>				
	No.	Course Learning Outcome	1	2	3	4	5 GR	4M 0 6	7	8	1ES ( 9	PO) 10	11	12
	CO1	<b>Understand</b> the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management.	2	3										
	CO2	<b>Explain</b> the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.		3										
	CO3	<b>Analyze</b> the classifications of radioactive waste and its conditioning and <b>develop</b> safety cases and assessments for repositories.			3									
	Evaluatethefueldesignandperformanceanalysisanddemonstratebothenvironmentalandradiologicalsafetyincaseofradioactivedisposalstosaveenvironment													
JUSTIFICAT	(3 – Higi	h, 2- Medium, 1-low) R CO-PO MAPPING								_				

Mapping	Corresponding Level of Matching	Justification					
CO1-PO1	2	In order to understand the various opportunities in the emergin fuel system and the classification of radioactive waste and its disposal management, the knowledge of mathematics, engineering fundamentals and an engineering specialization complex engineering problems is to be applied.	g field of nuclear conditioning and natural science, to the solution of				
CO1-PO2	3	In order to understand the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.					
CO2-PO2	3	In order to explain the fundamentals of Uranium mining, mil enrichment and fuel fabrication techniques, identification, forr literature and analysis of complex engineering problems reach conclusions using first principles of mathematics, natur engineering sciences are required.	ling, conversions, nulation, research ning substantiated ral sciences and				
CO3-PO3	CO3-PO3 3 In order to analyze the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories, it is required to design solutions for complex engineering problems and design systems, components o processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations						
CO4-PO7	CO4-PO7 2 In order to evaluate the fuel design and performance analysis and demonstr both environmental and radiological safety in case of radioactive waste dispos it is required to conduct investigations of complex problems using research-ba knowledge and research methods including design of experiments, analysis interpretation of data, and synthesis of information to provide valid conclusion						
<b>TEACHING</b>	LEARNING STRATE	GY					
Teaching and I	Learning Activities		Engagement (hours)				
	Face-to-Face Learning						
	Lecture		42				
	Practical / Tu	torial / Studio	-				
	Student-Centi		-				
	Non-face-to-f	8 Tace learning	84				
	Revision		21				
	Formal Assessment						
	Continuous A	ssessment	2				
	Mid-Term		1				
	Final Examin	ation	3				
			153				
TEACHING	METHODOLOGY						
Lecture and Di	scussion, Co-operative	and Collaborative Method, Problem Based Method					
COURSE SCI	HEDULE						
Weeks		Topics	Remarks				
Week-1	An overview of the uranium, Heap leaching	fuel cycle, different fuels and fuel utilization, mining	of				

Week-2	In Situ leaching, milling of uranium, solvent extraction of uranium, purification and conversion to UF6	Class Test
Week-3	Uranium enrichment: gaseous diffusion, uranium enrichment: centrifuge enrichment, laser isotope separation process, Separative Work Unit (SWU)	I, Final Exam
Week-4	Analysis of SWU, Fuel Rod And Assembly Design-1, Fuel Rod And Assembly Design-2	
Week-5	In core fuel management, Fuel Management And Fuel Reload Pattern -1, Fuel Management And Fuel Reload Pattern -2	Class Test
Week-6	Fuel Burn-up Calculation -1, Fuel Burn-up Calculation-2, properties of irradiated fuel	Exam
Week-7	Spent fuel management, nuclear fuel reprocessing, fusion fuel cycle, fuel cycle economy	
Week-8	Radioactive waste definition and classification, LLW, ILW and HLW, principles to manage radioactive waste	Mid
Week-9	Wastes from the 'front end' and 'back end' of the fuel cycle, decommissioning waste, transuranic waste, different separation techniques of nuclear wastes	Term, Final
Week-10	The purex process, conversion of radioactive wastes, decontamination of radioactive element, treatment process of gaseous, aqueous and solid wastes	Exam
Week-11	Conditioning process of HLW, ILW, LLW, spent fuels treatment and conditioning processes - incineration, compaction, cementation, bituminization, calcination, spent fuels treatment and conditioning processes - vitrification, synroc and composite waste forms	Class Test
Week-12	Composite waste forms, glass-ceramic composites, engineered encapsulation, transportation and storage systems of nuclear waste	3, Final Exam
Week-13	Different disposal techniques, shallow disposal, deep disposal, dry cask storage	
Week-14	Spent fuel pool, policy, governance, social and political issues, environmental impact assessment	

Com	oonents	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C5
t (40%)	Class Participation	5%+5% (Attnd)	CO1, CO2	C2, C4
	Mid term	15%	CO3	C4
Final Examination		60%	CO1,CO2,CO3,CO4	C2, C4, C5
Total Marks		100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

**REFERENCE BOOKS** 

- 1. P. D. Wilsion, The nuclear fuel cycle from ore to waste, oxford science publications, Oct 1997
- 2. INTERNATIONAL ATOMIC ENERGY AGENCY, Radioactive Waste Management: An IAEA Source Book, IAEA, 1992
- 3. OECD/NEA, Advanced Nuclear Fuel Cycles and Radioactive Waste Management, Nuclear Development, OECD Publishing, 2006
- 4. D. R. Wily, The chemistry of nuclear fuel waste deposal, Polytechnic International Press, 2002

5. R. E. Masterson, *Nuclear Engineering Fundamentals: A Practical Perspective*, 2nd ed., CRC Press, 2017 **REFERENCE SITE** 

	COURSE INFORMATION						
Course Code Course Title	: NE 415 : Radiation Interactions, Shielding and Protection	Lecture Contact Hours Credit Hours	: 3.00 : 3.00				
	PRE-REQUISITE						
	NE 301       CURRICULUM STRUCTURE						
	Outcome Based Education (OBE)						
	SYNOPSIS/RATIONALE						
	This course is designed to learn and familiarize about the radiation interaction with matter as w as special techniques and simulation methods for shielding analysis.						
	OBJECTIVES						
	<ol> <li>To understand the fundamentals of radiation shieldin of particle interactions.</li> <li>To know the Monte Carlo simulation for shielding a dose calculations.</li> <li>To identify various techniques for photons and neutr</li> <li>To evaluate transport solutions: straight-ahead appro- moments; albedos and duct penetration methods.</li> </ol>	ng in radiation fields and s nalysis and basic method ons. oximation, discrete ordina	sources review s for radiation tes, method of				
	LEARNING OUTCOMES						
	<ol> <li>Upon completion of the course, the students will be able</li> <li>Apply fundamentals of radiation shielding in radiati interactions.</li> <li>Analyze the common radiation sources encounter simulation for shielding analysis.</li> <li>Explain build-up factors, extending point kernel tech codes, medical facility shielding for photons and diff</li> <li>Evaluate transport solutions: straight-ahead approx moments; albedos and duct penetration methods: sky</li> </ol>	to on fields and sources revi ed in shield design and miques to include build-u ferent techniques for neutri imation, discrete ordinat vshine and air scatter.	Nonte Carlo p point kernel ron. es, method of				

	COURSE OUTCOMES & GENERIC SKILLS															
No.	Co	ourse Learning Outcome	Corre	espoi POs	nding	5	Blo Taxo	om' non	s ny	CP	, (	CA	KP	Ass M	essme ethod	ent s
CO1	Apply shielding sources	fundamentals of radiation g in radiation fields and review of particle interactions.		PO1			C	23		-		-	-		T, F	
CO2	Analyze encounte Monte ( analysis)	the common radiation sources ered in shield design and Carlo simulation for shielding		PO3			C	C4		-		-	1	Q,	ASG,	F
CO3	Explain point k build-up facility different	build-up factors, extending ernel techniques to include point kernel codes, medical shielding for photons and t techniques for neutron.		PO2			C	25		-		-	2	Ν	ИТ, F	
CO4	Evaluat ahead ordinate and d skyshine	e transport solutions: straight- approximation, discrete s, method of moments; albedos uct penetration methods; e and air scatter.		PO2			(	25		-		-	3		T, F	
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)															
	COUR	SE CONTENT														
	Fundam review Carlo s techniq point ke straight penetra	nental concepts: definition of of particle interactions, comminulation for shielding analy ues for photons: buildup face ernel codes, medical facility sh -ahead approximation, mether tion methods; skyshine and a	f a shi mon ra ysis, b tors, e hieldir hod c ir scat	eld, adiat asic exter ng, sj of m ter.	chan tion met nding pecia nome	racte sour hod g pc al te ents	eriza rces ls for oint l chni , dis	ition enc r ra kern que scre	ns o coun diat nel t es fo ete	f rad itere ion techt r neu ordi	diati d in dose niqu utron nate	ion f shie e cal les t ns, tr es, a	fields eld de lculat o inc ranspo ilbedo	and esign, ions, lude ort so os ar	sourc Mor spec build lution d du	tes nte ial up ns: uct
	SKILL	MAPPING (CO-PO MAPI	PING	)												
						<u>ח</u>	POC		MC		100	125	$\overline{(\mathbf{D}\mathbf{O})}$			
	No.	Course Learning Outcome	e	1	2	<u>Р</u> 3	4	5	6	7	8	9	10	11	12	
	CO1	<b>Apply</b> fundamentals of radi shielding in radiation fields sources review of pa interactions.	iation and rticle	2												
	CO2	<b>Analyze</b> the common radi sources encountered in s design and Monte Carlo simul for shielding analysis.	iation shield lation		3											
	CO3	<b>Explain</b> buildup factors, exter point kernel techniques to in buildup point kernel codes, me facility shielding for photons different techniques for neutro	nding clude edical s and n.		3											
	CO4	<b>Evaluate</b> transport solutions straight-ahead approximations approximation of the straight st	tions: ation,		2											

	discrete ordinates, method of moments; albedos and duct penetration methods; skyshine and air scatter.       Image: Constraint of the second sec						
JUSTIFICAT	ION FOR CO-PO MA	PPING					
Mapping	Corresponding Level of Matching	Corresponding Level of Matching Justification					
CO1-PO1	2	In order to apply fundamentals of radiation shielding in radia sources review of particle interactions, identification, formul literature and analysis of complex engineering problems reachin conclusions using first principles of mathematics, natural engineering sciences are required.	tion fields and ation, research ag substantiated sciences and				
CO2-PO2	3	3 In order to analyze the common radiation sources encountered in shield design and Monte Carlo simulation for shielding analysis, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and ongineering sciences are required					
CO3-PO2	3 In order to explain buildup factors, extending point kernel techniques to include buildup point kernel codes, medical facility shielding for photons and different techniques for neutron, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.						
CO4-PO2	PO2 2 In order to evaluate transport solutions: straight-ahead approximation, discrete ordinates, method of moments; albedos and duct penetration methods; skyshine and air scatter identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of methomatics, natural sciences and angineering sciences are required.						
TEACHING I	LEARNING STRATE	GY					
Teaching and I	Learning Activities		Engagement (hours)				
	Face-to-Face Learning Lecture Practical / Tu Student-Cent	g torial / Studio red Learning	42				
	Self-Directed Learnin Non-face-to-f Revision	g ace learning	84 21				
	Formal Assessment21Continuous Assessment2Mid-Term1Final Examination3						
	Total		153				
TEACHING N	METHODOLOGY						
Lecture and Di	scussion, Co-operative	and Collaborative Method, Problem Based Method					
COURSE SCI	HEDULE						
Weeks		Topics	Remarks				

Week-1       Fundamental concepts: definition of a shield         Week-2       Fundamental concepts: characterizations of radiation fields and sources review of particle interactions				
Week-3	Fundamental concepts: common radiation sources encountered in shield design	L'Adin		
Week-4	Monte Carlo simulation for shielding analysis (I)			
Week-5	Monte Carlo simulation for shielding analysis (II)	Class Test		
Week-6	Monte Carlo simulation for shielding analysis (III)	2, Final Exam		
Week-7	Basic methods for radiation dose calculations (I)			
Week-8	Basic methods for radiation dose calculations (II)	Mid		
Week-9	Special techniques for photons: buildup factors, extending point kernel techniques to include buildup point kernel codes, medical facility shielding (I)	Term, Final		
Week-10	Special techniques for photons: buildup factors, extending point kernel techniques to include buildup point kernel codes, medical facility shielding (II)	Exam		
Week-11	Special techniques for neutrons, transport solutions: straight-ahead approximation, discrete ordinates, method of moments (I)			
Week-12Special techniques for neutrons, transport solutions: straight-ahead approximation, discrete ordinates, method of moments (II)				
Week-13	Albedos and duct penetration methods; skyshine and air scatter (I)	Exam		
Week-14	Albedos and duct penetration methods; skyshine and air scatter (II) and review			

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C3, C4
× ,	Mid term	10%	CO3	C5
Final Examination		60%	CO1-CO4	C3, C4, C5
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. Melissa Martin & P. H. McGinley, *Shielding Techniques for Radiation Oncology Facilities*, 3rd Edition, USA, Medical Physics Publishing, 2020.
- 2. Claude Leroy & Pier-Giorgio Rancoita, *Principles of Radiation Interaction In Matter and Detection*, 4th Edition, Singapore, World Scientific Publishing, 2015
- 3. Lamarsh, J.R. and Baratta, A.J., Introduction to Nuclear Engineering, 3rd Edition, USA, Prentice Hall, 2001.

# **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: NE 417Lecture Contact: Nuclear Accidents Analysis and Nuclear RadiologicalHours: Successful Credit Hours: 3.00: 3.00: 3.00										
	PRE-REQUISITE										
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	The course is designed to learn and familiarize about the nuclear accidents and radiological emergencies cause by these accidents.										
	OBJECTIVES										
	<ol> <li>To understand the fundamentals of safety functions in major nuclear and radiological accidents investigation.</li> <li>To know various methods of accidental analysis.</li> <li>To identify various types of operating procedures and plant simulators.</li> <li>To evaluate the qualification and training of users.</li> <li>To understand nuclear or radiological emergency response plan of Bangladesh</li> </ol>										
	LEARNING OUTCOMES										
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Explain major nuclear and radiological accidents.</li> <li>Understand nuclear or radiological emergency response plan.</li> <li>Analyze various methods of accidental analysis for the better impact to the society in accidental conditions</li> <li>Evaluate various types of operating procedures and plant simulators.</li> </ol>										
	COURSE OUTCOMES & GENE	RIC SKILLS									
No.	Course Learning Outcome	Corresponding POs	Bloom Taxono	's CP	CA	KP	Assessment Methods				
CO1	<b>Explain</b> major nuclear and radiological accidents.	PO1	C2	-	-	3	T, Q, F				
CO2	<b>Understand</b> nuclear or radiological emergency response plan.	PO2	C4	-	-	4	T, ASG, F				
CO3	<b>Analyze</b> various methods of accidental analysis for the better impact to the society in accidental conditions	PO6	C5	-	-	5	MT, F				
CO4	Evaluate various types of operating procedures and plant simulators.PO3C61-6				Q,T, F						
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)										
	COURSE CONTENT										

Major nuclear and radiological accidents investigation, fundamental safety functions, categorization of initiating events, conservative analyses, best estimate analyses, accident modelling, licensing analysis, validation of emergency, operating procedures and plant simulators, analysis related to probabilistic safety analysis, support for accident management and emergency planning, analysis of operational events, regulatory audit analysis, sources of user effects, reduction of user effects, qualification and training of users, method of analysis, other ways to reduce user effects, format and structure of accident analysis results, review of accident analysis results.

Overview of National Nuclear or Radiological Emergency Response Plan (NNRER): Purpose, scope, types of emergencies, organization of the government response, radiological monitoring and assessment, medical assessment and response to radiological consequences, stages of the government response, international co-ordination-requests for assistance in nuclear or radiological emergency, maintaining and updating the NNRER plan.

#### SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
	Course Learning Outcome		2	3	4	5	6	7	8	9	10	11	12
CO1	Explain major nuclear and	2											
	radiological accidents.	4											
CO2	Understand nuclear or radiological		3										
	emergency response plan.												
CO3	Analyze various methods of												
	accidental analysis for the better						3						
	impact to the society in accidental					5	5						
	conditions												
CO4	Evaluate various types of operating				2								
	procedures and plant simulators.				3								
(3 – High, 2- Medium, 1-low)													

#### JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification					
CO1-PO1	2	In order to explain major nuclear and radiological accidents, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.					
CO2- PO2	3	In order to understand nuclear or radiological emergency response plan, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.					
CO3-PO6	3	In order to analyze various methods of accidental analysis, application of reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems is required.					
CO4-PO4	3	In order to evaluate various types of operating procedures and plant simulators, it is required to conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions					
TEACHING LEARNING STRATEGY							

Teaching and	Learning Activities	Engagement (hours)						
	Face-to-Face Learning	(nours)						
	Lecture							
	Practical / Tutorial / Studio							
	Student-Centred Learning							
	Self-Directed Learning	0.4						
	Non-face-to-face learning	84 21						
	Formal Assessment	21						
	Continuous Assessment	2						
	Mid-Term							
	Final Examination	3						
	Total	153						
TEACHING	METHODOLOGY							
Lecture and D	iscussion, Co-operative and Collaborative Method, Problem Based Method							
COURSE SC	HEDULE							
Weeks	Topics	Remarks						
Week-1	Major nuclear and radiological accidents investigation	Class Test						
Week-2	Fundamental safety functions, categorization of initiating events	1, Final						
Week-3	Fundamental safety functions, categorization of initiating events	Exam						
Week-4	Conservative analyses, best estimate analyses							
Week-5	Sensitivity and uncertainty, probabilistic analysis         Design analysis, licensing analysis, validation of emergency							
Week-6								
Week-7	Operating procedures and plant simulators, analysis related to probabilistic safety analysis	y						
Week-8	Support for accident management and emergency planning	Mid						
Week-9	Analysis of operational events, regulatory audit analysis							
Week-10	Sources of user effects, reduction of user effects							
Week-11	Qualification and training of users Method of analysis, other ways to reduce use effects Format and structure of accident analysis results	r						
Week-12	Overview of National Nuclear or Radiological Emergency Response Plan (NRER): Purpose, Scope, Types of Emergencies, Organization of the Government Response, Radiological Monitoring and Assessment,							
Week-13	-13 Medical Assessment and Response to Radiological Consequences, Stages of the Government Response,							
Week-14	eek-14 International Co-ordination-Requests for Assistance in Nuclear or Radiological Emergency, Maintaining and Updating the NNRER Plan.							
ASSESSMEN	T STRATEGY							
		<b>.</b>						
	Components Grading CO Blooms	l'axonomy						
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C6				
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Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2, CO4	C2, C4, C6				
	Mid term	10%	CO3	C5				
Final Examination		60%	CO1-CO4	C2, C4, C5, C6				
	Total Marks	100%						

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. International Atomic Energy Agency, *Accident Analysis for Nuclear Power Plants*, Safety Reports Series No. 23, IAEA, 2002.
- 2. International Atomic Energy Agency, *Accident Management Programmes for Nuclear Power Plants, IAEA*, Safety Standards Series No. SSG-54, IAEA, 2019

# **REFERENCE SITE**

## Level-4, Term-II

	COURSE INFORMATION							
Course Code Course Title	: NE 423 : Nuclear Power Plant Operation and In-core Fuel Management	Lecture Contact Hours Credit Hours	: 3.00 : 3.00					
	PRE-REQUISITE							
	None							
	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	The course is designed to learn and familiarize about the analyse the reactor core with fuel burnup.	in core fuel manageme	nt system and					
	OBJECTIVES							
	<ol> <li>To understand the fundamentals of in core fuel management.</li> <li>To know the fundamentals of reactor reload calculations.</li> <li>To identify various types of models for in-core fuel managements.</li> <li>To evaluate nuclear fuel cycle economics, core life time calculation.</li> <li>To know about fuel reshuffling and arrangement.</li> </ol>							
	LEARNING OUTCOMES							

	Upon completion of the course, the students will be able to							
	<ol> <li>Understand the operation and control of nuclear power reactor.</li> <li>Explain nuclear reactor start-up, operational modes, transients and shutdown.</li> <li>Compare various types of models for in-core fuel managements.</li> </ol>							
	4. Evaluate nuclear fuel cycle economics, core life time calculation, fuel reshuffling and							
	arrangement.							
	COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Learning Outcome	POs	Taxonomy	СР	CA	KP	Assessment Methods	
CO1	<b>Understand</b> the operation and control of nuclear power reactor.	PO1, PO2	C2	-	-	3	T, Q, F	
CO2	<b>Explain</b> nuclear reactor start-up, operational modes, transients and shutdown.	PO3	C5	-	-	4	ASG, F	
CO3	<b>Compare</b> various types of models for in-core fuel managements.	PO2	C5	-	-	5	MT, F	
CO4	<b>Evaluate</b> nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.	PO3	C5	1	-	6	T, F	
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kr tion; R - Report; F	nowledge Profi F – Final Exam	ile, T - , MT-	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)	
	COURSE CONTENT							
	Operation and control of nuclear po operations (including base load and following modes, etc.), transients, re Introduction to fuel management, v simulation and nodal methods, cor reactor reload calculations, models fo BWR in-core fuel management, fuel load designs and burnable poison calculation, fuel reshuffling and arra Importance of maintenance, organ interfaces with the regulatory organ management of spurious events/tr programs, review and audit, IAEA g	wer plant, reactor d non-base load actor stability, sl variables of core e burnup and for or in-core fuel ma management of placement, nuc ngement. izational structu ization, mainten ip or incidents uidelines in conr	or criticality a operations, nut down and e managemen uel, depletion magements, F other reactor lear fuel cyc are including ance program , replacemen nection with t	and stareacto refuent, reach n mod PWR i types, ele eco g adm n of N nts an he O&	art-up r follc lling o ctor c elling n-core optim onomio inistra IPP an d rep zM of	operation owing peration ore ar fuel n fuel n fization cs, co tive c d its c airs, NPPs.	tions, power and turbine ons. halysis, core amentals of hanagement, n of core re- re life time controls and components, surveillance	
	SKILL MAPPING(CO-PO MAPP	PING)						

	No	Course I	earning Outcome			Р	ROO	GR/	AM (	DUT	CON	1ES	(PO)	1		
	110.			1	2	3	4	5	6	7	8	9	10	11	12	
	CO1	control of nu	the operation and clear power reactor.	2	3											
	CO2	<b>Explain</b> nucleoperational is shutdown.	clear reactor start-up, modes, transients and			3										
	CO3	<b>Compare</b> va for in-core fu	rious types of models el managements.		3											
	CO4 <b>Evaluate</b> nuclear fuel c economics, core life calculation, fuel reshuffling arrangement.		nuclear fuel cycle core life time fuel reshuffling and			3										
	(3 – Hig	h, 2- Medium,	1-low)													
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corre Level o	esponding of Matching				Ju	ıstif	ica	tion							
CO1-PO1		2	In order understand knowledge of mather engineering specializa be applied.	In order understand the operation and control of nuclear power reactor, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.												
CO1-PO2		3	In order to understand the operation and control of nuclear power reactor, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.													
CO2-PO3		3	In order to explain nuclear reactor start-up, operational modes, transients and shutdown, it is required to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.													
CO3-PO2		3	In order to compare v required to conduct i knowledge and resear interpretation of data,	ario nves ch n and	us ty stigat netho synth	pes o ions ods in nesis	of m of nclue of in	ode com ding nfor	ls fo plex des mati	r in- pro ign o on to	core blen of ex	fuel ns us peri vide	mana sing r ments valid	ageme researc , anal concl	ents, it ch-bas ysis a usion	is ed nd s.
CO4-PO3		3	In order to evaluate nu reshuffling and arrang needs within realistic political, ethical, healt	uclea emer c co h an	ur fue nt, al onstra d saf	el cyo oility uints ety, 1	cle e to d suc man	con lesig h a ufac	omio gn a : is eo tura	cs, co syste cono bility	ore li m or mic, v, and	fe ti pro env d sus	me ca cess to rironn tainal	llculat o mee nental oility.	ion, f t desin , soci	ıel ed al,
TEACHING I	LEARNI	NG STRATI	EGY													
Teaching and I	Learning	Activities												Enga (h	geme ours)	nt
	Face-to	-Face Learnir	ng													
		Lecture Practical / Tr	utorial / Studio												42 -	
	Self-Di	rected Learni	no Learning												-	
	JUL DI	Non-face-to-	-face learning												84	
		Revision	G												21	
	Formal	Assessment														
	Continuous Assessment							2								

	Mid-Term Final Examination	1					
	Total	153					
TEACHING N	METHODOLOGY						
Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method						
COURSE SCI	HEDULE						
Weeks	Topics	Remarks					
Week-1	Operation and control of nuclear power plant, reactor criticality and startup operations, power						
Week-2	ek-2 Power operations (including base load and non-base load operations, reactor following and turbine following modes, etc.), transients, reactor stability, shut						
Week-3	Introduction to fuel management, variables of core management, reactor core analysis, core simulation and nodal methods, core burnup and fuel,	Глаш					
Week-4	Depletion modelling, fundamentals of reactor reload calculations, models for in-core fuel managements,						
Week-5	PWR in-core fuel management, BWR in-core fuel management       0         2						
Week-6	fuel management of other reactor types E						
Week-7	optimization of core re-load designs and burnable poison placement						
Week-8	The history of radiation effects; radiation units; exposure, radiation dose and biological dose; population dose II	Mid					
Week-9	Fissile material, fissionable material, fertile material, Ioninzing and non-ionizing radiation; neutron moderation and basics, nuclear fuel cycle economics	Term, Final					
Week-10	core life time calculation, fuel reshuffling and arrangement	Exam					
Week-11	core life time calculation, fuel reshuffling and arrangement						
Week-12	Importance of maintenance, organizational structure	Class Test					
Week-13	eek-13 Maintenance program of NPP and its components, administrative controls, facilities, replacements and repairs, surveillances						
Week-14	Review and audit programs, Regulatory Aspects, IAEA guidelines						
ASSESSMEN	T STRATEGY						

Components		Grading	СО	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C5
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C2, C5
	Mid term	10%	CO3	C5
Final Examination		60%	CO1-CO4	C2, C5
Total Marks		100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. G. Cochran, and N. Tsoulfanidis, The Nuclear Fuel Cycle: Analysis and Management, ANS 2002.
- 2. M. Driscoll, T. Downar, and E. Pilat, The Linear Reactivity Model for Nuclear Fuel Management
- 3. K. Ott, and W. Bezella, Introductory Nuclear Reactor Statics, ANS, 1983.
- 4. R. J. Stamm'ler, and M. Abate, Methods of Steady State Reactor Physics in Nuclear Design, Academic Press
- 5. P. Silvennoinen, "Reactor Core Fuel Management", Pergamon Press, 1976

## **REFERENCE SITE**

#### Level-4, Term-I

	COURSE INFORMATION								
Course Code	: NE 425		Lecture Contact	Hours		: 4.0	)0		
Course Title	: Nuclear Reactor Design and Feature	res	Credit Hours			: 4.0	00		
	PRE-REQUISITE								
	NE 207, NE 307								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	<ul> <li>This course is designed to understand and identify various types of approaches and methods of nuclear reactor core design. It also helps to analyze various designs of reactor core satisfying the parameters of the particular reactor type.</li> <li><b>OBJECTIVES</b> <ol> <li>To understand the fundamentals of nuclear reactor design for criticality and burnup calculation.</li> <li>To identify various types of principles and techniques of reactor core design methods.</li> <li>To analyze unique designs of reactor core satisfying the parameters of the particular reactor type.</li> </ol> </li> <li>4. To evaluate the various reactor designs based on knowledge and data from many nuclear engineering fields including reactor physics, thermal hydraulics, and nuclear safety.</li> </ul>						l methods of satisfying the		
							and burnup hods. icular reactor nany nuclear ety.		
	LEARNING OUTCOMES								
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Identify various types of principles and techniques of reactor core design methods.</li> <li>Analyze various unique designs of reactor core satisfying the parameters of the parameters of the parameter type.</li> <li>Evaluate the various reactor designs based on knowledge and data from many n engineering fields including reactor physics, thermal hydraulics, and nuclear safety.</li> </ol>					ls. he particular nany nuclear ety.			
	<b>COURSE OUTCOMES &amp; GENE</b>	RIC SKILLS							
No.	Course Learning Outcome	Correspondit POs	ng Bloom's Taxonomy	CP (	CA	KP	Assessment Methods		
CO1	<b>Identify</b> various types of principles and techniques of reactor core design methods.	PO2	C2	-	-	2	T, Q, F		

CO2	Analyze reactor of of the pa	e various unique designs of core satisfying the parameters articular reactor type.	P	03			C4		-	-		3	ASC	3, F
CO3	Evaluat based o many includin hydrauli	e the various reactor designs n knowledge and data from nuclear engineering fields g reactor physics, thermal cs, and nuclear safety.	P	02			C5		-	-		3	МТ	., F
CO4	Formula reactor p	ate the design procedure of parameters.	P	09			C6		3	3		5	T, F,	ASG
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)													
	COUR	SE CONTENT												
	<ul> <li>Fuel burn up and Reactivity Control: criticality calculation for square unit pin cell, hexagonal unit pin cell, 1-d cylindrical cell, fuel burn up analysis, fission product poisoning and xenon oscillation, effects of burnable poison and chemical shim, control rod worth, inherent reactivity effects, perturbation theory for reactivity calculations. Reactivity feedback.</li> <li>Nuclear Reactor Calculations: nuclear reactor design calculations, reactor core, plant dynamics and safety calculations.</li> <li>Reactor Design: design of various reactor core (i.e. LWR, FBR, SMR etc.).</li> <li>Advanced nuclear power plant design, evolutionary design, nuclear steam supply system, reactor pressure vessel and primary coolant pump, pressuriser, steam generator, separator and dryer design of reactor shielding and reflector, containment building, plant performance analysis, salient features of SMRs.</li> </ul>													
	SKILL	MAPPING (CO-PO MAR	PPING)											
	N					I	PROG	RAM	OUT	COM	1ES	(PO)		
	No.	Course Learning Outco	ome	1	2	3	4	5 6	7	8	9	10	11	12
	CO1	<b>Identify</b> various types of p and techniques of reactor com methods.	rinciples re design		3									
	CO2	<b>Analyze</b> various unique de reactor core satisfying the pa of the particular reactor type	esigns of trameters			3								
	CO3	<b>Evaluate</b> the various reactor based on knowledge and d many nuclear engineering including reactor physics, hydraulics, and nuclear safet	r designs ata from g fields thermal y.		2									
	CO4	<b>Formulate</b> the design proc reactor parameters.	edure of								2			
HISTIFICA	(3 – Hig	h, 2- Medium, 1-low)												
JUSTIFICA	TION F	UK CU-PU MAPPING												
Mapping	Corr Level	responding of Matching				Ju	stifica	ation						

CO1-PO2	3 In order to identify various types of principles and techniques of reactor core design methods, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.						
CO2-PO3	In order to analyze various unique designs of reactor core satisfying the param of the particular reactor type, it is required to conduct investigations of com problems using research-based knowledge and research methods including do of experiments, analysis and interpretation of data, and synthesis of informati provide valid conclusions.						
CO3-PO4	2 In order to evaluate the various reactor designs based on knowledge and data from many nuclear engineering fields including reactor physics, thermal hydraulics, an nuclear safety, it is required to conduct investigations of complex problems usin research-based knowledge and research methods including design of experiments analysis and interpretation of data, and synthesis of information to provide vali conclusions.						
CO4-PO9	2	In order to formulate the design procedure of reactor parame individual and group tasks through the design and analysis of o	eters, b differer	by performing nt reactors.			
TEACHING	LEARNING STRAT	EGY					
Teaching and	l Learning Activities		En	ngagement (hours)			
	Face-to-Face Learning	7		(nours)			
	Lecture						
	Practical / Tutorial / Studio						
	Student-Centred Learning						
	Self-Directed Learning						
	Non-face-to-f	s ace learning		84			
	Revision			21			
	Formal Assessment						
	Continuous Assessment						
	Mid-Term			1			
	Final Examina	ation		3			
	Total			153			
TEACHING	METHODOLOGY						
Lecture and I	Discussion, Co-operativ	e and Collaborative Method, Problem Based Method					
COURSE SO	CHEDULE						
Weeks		Topics		Remarks			
Week-1	Fuel Burnup and R poisoning	eactivity Control: fuel burnup analysis, fission produ	ıct	Class Test			
Week-2	Fuel Burnup and Reac	tivity Control: effects of burnable poison and chemical ship erent reactivity effects	m,	1, Final Exam			
Week-3	Fuel Burnup and Reac	tivity Control: perturbation theory for reactivity calculation	ns				
Week-4	Nuclear Design Calc	ulations: fundamental neutron transport equation ,neut	ron	~ -			
	spectrum, nuclear data	and cross sections	(	Class Test			
Week-5	Nuclear Design Calcu	lations: Lattice Calculation, Core Calculation		2, Final			
Week-6	Nuclear Design Calcu	lations: Lattice Calculation, Core Calculation	]	Exam			
Week-7	Advanced Nuclear Por	wer plant design					
Week-8	Evolutionary Design		]	Mid Term,			
Week-9	Nuclear Steam Supply System, Reactor Pressure Vessel and Primary Coolant Pump						

Week-10	Pressuriser, Steam Generator, Separator	
Week-11	Design of Reactor Shielding and Reflector	Cl
Week-12	Containment Building	Class Test
Week-13	Plant Performance Analysis	5, Fillai Evom
Week-14	Salient features of SMRs	Lam

Comp	onents	Grading	СО	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C6
(40%)	Class Participation	5%+ 5% (attnd)	CO1, CO2, CO4	C2, C4, C6
	Mid term	10%	CO3	C5
Final Examination		60%	CO1, CO2, CO3, CO4	C2, C4,C5,C6
Total Marks		100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

- 1. Y. Oka, Nuclear Reactor Design, 1st ed. Springer, 2014
- 2. H. Anglart, Applied Reactor Technology, 2011
- 3. A. Sesonske, *Nuclear Power Plant Design Analysis*, Technical Information Center, United States Atomic Energy Commission, 1973
- 4. S. Glasstone, A Sesonske, *Nuclear Reactor Engineering: Reactor Design Basics*, 1st ed. Springer US, 1994.
- 5. J. J. Duderstadt, L. J. Hamilton, Nuclear Reactor Analysis, 1st ed. Wiley, 1977

# **REFERENCE SITE**

#### Level-4, Term-I

	COURSE INFORMATION							
Course Code	: NE 426	Lecture Contact Hours	: 3.00					
Course Title	: Nuclear Reactor Design and Features Sessional	Credit Hours	: 1.50					
	PRE-REQUISITE							
	NE 425							
	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	This course is designed to learn and familiarize Features	the basics of Nuclear Read	ctors Design and					
	OBJECTIVES							
	To verify the theories and concepts learned in NE 4	25 practically.						

	LEARN	NING OUTC	COMES													
	1. Analyze the design and safety features of a reactor.															
	2. Ev.	2. Evaluate the performance parameters of a nuclear reactor.														
	3. Design and Formulate the reactor core and other feature for real life application.															
	COURS	SE OUTCO	MES & GENE	RIC S	KII	LS										
No.	Co	ourse Learning	Outcome	comeCorresponding POsBloom's TaxonomyCPCAKPAssessment Methods												
CO1	Analyze of a reac	the design and tor.	d safety features		PO4			C	C4		1		1	3	R,	Q, MT
CO2	<b>Evaluat</b> of a nucl	e the performation the performation of the performation of the performance of the perform	ance parameters	parameters PO5 C5 2 2 5 R, F, T												
CO3	Design and Formulate the reactor core and other feature for real life application.PO9C6336PR, Pr, T															
	(CP- Cor Quiz; AS	mplex Problem SG – Assignme	ns, CA-Complex ent; Pr – Presenta	Activi tion; R	ties, Re	KP-H eport;	Knov F –	wledg - Fina	ge F al Ez	Profil kam,	le, T MT-	– T - Mi	'est ; d Te	PR – rm Ex	Proje (am)	ect ; Q –
	COURS	SE CONTEN	NT													
	<ol> <li>measure the thermal coefficient of reactivity change.</li> <li>Analysis of shielding properties of water and water-iron combination against the fission neutron spectrum.</li> <li>Analysis the critical parameter for different core state scenario.</li> <li>Reactor Transient Scenario (Reactor Trip).</li> <li>Reactor Transient Scenario (LOCA and SBO).</li> <li>Performance analysis of a power rector by Monte Carlo Method.</li> <li>Designing of a reactor core using Deterministic or Probabilistic method.</li> <li>Burn up calculation of fuel assembly of a Nuclear Reactor using various software (COBRA, MCNP, TRACE, and ORIGEN).</li> <li>Burn up calculation of Nuclear Reactor Core using various software (COBRA, MCNP, TRACE, and ORIGEN).</li> <li>Analysis of reactivity feedback parameters of a power reactor.</li> </ol>															
	SKILL	MAPPING	(CO-PO MAP)	PING	)											
	 				1											
	No.	Course I	Learning Outcome	e	1		2 P	ROC	GRA	$\frac{MO}{c}$	$\frac{\text{OUTC}}{7}$	$\frac{ON}{O}$	1ES	$\frac{(PO)}{10}$	11	12
	I         2         3         4         5         6         7         8         9         10         11         12           CO1         Analyze the design and safety         3         3         4         5         6         7         8         9         10         11         12															
	features of a reactor.															
	CO2	Evaluate parameters o	eters of a nuclear reactor.													
	CO3	<b>Design and</b> core and oth application.	Formulate the real of the real	Formulate the reactor er feature for real life 3												
	(3 – Higl	h, 2- Medium,	1-low)													
JUSTIFICAT	ION FOI	R CO-PO M	APPING													
Mapping	Corre Level o	esponding f Matching					Ju	ıstifi	icat	ion						

Week-7	Mid Term		
Week-6	Performance analysis	s of a power reactor by Monte Carlo Method	
Week-5	Reactor Transient Sc	zenario (LOCA& SBO)	
Week-4	Reactor Transient SC		
week-3	Analysis the critical	parameter for different core state scenario	
Wast 2	A nolygic the pridical	10111	
Week-2	Analysis of shielding	g properties of water and water-iron combination against	the
Week-1	Study the transient be	ehaviour of a research reactor during shutdown and startup	and
Weeks		Topics	Remarks
COURSE SCH	HEDULE		
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method	
TEACHING N	METHODOLOGY		
	Total		121
	Final Quiz		1
	Continuous Assessm	lent	1
	Formal Assessment	F J	
	Engagement in Grou	in Projects	
	Preparation (	of Ouiz	14
	Preparation	of Lab Test	21
	Preparation	of Lab Reports	28
	Self-Directed Learnin	ng	20
	Student-Cen	tred Learning	-
	Practical / Tutorial /	Studio	28
	Lecture		
	race-to-race Learnin	ng	28
			(hours)
Teaching and I	earning Activities		Engagement
<b>TEACHING I</b>	LEARNING STRATE	EGY	
CO3- PO9	3	application, it is required function effectively as an individual, a leader in diverse teams and in multi-disciplinary settings	and as a member or
		problems, with an understanding of the limitations.	
CO2-PO5	3	create, select and apply appropriate techniques, resources, and n and IT tools, including prediction and modelling, to con	nodern engineering nplex engineering
		In order to evaluate the performance parameters of a nuclear re	actor, it is required
CO1-PO4	3	In order to analyze the design and safety features of a reactor conduct investigations of complex problems using research-ba research methods including design of experiments, analysis ar data, and synthesis of information to provide valid conclusions	or, it is required to sed knowledge and ind interpretation of
	1		

Week-8	Designing of a reactor core using Deterministic or Probabilistic method	
Week-9	Burn up calculation of fuel assembly of a Nuclear Reactor using various software (COBRA, MCNP, TRACE, ORIGEN)	
Week-10	Burn up calculation of Nuclear Reactor Core using various software (COBRA, MCNP, TRACE, ORIGEN)	
Week-11	Analysis of Reactivity feedback parameters of a power reactor	
Week-12	Lab Practice	
Week-13	Lab Test	
Week-14	Quiz and Viva	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
	Conduct of Lab Tests/Class Performance	25%	CO2, CO3	C5, C6
	Report Writing/ Programming	15%	CO1, CO2	C4,C5
	Mid-Term Evaluation (exam/project/assignment)	20%	CO1, CO3	C4, C6
	Viva Voce	10%	CO1, CO2, CO3	C3, C4, C5
	Final Evaluation (Lab Quiz)	30%	CO1, CO2, CO3	C3, C4, C5
Total Mark	ΣS	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

- 1. *A Guide to Nuclear Power Technology*, F. J. Rahn, A. G. Adamantiades, J. E. Kenton, and C. Braun, John Wiley and Sons, 1984.
- 2. Power Plant Engineering, Nage, 3rd eidtion, Tata Mc Graw Hill, 2002.
- 3. Nuclear Reactor Engineering: Reactor Design Basics by Samuel Glasstone Paperback, 1994.
- 4. *Nuclear Reactor Engineering: Reactor Systems Engineering*, 4th Edition, Vol. 2 by Samuel Glasstone, 1994.
- 5. Nuclear Reactor Analysis by Duderstad and Hamilton, Wiley, 1977.
- 6. Nuclear Reactor Design, Oka. Yoshoaki, Springer, 2014, ISBN 978-4-431-54897-3

#### **REFERENCE SITE**

Level-4, Term-II

	COURSE INFORMATION									
Course Code	: NE 427	]	Lecture Contact	Hours		: 3.0	)0			
Course Title	: Nuclear Power Plant Engineering		Credit Hours			: 3.0	00			
	PRE-REQUISITE	PRE-REQUISITE								
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	This course is designed to impart knowledge on the operation of different nuclear power plants and develop skill on fuel handling mechanism and basic considerations in nuclear power plant design.									
	OBJECTIVES									
	<ol> <li>To know the importance of Nuclear Power Plant operation.</li> <li>To understand the features of different sections of the Nuclear Power Plant.</li> <li>To understand the fuel handling mechanism to achieve the criticality.</li> <li>To understand the power plant operation cost.</li> </ol>									
	LEARNING OUTCOMES									
	Upon completion of the course, the students will be able to									
	<ol> <li>Apply the technical knowledge to design different types of nuclear power plants.</li> <li>Analyze the importance of different components inside the NPP.</li> <li>Understand fuel handling mechanism to achieve criticality.</li> <li>Formulate features of different sections of the Nuclear Power Plant.</li> </ol>									
-	COURSE OUTCOMES & GENER	RIC SKILLS	S							
No.	Course Learning Outcome	Correspondi POs	ng Bloom's Taxonomy	СР	CA	KP	Assessme nt Methods			
CO1	<b>Apply</b> the design knowledge to the power plants.	PO1, PO2	C3	-	-	1	T, Q, F			
CO2	<b>Analyze</b> the importance of different components inside the NPP.	PO1, PO9, PO10	с4 °	-	-	2	ASG, F			
CO3	<b>Understand</b> fuel handling mechanism to achieve criticality.	PO5	C2	-	-	6	MT, F			
CO4	<b>Compare</b> capital and operating cost of nuclear and fossil based power plant.	PO9	C5	1	-	7	Pr, T, F			
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)									

	Layout of react plant sy reheater auxiliar systems nuclear fossil fu	Layout of nuclear power plants; containment buildings; primary containment vessels; structure of reactor core; and mechanical stress in various structures. Description and analysis of power plant systems and components including steam generator, steam dryer and separator, pressurizer, reheater, heat exchanger, condenser, demineralizer, pumps, turbine, generator, cooling tower; auxiliary cooling systems. Fuel handling mechanisms; control and mechanisms; radwaste systems; electrical systems; reactor grid interface and load following. Basic considerations in nuclear plant design; components of nuclear power cost; economic comparison of nuclear and fossil fueled plants; dual and multipurpose nuclear plants; future trends in nuclear power cost.														
	SKILL	MAPPING	(CO-PO MAPPING)	)												
		C I				P	ROC	GRA	M	DUT	CON	1ES	(PO)			]
	No.	Course I	Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12	
	CO1	Apply the depower plants	Apply the design knowledge to the power plants.													
	CO2	Analyze the components	importance of different inside the NPP.	3								2	2			
	CO3	Understand mechanism te	fuel handling o achieve criticality.					2								
	CO4	Compare cap of nuclear an	Compare capital and operating cost of nuclear and fossil based power									2		3		
	(3 – Hig	h. 2- Medium.	1-low)												1	]
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corro Level o	esponding of Matching				Ju	stifi	cat	ion							
CO1-PO1		2	In order to apply the mathematics, natural specialization to the so	desig scie olutio	gn ki nce, on of	nowl eng com	edge ineei iplex	to ting eng	the fun ginee	powo dam ering	er pl enta prol	ants, ls ar blem	the k nd an s is re	nowl engi quire	edge neerii d.	of ng
CO1-PO2		3	In order to apply the experiments and analy	desią vze d	gn ki ata is	nowl s higi	edge hly r	to equ	the j ired.	powe	er pla	ants,	abili	ty to o	condu	ict
CO2-PO1		3	In order to analyze the knowledge of mathem engineering specializa required.	In order to analyze the importance of different components inside the NPP, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is required.												
CO2-PO9		2	In order to analyze the as an individual, and a	imp is a t	ortar eam	nce o mem	f dif ber	fere or a	nt co lead	ompo ler in	onent dive	ts ins erse t	ide th teams	e NPI is rec	?, to a juired	ıct I.
CO2-PO10		2	In order to analyze t communicating on c community at large th	In order to analyze the importance of different components inside the NPP, communicating on complex engineering activities with engineers and the community at large through discussions, reports and presentations are required.												
CO3-PO5		2	In order to understand approach, resources, o required.	fuel comp	hanc outer	lling base	mec ed d	han esig	ism n ap	to ac proa	hiev ch a	e crit	ticalit nalyti	y, sys ical to	temat ools a	tic ire
CO4-PO9		2	In order to compare ca plant, communicating community at large th	apita on c roug	l and comp h dis	ope olex e cuss	ratin engir ions,	g co neer rep	ost o ing a orts	f nuc activ and	clear ities pres	and with entat	fossil engi ions a	based neers are rec	l pow and tl quired	rer he I.

	4 PO11 In order to compare capital and operating cost of nuclear and forenaid								
CO4-PO11	3	plant, knowledge of engineering management and financia required.	al principles are						
<b>TEACHING</b>	LEARNING STRATI	EGY							
Teaching and I	Learning Activities		Engagement						
			(hours)						
	Face-to-Face Learnin	ng	40						
	Practical / T	utorial / Studio	42						
	Student-Cen	tred Learning	-						
	Self-Directed Learni	ng							
	Non-face-to	face learning	84						
	Revision		21						
	Formal Assessment	A	2						
	Mid-Term	Assessment	2						
	Final Exami	nation	3						
	Total		153						
<b>TEACHING</b>	METHODOLOGY								
Lecture and Di	scussion. Co-operative	and Collaborative Method. Problem Based Method							
	, , , , , , , , , , , , , , , , , , ,								
COURSE SCI	HEDULE								
COURSE SCI Weeks		Topics	Remarks						
COURSE SCI Weeks Week-1	HEDULE Layout of nuclear po	<b>Topics</b> wer plants	Remarks     Class						
COURSE SCI Weeks Week-1 Week-2	HEDULE Layout of nuclear po Containment buildin mechanical stress in	<b>Topics</b> wer plants gs; primary containment vessels; structure of reactor core; a various structures	Remarks Class nd Test 1, Final						
COURSE SCI Weeks Week-1 Week-2 Week-3	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal	<b>Topics</b> wer plants gs; primary containment vessels; structure of reactor core; a various structures ysis of power plant systems	RemarksndClassTest 1,FinalExam						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-4	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal Components includin	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a         various structures         ysis of power plant systems         ng steam generator	Remarks Class Test 1, Final Exam Class						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-4 Week-5	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal Components includin Description and anal	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a         various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer	RemarksndClassTest 1,FinalExamClass						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal Components includin Description and anal Separator, pressurize	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a         various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer	RemarksndClassTest 1,FinalExamClassTest 2,FinalExam						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal Components includin Description and anal Separator, pressurize Pumps, turbine	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer	RemarksndClassTest 1, Final ExamClassClassFinal ExamClass Test 2, Final Exam						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal Components includin Description and anal Separator, pressurize Pumps, turbine Generator, cooling to	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a         various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer         ower; auxiliary cooling systems	RemarksndClassTest 1, Final ExamClass Test 2, Final ExamMid Term						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8 Week-9	HEDULE Layout of nuclear po Containment buildin mechanical stress in Description and anal Components includin Description and anal Separator, pressurize Pumps, turbine Generator, cooling to Fuel handling mecha	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer         ower; auxiliary cooling systems         nisms; control and mechanisms; radwaste systems	RemarksndClassTest 1, Final ExamClass Test 2, Final ExamMid Term, Final						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-8 Week-9 Week-10	HEDULE         Layout of nuclear por         Containment building         mechanical stress in         Description and anal         Components including         Description and anal         Separator, pressurized         Pumps, turbine         Generator, cooling to         Fuel handling mecha         Electrical systems; reference	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer         ower; auxiliary cooling systems         nisms; control and mechanisms; radwaste systems         eactor grid interface and load following	RemarksndClassTest 1, Final ExamClass Test 2, Final ExamMid Term, Final Exam						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-7 Week-8 Week-9 Week-10 Week-11	HEDULE         Layout of nuclear port         Containment building         mechanical stress in         Description and anal         Components including         Description and anal         Separator, pressurized         Pumps, turbine         Generator, cooling to         Fuel handling mecha         Electrical systems; reg         Basic considerations	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer         ower; auxiliary cooling systems         nisms; control and mechanisms; radwaste systems         eactor grid interface and load following         in nuclear plant design; components of nuclear power cost	RemarksndClassTest 1, FinalExamClassTest 2, FinalExamMidFinalExam						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-7 Week-8 Week-9 Week-10 Week-11 Week-12	HEDULE         Layout of nuclear port         Containment building         mechanical stress in         Description and anal         Components including         Description and anal         Separator, pressurized         Pumps, turbine         Generator, cooling to         Fuel handling mecha         Electrical systems; respectively         Basic considerations         Economic comparison	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer         ower; auxiliary cooling systems         nisms; control and mechanisms; radwaste systems         eactor grid interface and load following         in nuclear plant design; components of nuclear power cost         on of nuclear and fossil fueled plants	RemarksClassndClassTest 1,FinalExamClassTest 2,FinalExamMidTerm,FinalExam						
COURSE SCI Weeks Week-1 Week-2 Week-3 Week-3 Week-4 Week-5 Week-5 Week-6 Week-7 Week-6 Week-7 Week-7 Week-8 Week-9 Week-10 Week-11 Week-12 Week-13	HEDULE         Layout of nuclear port         Containment building         mechanical stress in         Description and anal         Components including         Description and anal         Separator, pressurized         Pumps, turbine         Generator, cooling to         Fuel handling mecha         Electrical systems; respectively         Basic considerations         Economic comparison         Dual and multipurpon	Topics         wer plants         gs; primary containment vessels; structure of reactor core; a various structures         ysis of power plant systems         ng steam generator         ysis of steam dryer         r, reheater, heat exchanger, condenser, demineralizer         ower; auxiliary cooling systems         nisms; control and mechanisms; radwaste systems         eactor grid interface and load following         in nuclear plant design; components of nuclear power cost         on of nuclear and fossil fueled plants         se nuclear plants	RemarksndClass Test 1, Final ExamClass Test 2, Final ExamMid Term, Final ExamMid Term, Final ExamClass Test 3, Final Exam						

	Components	Grading	СО	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C4, C3
~ /	Mid term	10%	CO3	C2
	Final Examination	60%	CO1-CO4	C2, C3, C4, C5
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. J. H.Rust, Nuclear Power Plant Engineering, USA, Haralson, 1979
- 2. El-Wakil, M.M., Nuclear Energy Conversion, USA, Intext Educational Publishers, 1982
- 3. Lish, K.C., Nuclear Power Plant Systems & Equipment, USA, Industrial Press Inc., 1972

#### **REFERENCE SITE**

# Level-4, Term-II

	COURSE INFORMATION										
Course Code	: NE 428	Lecture Contact Hours :1.50									
Course Title	: Nuclear Power Plant Engineering Sessional	Credit Hours	: 0.75								
	PRE-REQUISITE										
	NE 427										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE	NOPSIS/RATIONALE									
	This course is designed to impart knowledge on the operation of different nuclear power plants and develop skill on fuel handling mechanism and basic considerations in nuclear power plant design.										
	OBJECTIVE										
	<ol> <li>To know the role of Nuclear Power Pla</li> <li>To understand the features of different</li> <li>To understand the function of fuel hand</li> <li>To understand the Power plant operation</li> </ol>	nt operation. sections of the Nuclear Power F lling mechanism. on cost.	Plant.								
	LEARNING OUTCOMES										

	Upon co	ompletion of	the course, the s	tuden	its w	ill b	e ab	le to	)								
	<ol> <li>Dessim</li> <li>Approximation</li> </ol>	sign and solv ulating tools. ply the differe a.	e NPP relevant	t prot	olem s and	on I net	the utror	bas	is o para	f sp ame	ecif: ters	ied to v	requ alida	ireme ate wi	ent b ith m	y usi easur	ng red
	COUR	SE OUTCON	MES & GENE	RIC S	SKII	LLS											
No.	Co	ourse Learning	Outcome	Corr	espo POs	nding	g	Blo Taxe	oom [*] onor	's ny	CF	) (	CA	KP	Ass M	essmo ethod	ent Is
CO1	Design and solve NPP relevant problem on the basis of specified requirement by using simulating tools.PO4C6114R, Q, TApply the different thermal hydraulics </td																
CO2	Apply the different thermal hydraulics and neutronics parameters to validate with measured data.PO5C3115R, Pr, T																
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)																
	COUR	SE CONTEN	T														
	<ol> <li>Determine reactor power in case of unrefer control for position and rule arginment by using specific simulating software.</li> <li>Compare different reactor parameters on steady state condition and any transient state such as LOCA condition.</li> <li>Calculation of radiation dose inside the containment and outside the containment in case of any transient situation.</li> <li>Determination of control rod worth and Control rod differential worth inside the reactor.</li> </ol>																
	SKILL	MAPPING	(CO-PO MAP)	PING	)												
																	-
	No	Course I	earning Outcome	,			Р	ROC	GRA	MC	OUT	COM	1ES	(PO)			
					1	2	3	4	5	6	7	8	9	10	11	12	
	CO1	<b>Design</b> and problem on requirement tools.	solve NPP relations of spectral structure shows a solution of the second structure str	evant vified ating				3									
	CO2	Apply the hydraulics parameters measured dat h, 2- Medium,	different the and neutro to validate a. 1-low)	ermal onics with					3								
JUSTIFICAT	ION FO	R CO-PO M	APPING														
Mapping	Corre Level o	esponding of Matching					Ju	ıstif	icat	ion							
CO1-PO4		3	In order to be specified requir	able to ement	o des by u	sign sing	and simu	solv ulatii	e N ng to	PP r ools,	eleva to a	ant p nalyz	probl zing	em oi data is	n the s requ	basis ired.	of
CO2-PO5		3	In order to e parameters to	able t valida	o ap te w	ply ith	the meas	diffe surec	erent 1 da	the ta,	ermal syste	hyo hyo	draul ic aj	ics ai oproad	nd ne ch, re	eutron esourc	ics es,

		computer-based de	sign approach a	nd analytical tool	s in the o	development of a					
<b>TEACHING I</b>	LEAR	NING STRATEGY	ie iequited.								
Teaching and I	Learnii	ng Activities				Engagement					
C						(hours)					
	Face	-to-Face Learning									
		Lecture				7					
		Practical / Tutorial / Studio	14								
		Student-Centred Learning	-								
	Self-	Directed Learning									
		Non-face-to-face learning	42								
		Revision	21								
	Forn	nal Assessment									
		Continuous Assessment	2								
		Mid term Final Examination									
	Final Examination										
	Tota	Total									
TEACHING N	NG METHODOLOGY										
Lecture and Di	scussi	on, Co-operative and Collaborative	Method, Proble	em Based Metho	d						
COURSE SCH	HEDU	LE									
Weeks		Topics Remark									
Week-1	Desi	besign a reactor component and analyze its parameters on different condition									
Week-2	Dete	ermine reactor power in case of diff	erent control roo	d position and di	fferent fu	ıel					
	alıgr	ment by using specific simulating	software								
Week-3	Com	such as LOCA condition	on steady state of	condition and an	y transie	ent					
	Cale	sulation of radiation dose inside the	containment a	nd outside the co	ontainme	ent					
Week-4	in ca	se of any transient situation	contaminent a	nd outside the ex	Jintaininte						
W 1- 5	Dete	rmination of control rod worth an	d control rod d	ifferential worth	inside t	he					
week-5	react	tor									
Week-6	Lab	Test									
Week-7	Quiz	z test, Viva									
ASSESSMEN	T STF	RATEGY									
					В	looms					
		Components	xonomy								
Continuou	10	Lab participation and Report   20%   CO 1, CO2   CO									
Assessmer	nt	Lahtest-1 Lahtest-2	40%	CO 1 CO2	(	¹³ C6					
(40%)		Project/ Presentation	15%	CO 2		<u> </u>					
			250/								
		Lad Quiz	25%	001,002	C	C3, C6					

	Total Marks	100%		
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# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Knoll, G.F.: Radiation Detection and Measurements, 2010.
- 2. Price, W.J.: Nuclear Radiation Detection, 1964.
- 3. Introduction to Health Physics by H. Cember, 1969.
- 4. Physics and Engineering of Radiation Detection, 2nd Edition by Syed Ahmed, 2007

#### **REFERENCE SITE**

#### Level-3, Term-I

	COURSE INFORMATION											
Course Code	: GEPM 381	Lecture Contact Hours	: 2.00									
Course Title	: Project Management and Finance	Credit Hours	: 2.00									
	PRE-REQUISITE											
	None											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/RATIONALE											
	This course has been designed to understand the overlapping connection between engineering and management with financial matters in an organization through the study of varied management practices and finance as an engineer.											
	OBJECTIVES											
	<ol> <li>To introduce some aspects of business management and business organization.</li> <li>To identify the tools and techniques needed to lead any project to its intended conclusion.</li> <li>To introduce sales fundamentals include understanding the customer and the competition, sales strategy, sales management, product positioning, product life cycle, sales structures, margins, and prospecting for new customers.</li> </ol>											
	LEARNING OUTCOMES											
	Upon completion of the course, the students wil	l be able to										
	<ol> <li>Develop in depth idea on nuclear project Management Functions.</li> <li>Compare between selected Theories of Maria</li> <li>Design nuclear project and to perform the full</li> <li>Develop knowledge of effective material maria</li> </ol>	management and organization agement. unctions in the Marketing Mix. anagement; management and res	n to perform the source allocation;									
	COURSE OUTCOMES & GENERIC SKILI	LS										

No.	Co	ourse Learning Outcome	Corre	espond POs	ling	Bloo Taxo	om's nomy	СР		CA	KP	Ass M	essment ethods	t
CO1	Develop project i to perfor	in depth idea on nuclear management and organization m the Management Functions.	PO	1, PO1	1	C	23	1		-	1	Т	', Q, F	
CO2	Compar of Mana	e between selected Theories gement.		PO1		C	24	2		1	1	A	SG, F	
CO3	Design the funct	nuclear project and to perform tions in the Marketing Mix.	PO	2, PO	3	C	25	2		-	1	Ν	MT, F	
CO4	<b>Develop</b> material and reso economy issues in	<ul> <li>knowledge of effective management, management</li> <li>burce allocation; Engineering</li> <li>y and assessment on ethical</li> <li>business situations.</li> </ul>	I	PO11		C	26	3		1	2		T, F	
	(CP- Co Quiz; As	mplex Problems, CA-Complex SG – Assignment; Pr – Presenta	Activit tion; R	ties, K - Rep	P-Kno ort; F	owledg – Fina	ge Prof 1 Exan	ile, T 1 <u>, MT</u>	– T - Mi	est ; id Te	PR – erm Ex	Proje (am)	ect ; Q -	-
	COUR	SE CONTENT												
	Manage appraisa (PPC) f layout p cost ce standard plannin strategy investm Marketi Manage	ement : Importance, need hier al, participative management functions, quantitative method planning, safety and loss ma ntres and allocation of over d costing, cost planning and g process; annual development r, financing, performance a ment; Management Accounting ing Management: Concepts ement; Management of innov	archy, ; Oper ds app nagem rhead contr nt plan analysi g : Cos s, stra ation a	motivation lied in lied in ent. ( costs ol, bu ; Nati is of st plar itegy, and ch	vation Mana n proc Cost n ; Mar idget onal b enter ining sales	, lead geme luctio nanag nagen and t budge rprise and c s, pros	ership ent : Pr n, qua gement aent a budget t, Fina , inve ontrol pmotic anolog	, wag roduc llity r t elen ccour ary c ncial estme , bud pn, p y life	e in tior nan nent ntin get a ater cyc	agent agent ts of g : nage appr and l and l at la	ives, ives, nning nent, cost margi Devel ement aisal, budge aws. Case s	perfo and locat of prinal lopm : obj crit etary Tech studie	control ion and roducts costing ent and ectives eria of control mology es.	, 1 1 , 1 , 1 , 1 , 7
	SKILL	MAPPING (CO-PO MAP	PING)											
							DAM			ALL C	$(\mathbf{DO})$			
	No.	Course Learning Outcome	e	1	2 3	4	5 6	7	8	9	10	11	12	
	CO1	<b>Develop</b> in depth idea on nu project management organization to perform Management Functions.	and the	3								2		
	CO2	<b>Compare</b> between sel Theories of Management.	lected	3										
	CO3	<b>Design</b> nuclear project an perform the functions in Marketing Mix.	d to the		3 2									
	CO4	<b>Develop</b> knowledge of efference material management, management, management, management and resource allocated terms assessment on ethical issues business situations. h, 2- Medium, 1-low)	ective ement ation; and es in									3		

JUSTIFICAT	ION FOR CO-PO M	APPING	
Mapping	Corresponding Level of Matching	Justification	
CO1-PO1	3	The knowledge of mathematics, science, and engineering fundar to develop in depth idea on nuclear industrial management ar perform the Management Functions.	nentals is required d organization to
CO1-PO11	2	In order to develop in depth idea on nuclear project management to perform the Management Functions, it is required to demon and understanding of engineering management principles and en- making and apply these to one's own work, as a member and le manage projects and in multidisciplinary environments.	t and organization Instrate knowledge conomic decision- cader in a team, to
CO2-PO1	3	The knowledge of mathematics, science, Engineering fundament compare between selected Theories of Management.	itals is required to
CO3-PO2	3	In order to design nuclear project and to perform the functions Mix, identification, formulation, research literature and ana engineering problems are required to reach substantiated conc principles of mathematics, sciences and engineering fundament	in the Marketing lysis of complex clusion using first als.
CO3-PO3	2	In order to design nuclear project and to perform the functions Mix, it is required to design solutions for complex engineer design systems, components or processes that meet spec appropriate consideration for public health and safety, cultu environmental considerations.	in the Marketing ing problems and ified needs with ral, societal, and
CO4-PO11	3	In order to develop knowledge of effective material managem learn Management and resource allocation; Engineering econom on ethical issues in Business situations, it is required to demon and understanding of engineering management principles and en- making and apply these to one's own work, as a member and le manage projects and in multidisciplinary environments.	ent; Students will iy and assessment istrate knowledge conomic decision- eader in a team, to
<b>TEACHING I</b>	LEARNING STRATE	EGY	
Teaching and I	Learning Activities		Engagement (hours)
	Face-to-Face Learnin Lecture Practical / Tr Student-Cen Self-Directed Learnin	ng utorial / Studio tred Learning ng	28
	Non-face-to- Revision	-face learning	56 14
	Formal Assessment Continuous Mid-Term Final Exami	Assessment	2 1 3
TEACHING	METHODOLOGY		104
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method	
COURSE SCI	HEDULE		
Weeks		Topics	Remarks
Week-1	Management Function	ons and Organization: Evolution	

Week-2 Week-3	Management functions: organization, theory and structure, span of control, authority delegation, manpower planning Management functions: organization, theory and structure, span of control, authority delegation, manpower planning	Class Test 1, Final
Week-4	Personnel Management: Importance, need hierarchy, motivation	Exam
Week-5	leadership, wage incentives, performance appraisal, participative management	
Week-6	Operation Management : Production planning and control (PPC) functions, quantitative methods applied in production	
Week-7	Quality management, location and layout planning, safety and loss management	Mid Term
Week-8	Cost management elements of cost of products, cost centres and allocation of overhead costs	Final Exam
Week-9	Management accounting : marginal costing, standard costing, cost planning and control, budget and budgetary control	
Week-10	Development and planning process; annual development plan; National budget	
Week-11	Financial management : objectives, strategy, financing, performance analysis of enterprise, investment appraisal, criteria of investment	Class Test
Week-12	Management Accounting: Cost planning and control, budget and budgetary control	2, Final
Week-13	Marketing Management: Concepts, strategy, sales promotion, patent laws	Exam
Week-14	Technology Management; Management of innovation and changes, technology life cycle	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C6
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2	C3, C4
	Mid term	10%	CO3	C5
	Final Examination	60%	CO1-CO4	C3, C4,C5, C6
	Total Marks	100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. P. Kotler, K. L. Keller, Marketing Management, 15th ed., Pearson, 2016
- 2. D. H. Besterfield, G. Besterfield, *Total Quality Management*, 3rd ed,. Prentice Hall, 2002
- **3.** J. Liker, *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, 1st ed., McGraw-Hill Education, 2004

#### **REFERENCE SITE**

# 1.2 Elective Courses

	COURSE INFORMATION							
Course Code	: NE 405		Lecture Cont	act Hours	:	3.00		
Course Title	: Nuclear Chemical Engineering and C	Corrosion	Credit Hours		:	3.00		
	PRE-REQUISITE	1						
	NE 251 and NE 409							
	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	The course is designed to learn and familiarize with different radiochemical process in nuclear fuel cycle and effect of corrosions in nuclear power applications.							
	OBJECTIVES							
	<ol> <li>OBJECTIVES</li> <li>To introduce the important role of radiochemical processes in different stages of nuclear fuel cycle (from front end to back end) and corrosion effects in nuclear power applications.</li> <li>To explain different radiochemical processes for reprocessing and producing radioisotopes by solvent extraction method, ion exchange method, The Purex process, Conversion of radioactive wastes.</li> <li>To familiarize about the Corrosion kinetics and different types of Aqueous and Non-aqueous corrosion in nuclear power applications.</li> <li>To discuss about the various effects of corrosion, corrosion monitoring and control in nuclear power applications.</li> </ol>							
	LEARNING OUTCOMES							
	Upon completion of the course, the st	udents will be a	able to					
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Understand the important role of radiochemical processes in different stages of nuclear fuel cycle (from front end to back end) and corrosion effects in nuclear power applications.</li> <li>Explain principles of solvent extraction method, ion exchange method, Radiochemical processes for reprocessing irradiated fuel, The Purex process, Conversion of radioactive wastes.</li> <li>Analyze the Corrosion kinetics and different types of Aqueous and Non-aqueous corrosion in nuclear power applications</li> <li>Evaluate the effects of corrosion, corrosion monitoring and control in nuclear power</li> </ol>							
	<b>COURSE OUTCOMES &amp; GENER</b>	IC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP CA	KP	Assessment Methods		
CO1	<b>Understand</b> the important role of radiochemical processes in different stages of nuclear fuel cycle (from front end to back end) and corrosion effects in nuclear power applications.	PO1	C2		1	T, F		
CO2	<b>Explain</b> principles of solvent extraction method, ion exchange method, Radiochemical processes for	PO2	C5		3	ASG, Q, F		

	reprocess, process, wastes.	sing irradiated fuel, The Purex Conversion of radioactive											
CO3	Analyze different aqueous applicati	e the Corrosion kinetics and types of Aqueous and Non- corrosion in nuclear power tons	PO	2		C	24		-	-	2	r	MT, F
CO4	Evaluat corrosio nuclear	e the effects of corrosion, n monitoring and control in power applications.	PO	2		C	25		-	-	3		T, F
	(CP- Co Quiz; As	mplex Problems, CA-Complex Ad SG – Assignment; Pr – Presentatio	ctivities n; R - R	KP- eport	Knov ;; F –	wledg Fina	ge Pr 1 Exa	ofile am, N	e, T – MT- 1	- Test Mid To	; PR – erm Ex	Proje (am)	ect ; Q –
	COUR	SE CONTENT											
	Basic c and nev analysis uraniun reproce nuclear reactior Radiatie corrosic in nucle Diffusio radiatio defect i of trans	hemical concepts regarding chewly developed for nuclear fuel s of nuclear spent fuels, , Pri a, Properties of Irradiated Fuel a ssing irradiated fuel, The Purex water technology and isotope ns, on damage induced core materi on in nuclear systems and design ear power applications, Corrosidon and reaction of fission produ n hardening or embrittlement a nuteraction with energetic neutro uranic elements, scaling.	emical cycle, inciples and Oth c proce separat ial prop a, Corro on mor acts, str and swo on, the c	therr Fue of er Ro ss, fi ion r erty sion itori uctur elling hem	nody I-Cy solve eacto ssion neth char kine ng a ral st g are ical	ynam cle 1 ent 1 or M n prc ods, nge, tics, nd c abili stud anal	nics a mate extra ateri oduct cher wate Aqu ontro tity of died ysis	and rial actio als, . s, an mica er or or or eous bl in f mee and usin	kine anal n ex Radi nd ad l eff liqu s and nuc etal c ana g rad	tics, te ysis, o ctensive ocher ctinide ects in id me l Non- lear p or non lyzed diotrac	echno charac vely f nical p e, fund nduce aquec ower metall in ter cers, th	logy terist or proceed dame d by le co ous co appli ic m ms o he ch	applied tics and urifying sses for ntals of nuclear rrosion, prrosion cations. aterials, f lattice emistry
	No.	Course Learning Outcome	1	2	P.	ROG	RAN	<u>1 OL</u> 6   '	$\frac{\text{JTCC}}{7}$	$\frac{\text{OMES}}{8}$	(PO) 10	11	12
	CO1	<b>Understand</b> the important role radiochemical processes in different stages of nuclear fuel cycle (free front end to back end) and corrosis effects in nuclear power applications.	of ent om ion ver 3			<u> </u>		~		~ /			
	CO2	<b>Explain</b> principles of solve extraction method, Radiochemi processes for reprocessi irradiated fuel, The Purex proce Conversion of radioactive wastes	ent cal ing ess, s.	3									
	CO3	Analyze the Corrosion kinetics a different types of Aqueous a Non-aqueous corrosion in nucle power applications.	und und ear	3									
	CO4	Evaluate the effects of corrosic corrosion monitoring and control nuclear power applications.	on, l in	3									
JUSTIFICAT	$\frac{(3 - H)}{[ON FO]}$	R CO-PO MAPPING											

Mapping	Corresponding Level of Matching	Justification							
CO1-PO1	3	In order to understand the important role of radiochemical process stages of nuclear fuel cycle (from front end to back end) and con- nuclear power applications, the knowledge of mathematics, engineering fundamentals and an engineering specialization to complex engineering problems is to applied.	esses in different rosion effects in natural science, the solution of						
CO2-PO2	3	3 In order to explain principles of solvent extraction method, Radiochemical processes for reprocessing irradiated fuel, The Purex process, Conversion of radioactive wastes, , identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.							
CO3-PO2	3	In order to analyze the Corrosion kinetics and different types of Aqueous and Non- aqueous corrosion in nuclear power applications, , identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.							
CO4-PO2	2	In order to evaluate the effects of corrosion, corrosion monitorir nuclear power applications, , identification, formulation, resear- analysis of complex engineering problems reaching substantia using first principles of mathematics, natural sciences and engi- are required.	g and control in ch literature and ated conclusions neering sciences						
TEACHING I	LEARNING STRATI	EGY							
Teaching and I	Learning Activities		Engagement (hours)						
	Face-to-Face Learnin Lecture Practical / Tr Student-Cen	ng utorial / Studio tred Learning	42						
	Self-Directed Learni Non-face-to- Revision	ng -face learning	84 21						
	Formal Assessment	Assessment	2						
	Mid-Term	nation	1						
	Total	nation	153						
<b>TEACHING</b> N	METHODOLOGY								
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method							
COURSE SCI	HEDULE								
Weeks		Topics	Remarks						
Week-1	Basic chemical conce	epts regarding chemical thermodynamics and kinetics,	Class Test						
Week-2	Technology applied material analysis,	and newly developed for nuclear fuel cycle, Fuel-Cycl	e I, Final Exam						

Week-3	Characteristics and analysis of nuclear spent fuels, Isotope separation methods,	
Week-4	Principles of solvent extraction extensively for purifying uranium,	
Week-5	Properties of Irradiated Fuel and Other Reactor Materials, Radiochemical processes for reprocessing irradiated fuel,	Class Test
Week-6	The Purex process, fission products, and actinide,	Exam
Week-7	Fundamentals of nuclear water technology, chemical effects induced by nuclear reactions,	
Week-8	Radiation damage induced core material property change, radiation hardening or embrittlement and swelling are studied and analyzed in terms of lattice defect interaction with energetic neutron,	Mid
Week-9	Faraday's laws of electrolysis and its application in determining the corrosion rate in metal and alloys, Corrosion Kinetics	Final
Week-10	Aqueous corrosion in nuclear power applications: fundamental science, materials and mechanisms	Exam
Week-11	Irradiation assisted corrosion and stress corrosion cracking (IAC/IASCC) in nuclear reactor systems and components	
Week-12	Electrochemical techniques for monitoring and controlling corrosion in water- cooled nuclear reactor systems,	Class Test
Week-13	the chemical analysis using radiotracers, Diffusion and reaction of fission products, structural stability of metal or nonmetallic materials,	3, Final
Week-14	Lifetime prediction techniques for nuclear power plant systems, Ageing management, Integrity assessment methods and lifetime calculations of reactor pressure vessel, piping and other load-bearing components, the chemistry of transuranic elements, scaling.	LXAIII

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO4	C2, C5
Assessmen t (40%)	Class Participation and Class attendance	5+5=10%	CO2	C5
	Mid term	10%	CO3	C4
Final Examination		60%	CO1-CO4	C2, C4, C5
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

**REFERENCE BOOKS** 

- 1. Dr. Damien Feron, *Nuclear Corrosion Science and Engineering*, 1st Edition, Woodhead Publishing, February 21, 2012
- 2. Zaki Ahmad, *Principles of Corrosion Engineering and Corrosion Control*, 1st Edition, Butterworth-Heinemann, October 2, 2006
- 3. Manson Benedict, *Thomas H. Pig ford, Hans Wolfgang*, Nuclear Chemical Engineering, 2nd Edition, Mcgraw-Hill Book Company, April 1, 1981
- 4. Pierre R. Roberge, Handbook of Corrosion Engineering, 3rd Edition, McGraw-Hill Education, July 8, 2019

#### **REFERENCE SITE**

	COURSE INFORMATION									
Course Code	: NE 407	Ι	Lecture Contact	Hours	: 3.	00				
Course Title	: Non-Destructive Testing and Evalu	ation C	Credit Hours		: 3.	00				
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	The course is designed to learn and familiarize with the basic principles and limitations of different Non-Destructive Tastings (NDT) and their applications in a variety of fields.									
	OBJECTIVES									
	<ol> <li>To understand the basic principle</li> <li>To enable the students to acquire nuclear power plants and a variet</li> <li>To introduce the limitations of d specifications related to non-dest</li> </ol>	es of various le knowledge of ty of other fie ifferent NDT tructive testin	Nondestructive t of the application lds. methods, techni g technology.	esting methons of Nondes ques and coo	ds. tructi les, st	ve testing in				
	LEARNING OUTCOMES									
	Upon completion of the course, the s	tudents will b	be able to							
	1. Understand the basic principles of various Nondestructive testing methods.									
	2. Explain the techniques, standards and specifications related to non-destructive testing technology.									
	3. Analyze the applications of Non other fields	-destructive to	esting in nuclear	r power plant	ts and	l a variety of				
	4. Evaluate the associated limitation	ns of differen	t NDT methods,	techniques a	nd co	odes.				
	<b>COURSE OUTCOMES &amp; GENER</b>	RIC SKILLS								
No.	Course Learning Outcome	Correspondin POs	ng Bloom's Taxonomy	CP CA	KP	Assessment Methods				

CO1	Underst various methods	t <b>and</b> the basic Nondestruc	e principles of ative testing	F	PO1		C2	-		-	2	1	r, Q, F	7
CO2	Explain specifica destructi	the techniques ations related ive testing techn	, standards and d to non- nology.	F	PO2	(	С3	-		-	3	A	ASG, H	7
CO3	Analyze destructi plants ar	the applicat ive testing in and a variety of c	ions of Non- nuclear power other fields.	F	PO3	(	C4	-		-	2	1	MT, F	
CO4	Evaluat different and code	e the associated t NDT metho es.	I	PO2	(	C5	1		-	3		T, F		
	(CP- Co Quiz; As	mplex Problem SG – Assignme	ns, CA-Complex ont; Pr – Presenta	Activititition; R	ies, KP-F - Report;	Knowled F – Fin	lge Prof al Exan	ïle, T 1 <u>, MT</u>	– Te - Mic	est ; <u>l Te</u>	PR – erm Ez	- Proj kam)	ect ; (	2 -
	COUR	SE CONTEN	T											
	Penetra specific techniq particle codes, s	nt Testing: p cations related ues, application testing; Basic standards and s	principles, tec. to liquid penet ons, limitations cs Of Ultrason specifications r	hniques rant tes s, code ic Test related t	s, appli- sting; Ba es, stand ing: prir to ultrase tions	cations, sics Of ards ar ciples, onic tes	, limit Magne id spec techni ting; B	ations etic Pa etic ficat ques, asics	s, co articl ions app Of F	b b le T re lica Radi	s, st estin lated tions iogra	andai g: pri to n , lim phic '	rds a ncipl nagne itation Testir	ind es, tic ns, ng:
	radiogra Nuclear	aphy; NDT ev r power plants MAPPING (	valuation, anal	ysis an PING)	id report	, Appl	ication	s of 1	None	dest	tructi	ve te	sting	to in
	radiogra Nuclear	aphy; NDT ev r power plants	(CO-PO MAP)	ysis an	nd report	, Appl		s of 2	None	dest		ve te	sting	to in
	radiogra Nuclear SKILL No.	aphy; NDT ev r power plants MAPPING ( Course L	earning Outcon	ysis an PING) ne		PROC		s of 2	COM	dest IES 9	( <b>PO</b> )	ve te	sting	to in
	radiogra Nuclear SKILL No. CO1	aphy; NDT ever plants MAPPING ( Course La Understand to various No methods.	s, applications, valuation, anal CO-PO MAP earning Outcon the basic princip ndestructive to	PING) ne esting	1 2 3	PROC 3 4	<b>GRAM</b> (	OUTO	COM 8	iest IES 9	( <b>PO</b> )	11 11	12	to in
	radiogra Nuclear SKILL No. CO1 CO2	Ample control of the second se	co-po MAP earning Outcon the basic princip ndestructive to techniques, stan tions related to sting technology	PING) ne esting dards non-	1 2 3 3	PROC 3 4	GRAM (	OUTO	COM 8	iES 9	( <b>PO</b> )	11 11	12	to in
	radiogra Nuclear SKILL No. CO1 CO2 CO3	Analyze the destructive test aphy; NDT events aphy; NDT events aphy; NDT events and specifical and specifical destructive test plants and a vents and specifical and specifical and specif	<b>CO-PO MAP</b> <b>earning Outcom</b> the basic princip ndestructive to techniques, stan tions related to <u>sting technology</u> applications of sting in nuclear p rariety of other fi	PING) ne les of esting dards non Non- power leds.	1 2 3 3 3	PROG 3 4	<b>RAM</b>	OUTO	COM 8	iES 9	(PO) 10	11 11	12	to in
	radiogra Nuclear SKILL No. CO1 CO2 CO3 CO4	Amaly: which is a set of the set	<b>CO-PO MAP</b> <b>earning Outcon</b> the basic princip ndestructive to techniques, stan tions related to sting technology applications of sting in nuclear p ariety of other fi associated limits t NDT met d codes.	PING) ne les of esting dards non- Non- power elds. ations thods,	1     2       3     3       3     3       3     3	PROC 3 4	GRAM (	OUT(	COM 8	IES 9	( <b>PO</b> ) 10	11 11	12	
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JUSTIFICAT	radiogra Nuclear SKILL No. CO1 CO2 CO3 CO4 (3 – Hig FION FC Correct Level of	MAPPING ( Course La MAPPING ( Understand to various No methods. Explain the and specifica destructive tes Analyze the destructive tes plants and a v Evaluate the of differen techniques an h, 2- Medium, DR CO-PO M esponding of Matching	<b>CO-PO MAP</b> <b>earning Outcon</b> the basic princip ndestructive to techniques, stan tions related to sting technology applications of sting in nuclear p rariety of other fi associated limita t NDT met d codes. 1-low) <b>IAPPING</b>	PING) ne les of esting dards non Non- power elds. ations thods,	1     2       3     3       3     3	PROC 3 4 Justif	<b>FRAM</b> 5       6       5       6       6       6       7       6       7       6       7       7       6       7       7       6       7       7       7       8       8       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10		COM 8	IES 9	( <b>PO</b> ) 10	11 11		

CO2-PO2	3 In order to explain the techniques, standards and specifications related to non- destructive testing technology, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.										
CO3-PO2	3	In order to analyze the applications of Non-destructive testing plants and a variety of other fields, it is required to design solu engineering problems and design systems, components or pro- specified needs with appropriate consideration for public h cultural, societal, and environmental considerations.	in nuclear power tions for complex ocesses that meet ealth and safety,								
CO4-PO2	3	In order to evaluate the associated limitations of different techniques and codes, it is required to create, select and a techniques, resources, and modern engineering and IT tools, ind and modelling, to complex engineering problems, with an und limitations.	t NDT methods, apply appropriate cluding prediction lerstanding of the								
TEACHING	LEARNING STRAT	TEGY									
Teaching and	Learning Activities		Engagement (hours)								
Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning											
Self-Directed Learning Non-face-to-face learning Revision											
	Formal Assessment Continuous Mid-Term Final Exami	Assessment nation	2 1 3								
TEACHING	METHODOLOGY		153								
Lecture and I	Discussion, Co-operativ	ve and Collaborative Method, Problem Based Method									
COURSE SO	CHEDULE										
Weeks		Topics	Remarks								
Week-1	NDT general knowle	edge									
Week-2	Manufacturing Proc	esses; types discontinuities associated with manufacturing	ng Class Test 1, Final								
Week-3	Basics of Visual Testing - principles, techniques, applications, limitations, codes, standards and specifications related to visual testing										
Week-4	Basics of Liquid limitations, codes, st	Penetrant Testing: principles, techniques, application andards and specifications related to liquid penetrant testing	ns,								
Week-5	Basics of Magnetic I	Particle Testing: principles, techniques, applications	2, Final								
Week-6	Basics of Magnet specifications related	ic Particle Testing: limitations, codes, standards at l to magnetic particle testing	nd Exam								

Week-7	Basics of Ultrasonic Testing: principles, techniques, applications.	
Week-8	Basics of Ultrasonic Testing: limitations codes, standards and specifications related to ultrasonic testing	Mid
Week-9	Basics of Radiographic Testing: principles, techniques,	Term, Final
Week-10	Basics of Radiographic Testing: applications, limitations,	Exam
Week-11	Basics of Radiographic Testing: codes, standards and specifications related to radiography	
Week-12	NDT evaluation, analysis and report	Class Test
Week-13	Applications of Non-destructive testing in Nuclear power plants.	Exam
Week-14	Applications of Non-destructive testing in Nuclear power plants.	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous Assessmen t (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2,C3, C5
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C2, C3
	Mid term	10%	CO3	C4
Final Examination		60%	CO1-CO4	C2-C5
	Total Marks	100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. Paul E. Mix, *Introduction to Nondestructive Testing*: A Training Guide, 2nd Edition, Wiley-Interscienc, 2005
- 2. Chuck Hellier, Rao, *Handbook of Nondestructive Evaluation*, 2nd Edition, Pearson Prentice Hall, June 3, 2005

### **REFERENCE SITE**

	COURSE INFORMATION		
Course Code Course Title	: NE 413 : Medical Applications of Nuclear Technology and Radiation Imaging	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

NE 301         CURRICULUM STRUCTURE         Outcome Based Education (OBE)         SYNOPSIS/RATIONALE         The course is designed to learn and familiarize with the applications of nuclear technology radiation imaging in different medical aspects.         OBJECTIVES         1. To be familiar with principles of radiographic imaging and nuclear medicines.         2. To apply this knowledge to the production of radiotracers, radiograph and the assessmer image quality         3. To understand the construction, operation of imaging and processing equipment, radio protection and quality control         4. To enable the students to acquire knowledge about the construction and operation of ger radiographic and fluoroscopic equipment, radiotherapy processes.         LEARNING OUTCOMES         1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.         2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical maging modalities (CT, SPECT and PET).         3. Analyze the evolution of ultrasonic and radiation imaging technologies in cli applications.         4. Evaluate different nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).         COURSE OUTCOMES & GENERIC SKILLS         No.       Course Learning Outcome POS       Taxonomy CP		PRE-REQUISITE												
CURRICULUM STRUCTURE           Outcome Based Education (OBE)           SYNOPSIS/RATIONALE           The course is designed to learn and familiarize with the applications of nuclear technology radiation imaging in different medical aspects.           OBJECTIVES           1. To be familiar with principles of radiographic imaging and nuclear medicines.           2. To apply this knowledge to the production of radiotracers, radiograph and the assessment image quality           3. To understand the construction, operation of imaging and processing equipment, radia protection and quality control           4. To enable the students to acquire knowledge about the construction and operation of ger radiographic and fluoroscopic equipment, radiotherapy processes.           LEARNING OUTCOMES           1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.           2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical imaging modalities (CT, SPECT and PET).           3. Analyze the evolution of ultrasonic and radiation imaging technologies in clin applications.           4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and interrapy).           COURSE OUTCOMES & GENERIC SKILLS           No.         Course Learning Outcome         Corresponding Bloom's Taxonomy CP CA KP Assession of radiotracers within h		NE 301												
Outcome Based Education (OBE)           SYNOPSIS/RATIONALE           The course is designed to learn and familiarize with the applications of nuclear technology radiation imaging in different medical aspects.           OBJECTIVES           1. To be familiar with principles of radiographic imaging and nuclear medicines.           2. To apply this knowledge to the production of radiotracers, radiograph and the assessment image quality           3. To understand the construction, operation of imaging and processing equipment, radio protection and quality control           4. To enable the students to acquire knowledge about the construction and operation of ger radiographic and fluoroscopic equipment, radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.           2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical imaging modalities (CT, SPECT and PET).           3. Analyze the evolution of ultrasonic and radiation imaging technologies in clin applications.           4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).           COURSE OUTCOMES & GENERIC SKILLS           No.         Course Learning Outcome           POs         Ca           Polfne and apply the basic properties of radiotracers within humaping methods.           CO1         Befine and apply the poly consection of the production applications.           4. Evaluate different Nuclea		CURRICULUM STRUCTURE												
SYNOPSIS/RATIONALE           The course is designed to learn and familiarize with the applications of nuclear technology radiation imaging in different medical aspects.           OBJECTIVES           1. To be familiar with principles of radiographic imaging and nuclear medicines.           2. To apply this knowledge to the production of radiotracers, radiograph and the assessment image quality           3. To understand the construction, operation of imaging and processing equipment, radio protection and quality control           4. To enable the students to acquire knowledge about the construction and operation of ger radiographic and fluoroscopic equipment, radiotherapy processes.           LEARNING OUTCOMES           1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.           2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical imaging modalities (CT, SPECT and PET).           3. Analyze the evolution of ultrasonic and radiation imaging technologies in clir applications.           4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).           COURSE OUTCOMES & GENERIC SKILLS           No.         Course Learning Outcome           Orresponding         Bloom's T , T, I axonomy           applications of different radiation imaging methods.           Explain the processes related to production and distribut		Outcome Based Education (OBE)												
The course is designed to learn and familiarize with the applications of nuclear technology radiation imaging in different medical aspects.         OBJECTIVES         1. To be familiar with principles of radiographic imaging and nuclear medicines.         2. To apply this knowledge to the production of radiotracers, radiograph and the assessmet image quality         3. To understand the construction, operation of imaging and processing equipment, radiographic and fluoroscopic equipment, radiodrapy processes.         LEARNING OUTCOMES         1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.         2. Explain the processes related to production and adititis UCT, SPECT and PET).         3. Analyze the evolution of ultrasonic and radiation imaging technologies in clin applications.         4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).         COURSE OUTCOMES & GENERIC SKILLS         No.       Course Learning Outcome         Porse point       Point         Point       Cl, C3       -         No.       Courses related to production of ultrasonic and radiation imaging methods.         COI       Explain the processes related to production and distribution of radiotracers used for nuclear medicine understand clinical PO1       Cl, C3       -       -       T, 1 applications of different radiation imagin		SYNOPSIS/RATIONALE												
OBJECTIVES           1. To be familiar with principles of radiographic imaging and nuclear medicines.           2. To apply this knowledge to the production of radiotracers, radiograph and the assessmening quality           3. To understand the construction, operation of imaging and processing equipment, radii protection and quality control           4. To enable the students to acquire knowledge about the construction and operation of ger radiographic and fluoroscopic equipment, radiotherapy processes.           LEARNING OUTCOMES           1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.           2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical imaging modalities (CT, SPECT and PET).           3. Analyze the evolution of ultrasonic and radiation imaging technologies in cli applications.           4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).           COURSE OUTCOMES & GENERIC SKILLS           No.         Course Learning Outcome         Corresponding Pos         Bloom's Taxonomy CP CA KP Assess Method internal radio therapy.           CO1         medicine and distribution of ultrasonic and radiation imaging methods.         -         -         T, 1           applications of different radiation imaging methods.         -         -         T, 1         Assessi		The course is designed to learn and familiarize with the applications of nuclear technology and radiation imaging in different medical aspects.												
1. To be familiar with principles of radiographic imaging and nuclear medicines.         2. To apply this knowledge to the production of radiotracers, radiograph and the assessmet image quality         3. To understand the construction, operation of imaging and processing equipment, radia protection and quality control         4. To enable the students to acquire knowledge about the construction and operation of ger radiographic and fluoroscopic equipment, radiotherapy processes.         LEARNING OUTCOMES         1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.         2. Explain the processes related to production and distribution of radiotracers within hu body and different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).         COURSE OUTCOMES & GENERIC SKILLS         No.       Course Learning Outcome       Corresponding       Bloom's Taxonomy       CP       CA       KP       Assessation applications of different radiation imaging methods.         CO1       medicine and apply the basic properties of radiotracers used for nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).         COURSE OUTCOMES & GENERIC SKILLS         No.       Course Learning Outcome       POs       Taxonomy       CP       CA       KP       Assessation applications of different radiation imaging methods.		OBJECTIVES												
LEARNING OUTCOMES         1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.         2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical imaging modalities (CT, SPECT and PET).         3. Analyze the evolution of ultrasonic and radiation imaging technologies in clin applications.         4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).         COURSE OUTCOMES & GENERIC SKILLS         No.       Course Learning Outcome       Corresponding POs       Bloom's Taxonomy       CP       CA       KP       Assess Methonications of different radiation imaging methods.         CO1       applications of different radiation imaging methods.       PO1       C1, C3       -       -       T, 1         applications of different radiation imaging methods.       PO2       C5       -       -       Q, ASS         CO2       radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET).       PO2       C4       -       1       MT, different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).		<ol> <li>To be familiar with principles of radiographic imaging and nuclear medicines.</li> <li>To apply this knowledge to the production of radiotracers, radiograph and the assessment of image quality</li> <li>To understand the construction, operation of imaging and processing equipment, radiation protection and quality control</li> <li>To enable the students to acquire knowledge about the construction and operation of general radiographic and fluoroscopic equipment, radiotherapy processes.</li> </ol>												
1. Define and apply the basic properties of radiotracers used for nuclear medicine Understand clinical applications of different radiation imaging methods.         2. Explain the processes related to production and distribution of radiotracers within hu body and different types of medical imaging modalities (CT, SPECT and PET).         3. Analyze the evolution of ultrasonic and radiation imaging technologies in clin applications.         4. Evaluate different Nuclear medicine technologies associated with Radiation the processes (both external and internal radio therapy).         COURSE OUTCOMES & GENERIC SKILLS         No.       Course Learning Outcome       Corresponding POs Taxonomy CP CA KP Assess Methods         0.       Course Learning Outcome       Corresponding POs Taxonomy CP CA KP Assess Methods         0.       Course Learning Outcome       Corresponding POs Taxonomy CP CA KP Assess Methods         0.       Course Learning Outcome       Corresponding POs Taxonomy CP CA KP Assess Methods         0.       Course Learning Outcome       Corresponding POs Taxonomy CP CA KP Assess Methods         0.       Course Learning Outcome       Corresponding POs Taxonomy CP CA KP Assess Methods         0.       Explain the processes related to production and distribution of radiotracers within human body and PO2 C5 Q, ASG different types of medical imaging methods.         CO3       Analyze the evolution of ultrasonic and radiation imaging technologies in PO2 C4 1 MT, clinical applications.         CO4		LEARNING OUTCOMES												
COURSE OUTCOMES & GENERIC SKILLSNo.Course Learning OutcomeCorresponding POsBloom's TaxonomyCPCAKPAssess Assess MetheC01Define and apply the basic properties of radiotracers used for nuclear medicine and Understand clinical applications of different radiation imaging methods.PO1C1, C3T, IC02Explain the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET).PO2C5Q, AS0C03Analyze the evolution of ultrasonic and radiation imaging technologies in clinical applications.PO2C4-1MT,C04Evaluate different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).PO6C53T, I		<ol> <li>Define and apply the basic properties of radiotracers used for nuclear medicine and Understand clinical applications of different radiation imaging methods.</li> <li>Explain the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET).</li> <li>Analyze the evolution of ultrasonic and radiation imaging technologies in clinical applications.</li> <li>Evaluate different Nuclear medicine technologies associated with Radiation therapy</li> </ol>												
No.Course Learning OutcomeCorresponding POsBloom's TaxonomyCPCAKPAssess: MetherC01Define and apply the basic properties of radiotracers used for nuclear medicine and Understand clinical applications of different radiation imaging methods.PO1C1, C3T, IC02Explain the processes related to production and distribution of 		COURSE OUTCOMES & GENEI	RIC SKILLS	FJ/										
Define and apply the basic properties of radiotracers used for nuclear medicine and Understand clinical applications of different radiation imaging methods.PO1C1, C3T, ICO2Explain the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET).PO2C5T, ICO3Analyze the evolution of ultrasonic and radiation imaging technologies in clinical applications.PO2C4-1MT,CO4Evaluate different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).PO6C53T, I	No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
Explain production and distribution different types of medicalies (CT, SPECT and PET).PO2C5Q, AS0CO3Analyze and radiation imaging technologies in 	CO1	<b>Define</b> and <b>apply</b> the basic properties of radiotracers used for nuclear medicine and <b>Understand</b> clinical applications of different radiation imaging methods.	PO1	C1, C3	-	-	-	T, F						
CO3Analyze the evolution of ultrasonic and radiation imaging technologies in clinical applications.PO2C41MT,CO4Evaluate different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).PO6C53T, H	CO2	<b>Explain</b> the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET).	PO2	C5	-	-	-	Q, ASG, F						
Evaluate different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).       PO6       C5       -       -       3       T, I	CO3	<b>Analyze</b> the evolution of ultrasonic and radiation imaging technologies in clinical applications.	PO2	C4	-	-	1	MT, F						
	CO4	<b>Evaluate</b> different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).	PO6	3	T, F									
(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)		(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)												

		Nuclear medicine technology: introduction, Radiopharmaceuticals, radiopharmaceutical dosimetry, Properties of radiotracers for nuclear medicine, production of radioisotopes, radioisotope generators, The technetium generator, The distribution of technetium-based radiotracers within the body, Radiation therapy: External beam therapy, Brachytherapy Medical imaging modalities, Medical imaging before x-rays, X-radiography, Radioisotopes gamma camera, Computed tomography (CT), Single photon emission computed tomography (SPECT), Data processing in SPECT/CT, Clinical applications of SPECT and SPECT/CT, Positron emission tomography (PET), Clinical applications of planar scintigraphy, Radiotracers used for PET/CT. Ultrasound, Sonar and other early applications of acoustics, basic principles of ultrasound imaging, Evolution of ultrasound technology and clinical applications, Magnetic resonance imaging, Early use of nuclear magnetic resonance (NMR) spectroscopy, Principles of NMR and MRI, Evolution of magnetic resonance imaging (MRI) technology and clinical applications, development and applications of functional MRI.															
		SKILL	MAPPING	(CO-PO MAPPING	)												
							P	RUC	TR A	M		COV	/FS	$(\mathbf{PO})$			
		No.	Course I	Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12	
			<b>Define</b> and	<b>apply</b> the basic	-	-	5		5	0	ŕ	Ŭ	_	10			
			properties of	radiotracers used for													
		CO1	nuclear medi	cine and Understand	2												
			clinical appl	lications of different													
			radiation ima	ging methods.													
			Explain the	processes related to													
			production	and distribution of													
		CO2	radiotracers v	vithin human body and		3											
			different type	es of medical imaging													
			modalities (C	T, SPECT and PET).													
			Analyze the	evolution of ultrasonic													
		CO3	and radiation	imaging technologies		3											
			in clinical ap	plications.													
			Evaluate	different Nuclear													
			medicine tee	chnologies associated													
		CO4	with Radiati	on therapy processes						3							
			(both extern	al and internal radio													
			therapy).														
		(3 - Hig)	h, 2- Medium,	1-low)	_	_		_					_				
	JUSTIFICAT	ION FO	K CO-PO M	APPING													
	Mapping	Corre	esponding				Ju	ıstif	icat	tion							
	11 0	Level o	of Matching	<b>x</b> 1 5 <b>-</b>	1 -	-					6	11			1 0		
				In order to understar	nd th	ne ba	asıc	prop	berti	es o	ot ra	dıotı	acer	s use	d for	nucle	ear
	CO1 DO1		2	medicine and clinical	app	licat	ions	010	liffe	erent	rad	atioi	1 im	aging	meth	ods, 1	the
	COI-POI		2	knowledge of mather	natic	s, na	atura		enc	e, e	ngin	eerin	g fu	ndam	entals	and	an
ļ				engineering specializa	lt10n	to t	ne s	oiuti	on	of c	omp	iex e	engin	eering	g pro	siems	18
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				principies or maniema		muu	- ++ + 131			~~~~ (	~11511				July	quil	-u

СОЗ-РО2	3	3 In order to analyze the evolution of ultrasonic and radiation imaging technologies in clinical applications, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.										
CO4-PO6	4-PO6 3 In order to evaluate different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy), application of reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems is required.											
TEACHING I	LEARNING STRATI	EGY										
Teaching and I	Learning Activities		Engagem (hours	nent								
	Face-to-Face Learnin Lecture Practical / T Student-Cen	ng utorial / Studio tred Learning	42									
	Sudent-Centred Learning       Self-Directed Learning       Non-face-to-face learning       Revision											
	Formal Assessment Continuous Assessment Mid-Term Final Examination											
	Total		153	153								
TEACHING N	METHODOLOGY											
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method										
COURSE SCI	HEDULE											
Weeks		Topics	Rema	arks								
Week-1	Nuclear medicine tec for nuclear medicine	chnology: introduction, Radiotracer, Properties of radiotrac , radiotracer half-life, Radiopharmaceuticals	ers Class	Tost								
Week-2	Radiopharmaceutica generator, The distril	l dosimetry, Radionuclide generators, The techneti bution of technetium-based radiotracers within the body	um 1, Fin	nal								
Week-3	Radiation therapy: E	xternal beam therapy ( I)										
Week-4	Radiation therapy: E	xternal beam therapy (II)										
Week-5	Week-5 Radiation therapy: External beam therapy (III)											
Week-6	Week-6 Radiation therapy: Brachytherapy (I)											
Week-7	Week-7 Radiation therapy: Brachytherapy (II)											
Week-8	Radiation therapy: B	rachytherapy (III)										

Week-9	Medical imaging modalities, Medical imaging before x-rays, X-radiography, Radioisotopes gamma camera	Mid Term
Week-10	Computed tomography (CT), Single photon emission computed tomography (SPECT), Data processing in SPECT/CT, Clinical applications of SPECT and SPECT/CT	, Final Exam
Week-11	Positron emission tomography (PET), Clinical applications of planar scintigraphy, Radiotracers used for PET/CT	
Week-12	Ultrasound, Sonar and other early applications of acoustics, basic principles of ultrasound imaging, Evolution of ultrasound technology and clinical applications	Class Test
Week-13	Magnetic resonance imaging, Early use of nuclear magnetic resonance (NMR) spectroscopy, Principles of NMR and MRI	5, Final Exam
Week-14	Evolution of magnetic resonance imaging (MRI) technology and clinical applications, development and applications of functional MRI.	

	Components	Grading	CO	<b>Blooms Taxonomy</b>
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C3, C5
	Class Participation and Class attendance	5+5=10%	CO1, CO2	C1, C3,C5
	Mid term	10%	CO3	C4
Final Examination		60%	CO1-CO4	C1, C3, C4, C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. W. R. Hendee, E. R. Ritenour, Medical Imaging Physics, 4th ed., John Wiley and Sons, 2002
- 2. E. B. Podgorsak, Ervin B. Radiation Physics for Medical Physicists, 3rd ed., Springer International Publishing, 2016
- 3. F. M.Khan, J. P. Gibbons, *Physics of Radiation Therapy*, 5th ed., Lippincott Williams & Wilkins, 2014
- 4. S. Webb, *The Physics of Medical Imaging*, CRC Press, 1988
- 5. D. Volterrani, P. A. Erba, I. Carriò, H. W. Strauss, G. Mariani, *Nuclear Medicine Textbook*, *Methodology and Clinical Applications*, Springer International Publishing, 2019

#### **REFERENCE SITE**

	COURSE INFORMATION		
Course Code Course Title	: NE 431 : Power System Engineering and Grid Interface with Nuclear Power Plants	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

	PRE-REQUISITE											
	EECE 119, EECE 221											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)			_	_	_						
	SYNOPSIS/RATIONALE											
	The course is designed to learn and far reaction and its technological constraints	amiliarize the diff ains and applicat	ferent fundarr ions.	nental j	proces	ses rel	ated to fusion					
	OBJECTIVES											
	<ol> <li>To know about the electrical power system and load characteristics.</li> <li>To understand the load curve.</li> <li>To understand power system protection.</li> <li>To understand power grid.</li> </ol>											
	LEARNING OUTCOMES											
	Upon completion of the course, the s	students will be a	able to									
	<ol> <li>Understand the role of Electrical Power System and Power system protection units.</li> <li>Explain the load curves, protective schemes and Grid Systems.</li> <li>Analyze the working principle of power system protection and grid stability.</li> <li>Evaluate the grid performance synchronization, and stability after interfacing with Nuclear power plant</li> </ol>											
	COURSE OUTCOMES & GENE	RIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
CO1	<b>Understand</b> the role of Electrical Power System and Power system protection units.	PO 1	C2	-	-	3	T, F, Q					
CO2	<b>Explain</b> the load curves, protective schemes and Grid Systems.	PO 2	C5	-	-	2	MT, F					
CO3	<b>Analyze</b> the working principle of power system protection and grid stability.	PO 2	C4	1	1	4	ASG, F					
CO4	<b>Evaluate</b> the grid performance synchronization, and stability after interfacing with Nuclear power plant.	PO 10	C5	1	1	5	T, F, Pr					
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-K tion; R - Report; F	nowledge Prof 7 – Final Exam	file, T , MT-	– Test Mid Te	; PR - erm Ex	- Project ; Q – am)					
	COURSE CONTENT											
	IntroductionBasics of nuclear power generation from NPPs, power requirements (stability, quality, and reliability), power transmission and distribution systems, emergency power supply system and power requirements in NPP and Communication Equipment used in grid systemsPower factor ImprovementPower factor, Power triangle, Power factor improvement, Power factor improvement equipment, Calculation of power factor corrections Network representation Single line and reactance diagram of power system, Per unit system of calculation. Causes of station blackout and their remedies Load curvesDemand factor, diversity factor, load duration curves, energy load curve, load											
	factor, capacity factor and plant factor	or.										

	Grid sy	stem and int	erfacing with NPP		T	ypic	al 1	ayo	ut	of a	a su	ıbsta	ution,	swit	tch g	gear,
	Transm	ission cables	and busbars, Sag, 7	Tran	smis	ssior	n to	wer	, Co	oron	ia ef	ffect	and	Ove	r-vol	tage
	phenom	enon and insu	ulation coordination.	Circ	uit b	reak	ers o	& R	elay	ys, C	)ver	volt	tage a	ind L	ighter	ning
	Protecti	on, Instrumer	nt transformers: CT ar	nd P	T, re	quir	reme	ents	for	grid	inte	erfac	ing v	vith N	<b>V</b> PP	
	Stabilit	y Swin	ng equation, power	angl	le e	quat	ion,	eq	ual	are	a cr	riteri	ion, i	multi	-macl	hine
	system,	step by step	solution of swing	equa	ation	i. Fa	actor	rs a	ffec	ting	; sta	bilit	y: Re	eactiv	ve po	wer
	compen	sation. Flex1b	ble AC transmission s	yste	<u>m (F</u>	AC	<u>TS),</u>	syr	nme	etric	al ar	<u>ıd u</u>	nsym	metri	cal ta	ult.
	SKILL MAPPING (CO-PO MAPPING)															
		1		,								- ~				1
	No.	Course L	Learning Outcome	1	2	P 3	$\frac{ROC}{4}$	JRA 5	M (	)UT 7	CON 8	/IES 9	(PO) 10	11	12	
		Understand	the role of Electrical													
	CO1	Power System	m and Power system	3												
		protection un	its.		ļ'	<b> </b>							<u> </u>	<u> </u>	i	
	CO2	Explain the i	Crid Systems		3											
		Analyze the	ze the working principle of							<u> </u>	<u> </u>					
	CO3	power system	n protection and grid		3											
		stability.	-													
		Evaluate th	e grid performance	grid performance												
	CO4	synchronizati	on, and stability after										3			
		nteriacing	with Nuclear power						İ İ							
	(3 - Hig)	h. 2- Medium,	1-low)	<u> </u>						L			L	L		1
JUSTIFICAT	<b>FION FC</b>	OR CO-PO N	IAPPING													
Manning	Corre	esponding				J	neti	fica	tior	,						
mapping	Level o	of Matching					uou	<u>.</u>		L 						
			In order to understand the role of Electrical Power System and Power system													
CO1-PO1		3	protection units the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex													
			engineering problems is to applied.													
			In order to explain the load curves, protective schemes and Grid Systems													
CO2-PO2		3	identification, formulation, research literature and analysis of complex engineering													
002102		5	problems reaching substantiated conclusions using first principles of mathematics,													
			In order to analyze f	he w	erin zorki	<u>g sci</u> ng r	rinci	inle	of 1	Juire	r sv	stem	nrot	ectior	and	orid
			stability it is required	to c	lesig	n so	lutio	ns f	or c	omp	lex e	engin	ieerin	g prol	blems	and
CO3-PO2		3	design systems, compo	onen	ts or	proc	esses	s tha	ıt me	et sp	pecifi	ied n	eeds v	with a	pprop	riate
			consideration for pub	olic h	iealth	1 and	d saf	ety,	cul	tural	, soc	cieta	l, and	envi	ronme	ental
			considerations.	ha a	rid a	tobil	ity n	orfo		200	it in	roqu	uirad (	lo aor		ianta
			effectively on comple	x en	ginee	ring	acti	vitie	s wi	ith th	n is ie en	gine	ering	comn	nunity	and
CO4-PO10		3	with society at large, s	such	as be	eing	able	to c	comp	orehe	end a	and v	vrite e	effecti	ve rep	orts
			and design documenta	tion,	, mak	ce eff	fectiv	ve p	resei	ntati	ons,	and g	give a	nd rec	ceive of	clear
			instructions													
TEACHING	LEARN	ING STRAT	EGY													
Teaching and	Learning	, Activities											]	Enga	geme	nt
	<b>F</b> (	<b>.</b>											_	(hc	ours)	
	Face-to-	-Face Learnin	ıg											42		
		Practical / Tu	utorial / Studio											2	+∠	
		Student-Cen	tred Learning											-		

Self-Directed Learning				
Non-face-to-face learning	84			
Revision	21			
Formal Assessment				
Continuous Assessment	2			
Mid-Term	1			
Final Examination	3			
Total	153			

# **TEACHING METHODOLOGY**

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

# COURSE SCHEDULE

Weeks	Topics	Remarks	
Week-1	Basics of nuclear power generation from NPPs, power requirements (stability, quality, and reliability)	Class Test	
Week-2	Power transmission and distribution systems, emergency power supply system and power requirements in NPP and Communication Equipment used in grid systems		
Week-3	Power factor, Power triangle, Power factor improvement, Power factor improvement equipment	Power factor	
Week-4	Calculation of power factor corrections		
Week-5	Single line and reactance diagram of power system, Per unit system of calculation.Causes of station blackout and their remedies		
Week-6	Week-6 Demand factor, diversity factor, load duration curves, energy load curve		
Week-7	load factor, capacity factor and plant factor.		
Week-8	Typical layout of a substation, switch gear, Transmission cables and busbars, Sag, Transmission tower,		
Week-9	-9 Corona effect and Over-voltage phenomenon and insulation coordination		
Week-10	Veek-10 Circuit breakers & Relays,		
Week-11	Over voltage and Lightening Protection, Instrument transformers: CT and PT		
Week-12	Swing equation, power angle equation, equal area criterion, multi-machine system, step by step solution of swing equation.		
Week-13	13Factors affecting stability: Reactive power compensation. Flexible AC transmission system (FACTS), requirements for grid interfacing with NPP5, Final Exam		
Week-14	Symmetrical and unsymmetrical fault, Review		

### ASSESSMENT STRATEGY

Components	Grading	СО	Blooms Taxonomy	
Class Test	20%	CO 1, CO3, CO4	C2, C4, C5	
Continuous Assessment	Class Participation	5%+5% (attnd)	CO 1, CO3	C2, C4
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(40%)	Mid term	10%	CO 2	C5
Final	Final Exam		CO 1-4	C2, C4, C5
Total	Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

1. Sunil S. Rao, Switchgear and Protection, 13th Edition, India, Khanna Publishers, 2008

Chunikhin M. Zhavoronkov, *High Voltage switch gear Analysis and Design*, Moscow, Mir publishers, 1989
 S. Chand & V.k.mehta and Rohit Mehta, *Principle of Power Systems: Principles of Power Systems*, 2nd
 Edition, India, 2020

4. William D Stevenson, Elements of Power System Analysis, 4th Edition, Mc Graw Hill Asia, 1982

**REFERENCE SITE** 

	COURSE INFORMATION									
Course Code	: NE 433	Lecture Contact Hours	: 3.00							
Course Title	: Fundamentals of Fusion Engineering	Credit Hours	: 3.00							
	PRE-REQUISITE									
	NE 105									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	The course is designed to learn and familiarize the different fundamental processes related to fusion reaction and its technological constrains and applications.									
	OBJECTIVES									
	<ol> <li>To familiarize the students about the role fusion reaction and thermonuclear condition</li> <li>To explain the different physical processes reaction rate, Lawson criteria fusion power magnetic fusion reactor.</li> <li>To introduce the students about different STELLATOR concept, Blanket concept of</li> <li>To discuss about different technological con the critical fusion reactor design parameters</li> </ol>	of fusion energy, Fusion reactions of fusion reaction. Is related to fusion reaction: fur density and radiation loses the Fusion confinement concept fusion reactor. straints related to fusion engine	etions, difficulty of sion cross section, e power balance in , TOKAMAK and eering and calculate							
	LEARNING OUTCOMES									

	Upon completion of the course, the students will be able to								
	<ol> <li>Understand the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction.</li> <li>Explain the fusion cross section, reaction rate, fusion power generation, Lawson criteria fusion power density and radiation loses, the power balance in magnetic fusion reactor.</li> <li>Analyze the Fusion confinement, TOKAMAK and STELLATOR concept, Blanket concept of fusion reactor.</li> <li>Evaluate plasma wall interactions, radiation damage to material and calculate the critical fusion</li> </ol>								
	COURSE OUTCOMES & GENE	RIC SKILLS							
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Understand</b> the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction.	PO1	C2	-	-	2	T, Q, F		
CO2	<b>Explain</b> the fusion cross section, reaction rate, fusion power generation, Lawson criteria fusion power density and radiation loses, the power balance in magnetic fusion reactor.	PO2	C5	-	-	3	MT, F		
CO3	Analyze the Fusion confinement, TOKAMAK and STELLATOR concept, Blanket concept of fusion reactor.	PO2	C4	-	-	5	ASG, F		
CO4	<b>Evaluate</b> plasma wall interactions, radiation damage to material and calculate the critical fusion reactor design parameters.	PO3	C5	-	-	5	T, F		
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-K tion; R - Report; F	nowledge Prof 7 – Final Exam	ile, T , MT-	– Test Mid Te	; PR - erm Ex	- Project ; Q – am)		
	COURSE CONTENT								
	Introduction Of Fusion Energy, Fusion Reactions, Difficulty Of Fusion Reaction And Thermonuclear Conditions Of Fusion Reaction, Fusion Cross Section, Reaction Rate, Sigma V Parameter Calculation, Fusion Power Generation Process, Fusion Power Density And Radiation Losses, Plasma Ignition And Heating Processes, Lawson Criteria, The Power Balance In Magnetic Fusion Reactor, Fusion Confinement, Inertial And Magnetic Confinement, TOKAMAK and STELLATOR Concept, Blanket Concept Of Fusion Reactor, Design Of Simple Magnetic Fusion Reactors, ITER and Applications Of Fusion Technology.								
	SKILL MAPPING (CO-PO MAP	PING)							

	DBOCDAM OUTCOMES (DO)															
	No.	Course L	earning Outcome	1	2	P 3	<u>4</u>	$\frac{JKA}{5}$	6	7		<u>9</u>	(PO)	11	12	
		Understand	the role of fusion	1	-	5	т		0	,	0		10		14	
		energy, Fusio	on reactions, difficulty													
	CO1	of fusion	reaction and	3												
		thermonuclea	r conditions of fusion													
		reaction.														
		Explain the	fusion cross section,													
		reaction ra	ite, fusion power													
	CO2	generation, L	Lawson criteria fusion		3											
		the nower	halance in magnetic													
		fusion reactor	r.													
		Analyze the	Fusion confinement,													
	CO3	TOKAMAK	and STELLATOR				3	2								
	0.05	concept, Blan	nket concept of fusion				5									
		reactor.														
		Evaluate pla	sma wall interactions,													
	CO4	radiation dar	critical fusion reactor		2	3										
		design param	eters.													
	(3 - Hig)	h, 2- Medium,	1-low)										1	1		
JUSTIFICAT	<b>FION FO</b>	OR CO-PO M	IAPPING													
Mapping	Corr	esponding				J	usti	fica	tior	1						
	Level	of Matching	In order to understan	d th	e rol	e of	fusi	on é	ner	ov 1	Fusic	n re	action	ns di	ficult	v of
CO1-PO1		2	fusion reaction and thermonuclear conditions of fusion reaction, the knowledge of													
		3	mathematics, natural science, engineering fundamentals and an engineering													
			specialization to the solution of complex engineering problems is applied.													
			In order to explain the fusion cross section, reaction rate, fusion power generation,													
		2	Lawson criteria fusion power density and radiation loses, the power balance in													
C02-P02		3	magnetic fusion reactor, identification, formulation, research literature and analysis													
			principles of mathematics, natural sciences and engineering sciences are required													
			In order to analyze	the	Fusi	on c	confi	nem	ient,	TO	KAN	MAK	C and	STE	LLA	ΓOR
			concept, Blanket concept of fusion reactor, it is required to conduct investigations													
CO3-PO2		3	of complex problem	s us	ing	resea	urch-	base	ed k	now	ledg	e ar	nd res	search	metl	nods
			including design of experiments, analysis and interpretation of data, and synthesis													
			In order to evaluate	nlaer	na u	$\frac{\text{cond}}{2911}$	nter	ons.	me	radi	ation	dan	nage	to ma	terial	and
			calculate the critical	fusi	on re	eacto	or de	sigr	n pa	rame	eters.	it i	s real	uired	to de	sign
CO4-PO3		2	solutions for complex	eng	ginee	ring	prot	olem	is ar	nd de	esign	sys	tems,	comp	onent	S 01
	processes that meet specified needs with appropriate consideration for public						olic he	alth								
			and safety, cultural, so	ociet	al, ar	nd en	viro	nme	ntal	cons	sider	atior	is.	_	_	
TEACHING	LEARN	ING STRAT	EGY													
Teaching and	Learning	g Activities											1	Engag	geme	nt
	East.	Esse L	~										_	(hc	urs)	
	Face-to	-Face Learnin	Ig												10	
		Droctice1 / T-	storial / Studia											2	F∠	
		Student Con	trad Learning												-	
	Salf Di	rected L cornig	neu Leannig										+		-	
	Self-Directed Learning							1								

Non-face-to-face learning	84
Revision	21
Formal Assessment	
Continuous Assessment	2
Mid-Term	1
Final Examination	3
Total	153

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Weeks	Topics	Remarks
Week-1	The Role Of Fusion Energy, Fusion Reactions, Difficulty Of Fusion Reaction, Fusion In Sun And Stars	Class Test
Week-2	Fusion Fuel Cycles, Energy Partition In Fusion Reaction, Thermonuclear Conditions	1, Final
Week-3	Concept Of Cross Section, Mean Free Path, And Collision Frequency, Calculation Of Fusion Cross Sections, Sigma-V Parameter	Lxam
Week-4	Distribution Functions, Reaction Rate, Fusion Power Density, Radiation Losses	
Week-5	Lawson and ignition criteria, Basic concept about plasma formation, Start-up and burning plasma analysis, Plasma Heating (ohmic heating, neural beam injection heating)	Mid Term,
Week-6	Power balance in a fusion reactor: 0-D conservation of energy relation, General Power Balance In Magnetic Fusion, Steady State Power Balance	FIIIai Exaiii
Week-7	Power balance in a fusion reactor: power balance in the plasma, Power balance in a reactor, Time dependent power balance in a fusion reactor	
Week-8	Fusion confinement: Necessity of confinement, Material confinement, Gravitational confinement, Electrostatic confinement	Class Test
Week-9	Inertial confinement: Energy balance, Compression energy, Laser and particle beam drivers	2, Final
Week-10	Magnetic confinement: energy and particle flow in magnetic field, Linear Mirror fusion concept, Tandem Mirror	Exam
Week-11	Magnetic confinement: TOKAMAK concept (I), Magnetic confinement: TOKAMAK concept (II), STELLATOR concept	
Week-12	Fusion blanket: Blanket concept, first wall loading, plasma wall interactions, Wall Impurity effects, blanket neutronics and energetic, Tritium Inventor, methods of recovery, tritium breeding induced radioactivity, radiation damage to material	Class Test
Week-13	Design of a simple magnetic fusion reactor: Generic fusion reactor, Critical reactor design parameter, Design goals, and basic engineering and nuclear physics constraints	Exam
Week-14	Design of a simple magnetic fusion reactor: design of the reactor, Fission-fusion hybrids reactor, Prospect of ITER	
ASSESSMEN	NT STRATEGY	

Comp	oonents	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
t (40%)	Class Participation	5%+5% (attnd)	CO1, CO3	C2,C4
	Mid term	10%	CO2	C5
Final Examination		60%	CO1, CO2, CO3,CO4	C2, C4, C5
Total	Marks	100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

- 1. Kenro Miyamoto, Plasma Physics and Controlled Nuclear Fusion, 2005th Edition, Springer 2005
- 2. A A Harms, D R Kingdon, K F Schoepf, Principles of Fusion Energy: An Introduction to Fusion Energy for Students, WSPC, 16 Jun. 2000

### **REFERENCE SITE**

	COURSE INFORMATION								
Course Code Course Title	: NE 459 : Computational Fluid Dynamics (CFD)	Lecture Contact Hours Credit Hours	: 3.00 : 3.00						
	PRE-REQUISITE	ISITE							
	MATH 101, MATH 103 and NE 351								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	The course is designed to learn and familiarize the different fundamental processes related to fusion reaction and its technological constrains and applications.								
	OBJECTIVES								
	<ol> <li>To familiarize students with the basic steps and terminology associated with CFD.</li> <li>To develop students' understanding of the conservation laws applied to fluid motion and he transfer and basic computational methods including explicit, implicit methods, discretization schemes and stability analysis.</li> <li>To develop practical expertise in solving CFD problems with a commercial CFD coor ANSYS CFX.</li> <li>To develop an awareness of limitations of CFD and its application in nuclear systems.</li> </ol>								

	LEARNING OUTCOMES							
	Upon completion of the course, the s	students will be a	able to					
	<ol> <li>Understand basic steps and terminology associated with Computational Fluid Dynamics (CFD).</li> <li>Explain the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretisation schemes and stability analysis.</li> <li>Analyze variety of computational techniques that can be used for solving engineering problems.</li> <li>Evaluate complex problems related to nuclear system using CFD with the specific focus on developing practical skills in using a commercial CFD package, ANSYS CFX.</li> </ol>							
	COURSE OUTCOMES & GENE	RIC SKILLS	1		T	T		
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods	
CO1	<b>Understand</b> basic steps and terminology associated with Computational Fluid Dynamics (CFD).	PO1	C2	-	-	3	T, Q, F	
CO2	<b>Explain</b> the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretisation schemes and stability analysis.	PO2	C5	-	-	4	ASG, F	
CO3	<b>Analyze</b> variety of computational techniques that can be used for solving engineering problems.	PO3	C4	-	-	5	T, MT, F	
CO4	<b>Evaluate</b> complex problems related to nuclear system using CFD with the specific focus on developing practical skills in using a commercial CFD package, ANSYS CFX.	PO5	C5	3	-	6	T, F	
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta COURSE CONTENT	Activities, KP-Kı tion; R - Report; I	nowledge Prof F – Final Exam	ïle, T - 1, MT-	– Test Mid Te	; PR – erm Ex	Project ; Q – am)	
	Introduction to CFD and some exa Defining a CFD problem, Creating momentum conservation and Navier similarity and energy conservation Turbulence: basics and introduction, – discretisation, Solution Procedur verification, applications in nuclear s	amples of CFD, and/or Importin -Stokes equation, Initial and t Turbulence: app es, Post process systems.	Introduction of Geometry ns, Kinemation ooundary con- lications of m sing – analy	n to A in De c prop ndition nodels sis of	NSYS sign M erties ns: pra , Comj result	CFX fodele of flut actical putatic s, Va	and Fluent er, Mass and ids, dynamic guidelines, onal methods lidation and	

										1						
	No.	Course L	earning Outcome	1	2	P	ROC	iRA	АМ (		CON °	1ES	(PO)	11	12	
		Understand	hasic steps and	1	2	3	4	3	0	/	0	9	10	11	12	
	001	terminology	associated with													
	COI	Computationa	al Fluid Dynamics	3												
		(CFD).														
		Explain the	conservation laws													
		applied to fl	uid motion and heat													
	CO2	methods inclu	iding explicit implicit		3											
		methods, di	scretisation schemes													
		and stability a	analysis.													
		Analyze vari	ety of computational			_										
	CO3 techniques that can be used for				3											
		Fyeluate con	eering problems.													
		to nuclear sv	stem using CFD with													
	COA	the specific	focus on developing					2								
	C04	practical sl	cills in using a					3								
		commercial C	CFD package, ANSYS													
	(3 – Hig	СГА. h 2- Medium	1-low)													
JUSTIFICAT	<b>FION FC</b>	DR CO-PO M	IAPPING													
Monning	Corr	esponding				T,		ino	tion							
wiapping	Level o	of Matching				JL	isui	ica	uon							
CO1-PO1			In order to understand basic steps and terminology associated with Computational Fluid Dynamics (CFD) the knowledge of mathematics natural science													
	3		riud Dynamics (CFD), the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of													
			complex engineering problems is applied.													
			In order to explain the conservation laws applied to fluid motion and heat transfer													
			and basic computational methods including explicit, implicit methods,													
CO2-PO2		3	discretisation schemes	s and	. stat	nley	anai	ysi: nee	5, 100 ring	ntifi	catio	on, Io s rea	ormul	ation,	resea tantia	rcn ted
			conclusions using first principles of mathematics, natural sciences and engineering													
			sciences are required.	<u>^</u>												
			In order to analyze var	iety	of co	mpu	tatio	nal	tech	niqu	es th	at ca	n be u	sed fo	r solv	ing
CO3-PO3		3	problems and design s	, 11 19	s req	uirec	1 to (	iesi	gn s		ons : ses t	for c hat r	omple	ex eng	gineer	ing eds
003103		5	with appropriate consi	idera	tion.	for p	onel	c he	ealth	and	safe	ty, c	ultura	l, soci	etal, a	and
			environmental conside	eratio	ons.	1										
		2	In order to evaluate co	ompl	ex p	roble	ems i	ela	ted t	o nu	clear	syst	tem us	sing C	FD w	vith
CO4-PO4		3	the specific focus on package ANSVS CEX	dev Zit	elop	ing	prac	tica	I SKI	ulato	n us r sof	ing twa	a con	nmerc	ial C	FD
			package, monoris er z	<b>x</b> , n	15 100	14110	<u>u 10</u>	use	51111	unato	1 301	tvu				
TEACHING	LEARN	ING STRAT	EGY													
Teaching and	Learning	Activities											F	Ingag	emer	nt
Teaching and	Leanne	, 11001 (10105											-	(ho	urs)	
	Face-to	-Face Learnin	g										1		/	
		Lecture											1	4	2	
		Practical / Tu	itorial / Studio										1	-		
	0.10 5	Student-Cent	tred Learning										-	-		
l	Self-Directed Learning															

Non-face-to-face learning	84
Revision	21
Formal Assessment	
Continuous Assessment	2
Mid-Term	1
Final Examination	3
Total	153

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

## COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to CFD and some examples of CFD	
Week-2	Introduction to ANSYS CFX and Fluent Defining a CFD problem, Creating and/or Importing Geometry in Design Modeller	Class Test 1, Final Exam
Week-3	Mass and momentum conservation and Naiver-Stokes equations	Laum
Week-4	Kinematic properties of fluids, dynamic similarity and energy conservation	
Week-5	Initial and boundary conditions: practical guidelines	Class Test
Week-6	Turbulence: basics and introduction	Exam
Week-7	Turbulence: applications of models	
Week-8	Computational methods – discretisation (I) (FVM/FEM/FDM)	Mid Torm
Week-9	Computational methods – discretisation (II) (FVM/FEM/FDM)	Final
Week-10	Computational methods – discretisation (III) (FVM/FEM/FDM)	Exam
Week-11	Solution Procedures	
Week-12	Post processing – analysis of results,	Class Test
Week-13	Validation and verification	S, Final Exam
Week-14	Applications in nuclear systems.	
ASSESSME		

# ASSESSMENT STRATEGY

Components	Grading	СО	Blooms Taxonomy
Class Test/ Assignment (1- 3)	20%	CO1, CO3, CO4	C2, C4, C5

Continuous Assessmen	Class Participation and Class attendance	5+5=10%	CO1, CO3	C2, C4
t (40%)	Mid term	10%	CO2	C5
F	Final Examination	60%	CO1, CO2, CO3, CO4	C2, C4, C5
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. J.Y. Tu, G.H. Yeoh, and C. Liu, *Computational Fluid Dynamics: A Practical Approach*, 3rd Edition, 2018
- 2. H.K. Versteeg and W. Malalasekera, An introduction to Computational Fluid Dynamics. The Finite Volume Method, 2nd ed., Pearson, 2007
- 3. J.D. Anderson, Computational Fluid Dynamics, McGraw-Hill Education, 1995
- 4. P.J. Roache, Fundamentals of Computational Fluid Dynamics, Hermosa Pub, 1998
- 5. S. V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing Corporation, 1980

#### **REFERENCE SITE**

	COURSE INFORMATION										
Course Code Course Title	: NE 479 : Radioactive Waste Treatment and Disposal Techniques	1Lecture Contact Hours: 3.00Credit Hours: 3.00									
	PRE-REQUISITE										
	NE 409										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	The course is designed to learn and familiarize with the different processes related to radioactive waste treatment and disposal techniques.										
	OBJECTIVES										
	<ol> <li>To demonstrate advanced knowledge of the general classification of nuclear waste and the basic principles of radioactive waste management.</li> <li>To introduce students with various options of nuclear waste disposals and associated physical phenomenon.</li> <li>To develop the analyzing ability of issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository</li> <li>To develop the ability to evaluate long-term safety disposal facility for radioactive waste and Environmental risk</li> </ol>										
	LEARNING OUTCOMES										

	Upon completion of the course, the s	students will be a	able to							
	<ol> <li>Understand the general classification of nuclear waste and the basic principles of radioactive waste management.</li> <li>Explain various options of nuclear waste disposals and associated physical phenomenon.</li> <li>Analyze the issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository</li> <li>Evaluate long-term safety disposal facility for radioactive waste and Environmental risk</li> </ol>									
	4. Evaluate long-term safety disposal facility for fadioactive waste and Environmental fisk assessment									
	COURSE OUTCOMES & GENE	RIC SKILLS	I	1	1	1				
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods			
CO1	<b>Understand</b> the general classification of nuclear waste and the basic principles of radioactive waste management.	PO1	C2	-	-	3	T, Q, F			
CO2	<b>Explain</b> various options of nuclear waste disposals and associated physical phenomenon.	PO2	C5	-	-	4	ASG, F			
CO3	<b>Analyze</b> the issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository	PO3	C4	-	-	5	T, MT, F			
CO4	<b>Evaluate</b> long-term safety disposal facility for radioactive waste and Environmental risk assessment	PO4	C5	3	-	6	T, F			
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-K tion; R - Report; F	nowledge Prof 7 – Final Exam	file, T , MT-	– Test Mid Te	; PR - erm Ex	- Project ; Q – am)			
	COURSE CONTENT									
	Introduction to nuclear power, the reprocessing. The international conte of radioactive wastes, Waste treatm TRU wastes, Storage of the various to Disposal of Nuclear Waste the opti geological disposal, Multiple Barrier subsurface-EBS R&D areas and issu Geological Disposal Concepts: Hard and the geological barrier, the rec geological disposal. Key issues as Facility, Safeguards aspects and m Assessing the long-term safety of a Environmental risk assessment, the I	e nuclear fuel c ext of nuclear wa ent: current con- types of waste, R ons, deep geolo rs approaches. Th es that need to b rock, clays/shale quirements for s ssociated with fi- nonitoring of a surface or geolo ERICA tool and	ycle and wa ste managem cepts and fut &D in treatn gical disposa he geological e addressed i es, evaporates subsurface cl inding and so repository, P gical disposa mixture toxic	ste ge ent: la ure pr nent ar l, The / hydr n deve , the ro haracto electin ublic l facili ity.	enerati ws and ospect nd stor Safet ro geo eloping oles of erization ng a C partici ity for	on; sp l regul s of II age. y Cas logica g a saf engin on to Geolog patior radio	bent fuel and ations; Types LW, HLW & e concept for l and coupled ety case. eered barriers support safe ical Disposal n approaches, active waste,			
	SKILL MAPPING (CO-PO MAP	PING)								
	No.         Course Learning Outcome	1 2 3	PROGRAM ( 3 4 5 6	OUTCO	OMES ( 8 9	PO) 10	11 12			

		-														
		Understand th	ne general classification													
	CO1	of nuclear wast	e and the basic principles	3												
		of radioactive	waste management.													
	600	Explain vario	ous options of nuclear		2											
	02	waste disposais	waste disposals and associated physical 3													
		Analyze the	issues associated with													
		finding and	selecting a Geological													
	CO3	Disposal Facil	lity. Safeguards aspects			3										
		and monitoring	g of a repository													
		Evaluate lon	g-term safety disposal													
	CO4	facility for	radioactive waste and				3									
	(2 11, 1	Environmental	risk assessment													
HIGTIFICAT	(3 – High, 2- Medium, 1-low)															
JUSTIFICA	TION FO		IAPPING													
Mapping	Corr	esponding				ľ	usti	fica	tion							
	Level	of Matching								-						
			In order to understan	d th	e gei	neral	clas	sifi	catio	n of	f nuo	clear	wast	e and	the b	oasic
CO1-PO1		3	principles of radioacti	ve w	aste	mana	igem	ent,	the l	knov	wled	ge of	math	emati	cs, na	tural
001101		C	science, engineering f	unda	men	tals a	and a	n en	igine	erin	g sp	ecial	izatio	n to th	ne solu	ition
			of complex engineerin	ig pr	oble	ms 15	app	lied	•							
			In order to Explain	varic	ous c	optio	ns o	f nu	iclea	rw.	aste	disp	osals	and	associ	ated
CO2-PO2		3	physical phenomenoi	n, 10	lenti	ticati	on,	torr	nula	tion,	, res	searc	h the	liter	ature	and
			analyze complex engin	neeri	ng p	roble	ems,	expl	ainii	ng va	arioi	is op	tions	of nuc	lear w	/aste
		disposais and associated physical phenomenon are required.									• 1					
			In order to analyze the	le 1ss	sues	asso	ciate	d w	ith f	indi	ng a	nd se	electii	ng a C	jeolog	gical
CO2 DO2		2	to design solutions for complex engineering problems and design systems													
C03-F03		3	components or processes that meet specified needs with appropriate consideration													
			for public health and s	atet		ltura	spec	niets	u nec il an	d er	with	appi	opiia ntal c	onside	ratio	11011
			In order to evaluate	ong.	term	saf	$\frac{1}{2}$	lisna	n, an Seal	faci	lity	for r	adioa	ctive	waste	and
			Environmental risk as	sessi	nent	it is	s rea	nire	d to	cond	fuct	inve	stigati	ions o	f com	nlex
CO4-PO4		2	problems using resear	ch-b	ased	kno	wled	lge a	and r	esea	arch	meth	ods i	nclud	ing de	sign
001101		-	of experiments, analy	sis a	nd in	terp	etati	ond	of da	ta. a	ind s	vnth	esis o	f info	rmatio	on to
			provide valid conclusi	ons.		··· I				,		5				
TEACHING	LEARN	NING STRAT	EGY													
<b>m</b> 1 1 1	<b>x</b> :													_		
Teaching and	Learning	g Activities												Enga	geme	nt
														(ho	ours)	
	Face-to	-Face Learnin	g													
		Lecture												2	12	
		Practical / Tu	itorial / Studio												-	
		Student-Cent	tred Learning												-	
	Self-Di	irected Learnir	ng													
		Non-face-to-	face learning											8	34	
		Revision	vision								4	21				
	Formal	Assessment														
		Continuous A	Assessment												2	
		Mid-Term													1	
		Final Examin	nation												3	
	Total												1	1	53	
TEACHING	METH	ODOLOGY												1		
incinito	11121110															

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Weeks	Topics	Remarks				
Week-1	Introduction to nuclear power, the nuclear fuel cycle and waste generation; spent fuel and reprocessing, The international context of nuclear waste management: laws and regulations; IAEA, NEA, Euratom, Fukushima.	Class Test				
Week-2	Types of radioactive waste: operational, reprocessing, decommissioning. Types of waste: ILW, HLW, HAW; TRU waste. Material not yet declared as waste: Spent fuel, Plutonium, Uranium. The concept of the radioactive waste Inventory.	1, Final Exam				
Week-3 Waste treatment: ILW current concepts and future prospects (cement grouting, thermal treatment, alternative matrices)						
Week-4	Waste treatment: HLW vitirification and canister storage. Alternative treatments (ceramics, synroc, transmutation), TRU wastes					
Week-5	Storage of the various types of waste: Example stores, on-site storage, decay storage, R&D in treatment and storage.	Class Test				
Week-6	Week-6 Disposal of Nuclear Waste the options: including near-surface disposal and deep borehole.					
Week-7	Deep geological disposal: the concept, the international consensus, variations in overarching approaches to developing Geological Disposal Facilities (GDFs) internationally					
Week-8	The Safety Case concept for geological disposal, Processes requiring consideration, Multiple Barriers approaches.					
Week-9	The geological / hydro geological and coupled subsurface-EBS R&D areas and issues that need to be addressed in developing a safety case.	Mid Term, Final Exam				
Week-10	Geological Disposal Concepts: Hard rock, clays/shales, evaporates.					
Week-11	Geological Disposal Concepts: an analysis of the roles of engineered barriers and the geological barrier. The requirements for subsurface characterization to support safe geological disposal.					
Week-12	Key issues associated with finding and selecting a Geological Disposal Facility: The role of geology and geological information. Principles of screening (national and regional), site identification, site selection and site assessment, both surface and underground					
Week-13	Safeguards aspects and monitoring of a repository, Public participation approaches	Exam				
Week-14	Assessing the long-term safety of a surface or geological disposal facility for radioactive waste, Environmental risk assessment, the ERICA tool and mixture toxicity					
ASSESSME	NT STRATEGY					

	Components	Grading	СО	Blooms Taxonomy				
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5				
(40%)	Class Participation and Class attendance	5%	CO1, CO3	C2, C4				

Mid term	15%	CO2	C5
Final Examination	60%	CO1, CO2, CO3, CO4	C2, C4, C5
Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. INTERNATIONAL ATOMIC ENERGY AGENCY, Radioactive Waste Management: An IAEA Source Book, IAEA, 1992
- 2. F. Barker, Management of Radioactive Wastes, Thomas Telford Publishing, 1998
- 3. D. R. Wily, *The chemistry of nuclear fuel waste deposal*, Polytechnic International Press, 2002
- 4. OECD/NEA, Advanced Nuclear Fuel Cycles and Radioactive Waste Management, Nuclear Development, OECD Publishing, 2006

#### **REFERENCE SITE**

	COURSE INFORMATION								
Course Code Course Title	: NE 489 : Nuclear Power Project: Construction and Decommissioning Strategies	Lecture Contact Hours Credit Hours	: 3.00 : 3.00						
	PRF-REOLIISITE								
	NE 101								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	The course is designed to learn and familiarize with the processes associated with a nuclear power project and its decommissioning policies and strategies.								
	OBJECTIVES								
	<ol> <li>To familiarize the students about the different and decommissioning.</li> <li>To introduce the different strategies related at distinct phases (preparatory, after concret</li> <li>To introduce the decommissioning polices,</li> <li>To discuss about the subsequent radiologic assurance methods in nuclear project manage</li> </ol>	ent stages of a nuclear power p nuclear power project Constru e pouring and commissioning). strategies and cost analysis. al risk associated with decomm gement.	roject construction ction Management nission and quality						
	LEARNING OUTCOMES								

	Upon completion of the course, the s	students will be a	able to							
	<ol> <li>Understand the different stages of a nuclear power project construction and decommissioning.</li> <li>Explain the different strategies related nuclear power project Management at distinct phases (preparatory, after concrete pouring and commissioning).</li> <li>Analyze the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management.</li> <li>Evaluate polices, strategies and cost analysis.</li> </ol>									
	COURSE OUTCOMES & GENE	RIC SKILLS								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods			
CO1	<b>Understand</b> the different stages of a nuclear power project construction and decommissioning.	PO1	C2	-	-	3	T, Q, F			
CO2	<b>Explain</b> the different strategies related nuclear power project Management at distinct phases (preparatory, after concrete pouring and commissioning).	PO11	C5	-	-	4	ASG, F			
CO3	<b>Analyze</b> the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management.	PO7, PO11	C4	-	-	5	T, MT, F			
CO4	<b>Evaluate</b> polices, strategies and cost analysis.	PO6, PO7	C5	3	-	6	T, F			
	<ul> <li>(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta</li> <li>COURSE CONTENT</li> <li>Nuclear Project Management</li> </ul>	Activities, KP-K tion; R - Report; F	nowledge Prof F – Final Exam	file, T , MT-	– Test Mid Te	; PR - erm Ex	– Project ; Q – am)			
	<ul> <li>Nuclear Project Management         Introduction to Nuclear Project Management, Nuclear Power development strategy, Nuclear Power             Infrastructure development and policies         </li> <li>Nuclear Power Project: Construction         Introduction, Construction Management: Preparatory Phase, Construction Management:             Construction Phase (After Concrete Pouring), Construction Management: Commissioning Phase,             Construction Management Issues and Lessons Learned.     </li> </ul>									
	Nuclear Power Project: DecommissionDecommissioning Policies and StApproaches, Decommissioning CostDecommissioning Planning and AppAnd Environmental Protection.SKILL MAPPING (CO-PO MAP)	rategies, Decon t Data, Managen proval, Quality A <b>PING</b> )	nes nent for Activ ssurance, Wa	Cost ve Pha ste Ma	Estima uses of anager	ating Deco nent, S	and Funding mmissioning, Safety, Health			

				PROGRAM OUTCOMES (DO)										1		
	No.	Course I	earning Outcome	1	2	г 3	4	5	6	7		9	(FO)	11	12	1
		Understand	the different stages of	1	2	5	-	5	0	,	0		10	11	12	
	CO1	a nuclear	power project	2												
		construction	and decommissioning.													
		Explain the	different strategies													
		related nuc	lear power project													
	CO2	Management	at distinct phases											3		
		(preparatory,	after concrete pouring													
		and commissioning).														ł
		radiological	risk associated with													
	CO3	decommissio	n and quality							3				2		1
	005	assurance r	nethods in nuclear							5				-		
		project mana	gement.													1
	CO4	Evaluate po	olices, strategies and						r	2						1
	004	cost analysis.							2	2						l
	(3 – Hig	h, 2- Medium,	1-low)	_		_	_	_	_	_		_				
JUSTIFICAT	FION FO	OR CO-PO M	IAPPING													
Mapping	Corr	esponding				J	usti	fica	ntion	1						
	Level	of Matching	<b>T 1</b> <i>i</i> <b>1</b> <i>i</i> <b>1</b>	1.1	1.00				6	1						
			In order to understand	n order to understand the different stages of a nuclear power project construction												
CO1-PO1	2		fundamentals and an engineering specialization to the solution of complex													
			engineering problems is applied.													
		In order to explain	the	dif	fere	nt s	trate	egies	s rel	lated	nu	clear	powe	er pro	oject	
CO2 PO11		2	Construction Management at distinct phases (preparatory, after concrete pouring													
C02-F011		5	and commissioning), it is needed to function effectively as an individual, and as a													
			member or leader in d	livers	se tea	ams a	and i	n m	ulti-	disci	iplina	ary s	etting	s.		
			In order to understand the impact of professional engineering solutions towards													
CO3-PO7		3	society and the environment, and demonstrate knowledge of and the need for													
			nuclear project manage	ieme	nt is	reau	ar te ired	2CIII	1010§	<u>y</u> , c	Juan	ty a:	ssuran		letiiou	5 111
			In order to analyze the	e sub	seau	ient i	radio	olog	ical	risk	asso	ciate	d with	n deco	mmis	sion
CO2 DO11		2	and quality assurance	e me	thod	s in	nuc	lear	pro	ject	man	ager	nent,	it is	neede	d to
C05-P011		2	function effectively as an individual, and as a member or leader in diverse teams											ams		
			and in multi-disciplina	ary s	etting	gs.										
		2	In order to assess socie	etal, I	healt	h, sa	fety,	leg	al ar	id cu	ltura	l issu	ies wi	th the	engin	leers
CO4-PO6		2	and society relevant	to p	rofes	sion	al nu		ar e	ngin	eerin	ig pi	actice	e, eva	luatio	n of
			In order to evaluate of	onst	ructi	on $\mathcal{X}$	nce dec	s, si 'om	miss	ioni	ng ng	olice	s stra	ategie	s and	cost
~~ . ~ ~ ~		_	analysis, it is required	to 1	indei	rstan	d an	d ev	valua	nte th	ne su	stain	abilit	v and	impa	ct of
CO4-PO7		3	professional engineeri	ing v	vork	in th	e so	lutio	on o	f con	npley	k eng	ineer	ing pr	oblen	ns in
			societal and environm	enta	l con	texts	5.							UT		
TEACHING	LEARN	ING STRAT	EGY													
Teaching and	Learning	Activities											1	Enga	reme	nt
i cucining and														(hc	ours)	
	Face-to	-Face Learnin	ıg													
		Lecture												2	12	
		Practical / Tu	itorial / Studio										1		-	
	Student-Centred Learning								1		-					

Self-Directed Learning	
Non-face-to-face learning	84
Revision	21
Formal Assessment	
Continuous Assessment	2
Mid-Term	1
Final Examination	3
Total	153

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Weeks	Topics	Remarks					
Week-1	Introduction to Nuclear Project Management,						
Week-2	Nuclear Power development strategy, Nuclear Power Infrastructure development policies						
Week-3	Construction Management — Preparatory Phase: Main contract management, Licensing management, Project risk management,	Exam					
Week-4	Coordination of construction activities, Categorization of construction work packages, Project scheduling and control during the construction phase						
Week-5	Construction Management — Construction Phase (After Concrete Pouring): Quality planning and management, Construction inspection, Safety and environmental management system, Developing a human resources plan	Class Test					
Week-6	Construction infrastructure development, Security Construction Management — Construction Phase (After Concrete Pouring): Overview of organizations (site and HQ) and main activities during construction	2, Final Exam					
Week-7	Construction Management — Commissioning Phase: Construction completion process, Turnover processes, preserving reference data, material conditions, keep test material						
Week-8	Construction Management Issues and Lessons Learned: Construction management issues, Country specific lessons learned						
Week-9	Decommissioning policy, Decommissioning strategies, Decommissioning cost estimating and funding approaches: Elements of decommissioning cost estimates, Approaches for estimating costs, Funding aspects	Mid Term, Final Exam					
Week-10	Decommissioning cost data: Reactor types and sizes, Reactor history and decommissioning schedule, Cost data reporting and conversion, Summary presentation of cost data						
Week-11	Management for Active Phases of Decommissioning						
Week-12	Decommissioning Planning and Approval, Quality Assurance	Class Test					
Week-13	Waste Management: Waste management strategy, Waste management arrangements	3, Final Exam					
Week-14	Safety, Health And Environmental Protection: Instrument used to characterize radiation levels within decommissioning environment, Environmental Impact Assessment (EIA)						

Components		Grading	CO	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
Assessment Class Participation and (40%) Class attendance		5%	CO1, CO3	C2, C4
	Mid term	15%	CO2	C5
Fii	nal Examination	60%	CO1, CO2, CO3, CO4	C2, C4, C5
	Total Marks	100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Project Management In Nuclear Power Plant Construction: Guidelines And Experience, Iaea Nuclear Energy Series No. Np-T-2.7
- 2. Nuclear Power Project Management A Guidebook, Iaea Technical Reports Series No. 279
- 3. Decommissioning Nuclear Power Plants: Policies, Strategies And Costs, Oecd 2003
- 4. Organization And Management For Decommissioning Of Large Nuclear Facilities, Technical Reports Series No. 399
- 5. Decommissioning Of Nuclear Power Plants, Research Reactors And Other Nuclear Fuel Cycle Facilities, Specific Safety Guide No. Ssg-47

#### **REFERENCE SITE**

	COURSE INFORMATION								
Course Code	: NE 491	Lecture Contact Hours	: 3.00						
Course Title	: Fundamentals of Plasma Engineering	Credit Hours : 3.00							
	PRE-REQUISITE								
	PHY 101, NE 105								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	The course is designed to learn and familiarize v applications.	vith the fundamental physics of	plasmas and their						
	OBJECTIVES								
	<ol> <li>To make known the students about the bas ionized gas consisting of charged particles (</li> <li>To explain different approaches to explain fluid approach and kinetic statistical approaches</li> </ol>	tic plasma parameters, under w (electrons and ions) can be treat plasma phenomena, the single p ch to describe different plasma	hat conditions an ed as plasma. particle approach, phenomena.						

	3. To discuss about the stability of plasma equilibrium and plasma instabilities of charged								
	particles moving in electric and magnetic fields that are either uniform or very slowly in space								
	and unne. 4 To introduce students about the conditions for plasme to be in a state of a perfect or a ner								
	4. To introduce students about the conditions for plasma to be in a state of a perfect or a non-								
	perfect merinouynamic equinorium and formulate mathematical tool to describe waves in plasma, as a continuous media								
	LEARNING OUTCOMES								
	Upon completion of the course, the s	students will be a	able to						
	- F								
	1. Apply the principal models of th	e nuclear study a	and radioactiv	vity.					
	2. Analyze the nuclear force, electr	on scattering, ne	utrino hypotł	nesis a	nd dev	iteron	properties.		
	3. Explain the spontaneous decay of	of nuclei, nuclear	reactions, fis	ssion a	nd fus	ion pr	ocess.		
	4. Evaluate the nuclear force, nucle	ear reactions met	hods and read	ction t	neory.				
	COURSE OUTCOMES & CENE	RIC SKILLS							
		Corresponding	Bloom's	GD		wb	Assessment		
No.	Course Learning Outcome	POs	Taxonomy	СР	CA	KP	Methods		
	Understand the basic plasma								
CO1	parameters, under what conditions an	PO1	C2			3	тор		
COI	particles (electrons and ions) can be	roi	C2	-	-	5	1, Q, I		
	treated as plasma								
	Explain the single particle approach,								
CO2	fluid approach and kinetic statistical	PO2	C5	-	-	4	ASG, F		
	phenomena								
	<b>Analyze</b> the stability of this								
	equilibrium and account for the most								
	important plasma instabilities the								
CO3	velocities, both fast and slow (drift velocities) of charged particles	PO2	C4	-	-	5	T, MT, F		
	moving in electric and magnetic fields								
	that are either uniform or very slowly								
	in space and time				<b> </b>	<b> </b>			
	<b>Evaluate</b> the conditions for plasma to be in a state of a perfect or a per								
	perfect thermodynamic equilibrium								
CO4	and formulate mathematical tool to	PO2	C5	3	-	6	T, F		
	describe waves in plasma, as a								
	continuous media.				<u> </u>	<u> </u>	<u> </u>		
	(CP- Complex Problems, CA-Complex	Activities. KP-Ki	nowledge Profi	ile. T -	- Test :	PR –	Project : O –		
	Quiz; ASG – Assignment; Pr – Presenta	tion; R - Report; H	F – Final Exam	, MT-	Mid Te	erm Ex	am)		
	COURSE CONTENT								
	Basic plasma properties and collectiv	e behaviour, Mo	otion of charg	ed par	ticles i	in maş	gnetic fields,		
	plasma confinement schemes, Collis	sions in Plasmas	, Plasma Moo	dels, N	1HD n	nodels	s, , two-fluid		
	hydrodynamic plasma models, the V	/lasov plasma m	odel, kinetic	theory	y of pl	asma,	the relation		
	between kinetic and fluid models, w	ave propagation	in a magnetic	c field	, Wave	es and	Instabilities		
	, simple equilibrium and stability	analysis, electr	on plasma	waves	and	landa	u damping,		
	applications of plasma.								

SKILL MAPPING (CO-PO MAPPING)															
	N	Course	I somine Outsoms			I	PROC	GRA	AM (	DUT	COM	1ES	(PO)		
	NO.	Course	Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12
	CO1	Understand parameters, an ionized ga particles (ele	erstand the basic plasma meters, under what conditions onized gas consisting of charged icles (electrons and ions) can be												
	CO2	<b>Explain</b> t approach, flu statistical a different plas	he single particle and approach and kinetic pproach to describe sma phenomena		3										
	CO3	Analyze the equilibrium a important p velocities, bo velocities), moving in fields that are slowly in spa	he stability of this and account for the most lasma instabilities the oth fast and slow (drift of charged particles electric and magnetic e either uniform or very ace and time		3										
	CO4	<b>Evaluate</b> the to be in a star perfect therm and formulat describe war continuous n	<b>ate</b> the conditions for plasma a state of a perfect or a non- thermodynamic equilibrium rmulate mathematical tool to be waves in plasma, as a uous media.												
	(3 – Hig	h, 2- Medium,	1-low)												
JUSTIFICAT	ION FO	R CO-PO M	APPING												
Mapping	Corre Level o	esponding of Matching				Ju	stific	cati	ion						
CO1-PO1		3	In order to understand ionized gas consisting plasma the knowled fundamentals and an engineering problem	l the of cl lge engi s is t	basi narge of ineer	c pl ed pa math ring plie	asma article hema spec d.	pa es ( atic cial	rame elect s, n izati	eters, rons natur on to	und and al s o the	ler w ions scier e sol	what c ) can nce, ution	onditi be tre engin of co	ons an ated as eering mplex
CO2-PO2		3	In order to explain the single particle approach, fluid approach and kinetic statistical approach to describe different plasma phenomena identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.												
CO3-PO2		3	In order to analyse the stability of this equilibrium and account for the most important plasma instabilities the velocities, both fast and slow (drift velocities), of charged particles moving in electric and magnetic fields that are either uniform or very slowly in space and time identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required.												
CO4-PO2		3	In order to evaluate the perfect thermodynamic waves in plasma, as literature and analysis	e cono c equ a con of c	dition ilibri ntinu omp	ns fo ium ous lex e	r plas and f medi engin	sma forn a, eer	to b nulat ident ing p	e in te ma tifica probl	a star athen tion, ems	te of natic for reac	a perf al too mulati hing	fect or l to d lon, re substa	a non- escribe esearch ntiated

	conclusions using first principles of mathematics, natural sciences are required.	es and engineering						
TEACHING I	LEARNING STRATEGY							
Teaching and Learning Activities								
	Face-to-Face Learning							
	Lecture							
	Practical / Tutorial / Studio	-						
	Student-Centred Learning	-						
	Self-Directed Learning	0.4						
	Non-face-to-face learning	84						
	Revision	21						
	Formal Assessment	2						
	Continuous Assessment	2						
	Mid-Term Einel Exemination							
	Final Examination	3 152						
TEACHINC		155						
TEACHING								
Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method							
COURSE SCI	HEDULE							
Weeks	Topics	Remarks						
	Basic Description of a Plasma							
Week-1	Fundamental Space and Time Scales							
	Plasma Parameter	Class Test						
	Basic Description of a Plasma	1 Final						
Week-2	Plasma Oscillations	I, Filial						
	• Debye shielding	Exam						
Week-3	Motion of charged particles in magnetic fields							
Week-4	Plasma confinement schemes, Collisions in Plasmas							
Week-5	Plasma Models (MHD model)	Class Test						
Week-6	Plasma Models (Two-fluid hydrodynamic plasma model)	Exam						
Week-7	k-7 Plasma Models (The Vlasov plasma model)							
Week-8	Kinetic Theory Of Plasma	Mid						
Week-9	The Relation Between Kinetic And Fluid Models	Term, Final						
Week-10	Plasma Wave , Electron Plasma Waves	Exam						
Week-11	Wave Propagation In A Magnetic Field							

Week-12	Waves And Instabilities	Class Tost
Week-13	Simple Equilibrium And Stability Analysis	3, Final
Week-14	Landau Damping, applications of plasma	Exam

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
Assessment (40%)	Class Participation and Class attendance	5%	CO1, CO3	C2, C4
	Mid term	15%	CO2	C5
Final Examination		60%	CO1, CO2, CO3, CO4	C2, C4, C5
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

1. Chen, Francis F, Introduction to Plasma Physics, 2nd edition, New York, Springer, 1984

Goldston, R. J. and P. H. Rutherford, Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995.
 J. A. Bittencourt, Fundamentals of Plasma Physics, 3rd edition, New York, NY: Springer, 2004

## **REFERENCE SITE**

## CHAPTER 6

## 6.1 <u>Courses Offered by Other Departments to NE Students</u>

## 6.1. a. <u>Department of Science and Humanities</u>

## **Physics:**

## Level 1 Term I

	COURSE INFORMATION										
Course Code Course Title	: PHY 101 : Waves and Oscillations, Optics and Modern Physics	Lecture Contact Hours Credit Hours	: 3.00 : 3.00								
	PRE-REQUISITE										
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	This course is the basic physics in the field of Waves and Oscillations, Optics and Modern physics. The course will be emphasized basic concepts, theories and solve quantitative problems which can be applicable in a wide spectrum of engineering disciplines.										
	OBJECTIVES										
	<ol> <li>To define the different parameter and concepts of W physics.</li> <li>To explain the basic theories of Waves and Oscillati To solve numerical problems regarding Waves and</li> </ol>	Vaves and Oscillations, ( ions, Optics and Moderr Oscillations, Optics and	Optics and Modern n physics. Modern physics.								
	LEARNING OUTCOMES										
	Upon completion of the course, the students will be abl	e to									
	<ol> <li>Define different basic parameters in the field of W physics such as periodic motion, simple harmonic in diffraction, polarization and prism, photoelectric e model, radioactive decay, fusion, fission etc.</li> <li>Explain different basic theories in the field of W physics such as the wave motion for different syster interference, diffraction, polarization special theory transformation, and nuclear reaction etc.</li> <li>Solve quantitative problems in the field of Waves a such as energy of wave motion, wavelength, difference and the physics and the physics are provided by the physics of the physics are physical and the physics are physical and the physical an</li></ol>	Vaves and Oscillations, motion, undamped oscil ffect, Compton effect, n vaves and Oscillations, ems along with energy, o ory of relativity, Comp and Oscillations, Optics fraction pattern, relativity	Optics and Modern lations, interference, matter wave, atomic Optics and Modern different formula for oton theory, nuclear and Modern physics istic energy, photon								

	COURSE OUTCOMES & GENERIC SKILLS								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Define</b> different basic parameters in the field of Waves and Oscillations, Optics and Modern physics such as periodic motion, simple harmonic motion, undamped oscillations, interference, diffraction, polarization and prism, photoelectric effect, Compton effect, matter wave, atomic model, radioactive decay, fusion, fission etc.	meters and fodern notion, ations, action, prism, model, fission			-	1	T, F, MT		
CO2	<b>Explain</b> different basic theories in the field of Waves and Oscillations, Optics and Modern physics such as the wave motion for different systems along with energy, different formula for interference, diffraction, polarization special theory of relativity, Compton theory, nuclear transformation, and nuclear reaction etc.	PO-1	C1	-	-	1	F, MT		
CO3	<b>Solve</b> quantitative problems in the field of Waves and Oscillations, Optics and Modern physics such as energy of wave motion, wavelength, diffraction pattern, relativistic energy, photon energy, Compton shift, nuclear binding energy etc.	PO-1	C2	-	-	2	T, F, MT, ASG		
	(CP- Complex Problems, CA-Comple ASG – Assignment; Pr – Presentation	x Activities, KP-Kn ; R - Report; F – Fin	owledge Profil al Exam, MT-	e, T – T Mid T	Гest ; Pl erm Exa	R – Proj am)	ject ; Q – Quiz;		
	COURSE CONTENT								
	<ul> <li>Waves and Oscillations: Simple I of a SHM and its solution, total energy of a body executing SHM, I pendulum, spring-mass system, tw and its different condition, forced progressive wave, differential equaverage kinetic and potential energy</li> <li>Optics: Lens, equivalent lens and of light, Young's double slit exp diffraction of light, diffraction by prism, diffraction gratings, polariz refraction, Nicole prism, optical action of light and potential energy</li> </ul>	Harmonic Motion ( energy of a body) LC oscillatory circle to body oscillation oscillation and its lation of a progres gy of a progressive power, defects of periment, Interfere single slit, diffract ation of light, Brey civity and polarin	(SHM) and it executing SH uit, Pendulum and reduced s different co essive wave, wave, Station images and of ence in thin t ion by double wster's law, M neters, optical	s prop IM, av i: simp l mass ndition energy nary w differe film a e slits, Malus l instru	erties, l rerage l ile, con , damp n, reson y densi vave nt aber nd Nev Fraunh law, po uments	Differe kinetic apound ed harn nance, ity of v rrations wton's nofer an olarizati , resolv	ntial equation and potential and torsional monic motion equation of a wave motion, a, Interference ring method, and Fresnel bi- ion by double ving power of		

	Modern Galilear addition Compto energy o law, hal	<b>h physics:</b> Ga h transformation, relativity of a on effect, de B equation, class f-life, mean lif	lilean relativity & Reference fr on, Lorentz Transformation, L mass, mass energy relation, Mon Broglie matter wave, Bohr atom dification of nucleus, nuclear bin fe, nuclear reaction, introduction	ame eng mer me din to	e, S gth ntur ode g e nuc	Spe con n e el a ner elea	cial ntra ner nd gy, r re	l th acti gy exp rac	ion, rela plan dioa	y ( T atic nati acti	of 1 ime on, ion ivit	rela e d Pho , at y, r	tivity ilatio otoele omic adio	⁷ pos on, V ectric orbi active	tulate eloci effe tal an deca	es, ty ct, nd ay
	SKILL	MAPPING (	CO-PO MAPPING)													
						PR	06	R 4	M			101	IFS (	PO)		1
	No.	Cor	urse Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12	
	CO1	<b>Define</b> differe Waves and O physics such harmonic mo interference, prism, photoe matter wave, a fusion, fission	nt basic parameters in the field of oscillations, Optics and Modern as periodic motion, simple otion, undamped oscillations, diffraction, polarization and electric effect, Compton effect, atomic model, radioactive decay, etc.	3												
	CO2	<b>Explain</b> differ Waves and O physics such a systems along for interfere special theory nuclear transf etc.	rent basic theories in the field of Oscillations, Optics and Modern as the wave motion for different g with energy, different formula nce, diffraction, polarization of relativity, Compton theory, formation, and nuclear reaction	3												
	CO3	Solve quantita and Oscillation such as energ diffraction pate energy, Comp etc.	tive problems in the field of Waves ons, Optics and Modern physics y of wave motion, wavelength, ttern, relativistic energy, photon oton shift, nuclear binding energy	3												
	(3 – Higi	h, 2- Medium, 1	-low)													
JUSTIFICA	TION FO	OR CO-PO M	IAPPING													
Mapping	Corresp Level of	ponding f Matching		Ju	stif	ica	tio	n								
CO1-PO1		3	The conceptual knowledge of engineering discipline	of	the	n	atuı	ral	SC	ien	ces	aj	pplic	able	to t	he
CO2-PO1		3	The theory-based knowledge of the natural sciences applicable to the engineering discipline													
CO3-PO1	PO1 3 The numerical analysis-based knowledge of the natural sciences applicable to the engineering															
TEACHING	<b>LEARN</b>	ING STRAT	EGY													
Teaching and	l Learning	g Activities									_		Eng (	agen hours	nent	
	Face-to-	-Face Learning	5													

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Lecture	42
Practical / Tutorial / Studio	-
Student-Centred Learning	-
Self-Directed Learning	
Non-face-to-face learning	84
Revision	21
Formal Assessment	
Continuous Assessment	2
Mid-Term	1
Final Examination	3
Total	153

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

Weeks	Topics	Remarks						
	Introductory class: Brief discussion on total syllabus, basic requirements of the							
	course, assessment of the course	-						
Week-1	Simple harmonic motion (SHM) and its differential equations, graphical							
	representation of SHM	-						
	Average K.E and total energy	Class Test						
	Spring-mass system, electric oscillatory circuit	1, Final						
Week-2	Simple, compound and torsional pendulum	Exam						
	Combination of two SHM	-						
	Combination of two SHM							
Week-3	Two body oscillations, reduced mass							
	Damped oscillations and its differential equation							
	Displacement equation of damped oscillation, electric damped oscillatory circuit							
Week-4	Forced oscillation and its differential equation							
	Displacement equation of forced oscillation, resonance							
	Plane progressive wave, energy density of wave							
Week-5	Stationary wave	Class Tost						
	Lens and combination of lenses, power of lens	2 Final						
	defects of images and different aberrations	2, Fillal						
Week-6	defects of images and different aberrations	Exam						
	Interference of light, young's double slit experiment							
	Interference in Thin films, Newton's ring							
Week-7	Diffraction : Fresnel & Fraunhofer diffraction							
	Diffraction by single slit							
	Diffraction by double slit, Diffraction gratings							
Week-8	Polarization and Production and analysis of polarized light							
	Optics of crystals, Nicole prism							
	Brewster's and Malus law	Mid Term,						
Week-9	Optical activity and polarimeter	<b>Final Exam</b>						
	Laser & its applications							
Week 10	Theory of relativity: Frame of Reference, Postulates of special relativity, Galilean							
Week-10	Transformation							

	Theory of relativity: Lorentz Transformations, Length Contraction and Time dilation				
	Velocity addition, Relativistic mass: Concept of relativistic mass and its expression				
	Theory of relativity: Mass and Energy equivalence equation and concept of Massless particle and its expression. Related numerical problems				
Week-11	Photoelectric Effect, photocurrent and work function, kinetic energy, stopping potential				
	Photoelectric equation, characteristics of photoelectric effect				
	Compton effect: Definition, Compton wavelength shift, limitation	Close Test			
Week-12	De Broglie Concept, Condition for wave and particle behavior, Bohr atomic model				
	Expression for Bohr radii and orbital energy for hydrogen atom	5, Final			
	Classification of Nucleus, nuclear binding energy	Exam			
Week-13	Radioactivity and its transformation, Radioactive Decay Law,				
	Half- life, Mean life, nuclear reaction				
	Concept of Fusion, Fission and nuclear chain reaction				
Week-14	General idea on nuclear reactor and nuclear power plant				
	Follow up of the course				

	Components	Grading	CO	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment	20%	CO1, CO3	C1, C2
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO3	C2
(,	Mid term	10%	CO1, CO2, CO3	C1, C2
Final Examination (60%)		60%	CO1, CO2, CO3	C1, C2
	Total Marks	100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

1. Halliday, Resnick and Walker, Fundamentals of Physics, 10th edition, John Wiley & Sons, 2013.

- 2. Serway and Jewett, *Physics for Scientists and Engineers*, 8th edition, Cengage Learning, 2010.
- 3. Arthur Beiser, *Concept of Modern Physics*, USA: Tata McGraw-Hill Education, 2002.
- 4. Hugh D. Young and Roger A. Freedman, *University Physics with Modern Physics*, Boston, USA: Pearson Addison Wesley, 2006.

5. Marshall L. Burns , *Modern Physics for Science and Engineering*, California, USA: Harcourt College Pub, 1988.

- 6. Walter Fox Smith , *Waves and Oscillations*, Oxford, UK: University Press, 2010.
- 7. H. J. Pain, The Physics of Vibrations and Waves
- 8. Francis A. Jenkins and Harvey E. White, *Fundamental of Optics*
- 9. Grant R. Fowles, *Introduction to Modern Optics*

### **REFERENCE SITE**

# Level 1 Term I

	COURSE INFORMATION											
Course Code	: PHY 102	I	Lecture Contact	t Hours	: 3.0	0						
Course Title	: Physics Sessional	(	Credit Hours		: 1.50	0						
	PRE-REQUISITE											
	None											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)											
	SYNOPSIS/ RATIONALE											
	This course is a laboratory course for the basic physics in the field of Waves and Oscillat Optics, Mechanics, Electricity, Modern physics and Thermal physics. The course wil emphasized fundamental experiments on different fields of physics which can be applicable wide spectrum of engineering disciplines. This laboratory course will enable students to unders basic physics practically as well as do work with team or individual.											
	OBJECTIVES											
	<ol> <li>To develop basic physics knowle</li> <li>To practice use of basic scientific</li> </ol>	edge practically c instrument	7									
	LEARNING OUTCOMES											
	Upon completion of the course, the students will be able to											
	<ol> <li>Define the different parameter Electricity, Modern physics and</li> <li>Describe the different phenome Electricity, Modern physics and</li> <li>Construct Experiments by an in regarding Waves and Oscillati Thermal physics etc.</li> <li>Prepare a report for an experiment</li> </ol>	rs regarding W Thermal physic ena regarding Thermal physic ndividual or by ons, Optics, M ntal work.	Vaves and Ose es etc. Waves and Os es etc. y a group to d Mechanics, Ele	cillations, scillations, etermine d ctricity, M	Optics, Optics ifferen odern	, Mechanics, , Mechanics, t phenomena physics and						
	COURSE OUTCOMES & GENEI	RIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP CA	KP	Assessment Methods						
CO1	<b>Define</b> the different parameters regarding Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics etc.	PO-1	C1		PO-1 C1		1	Q				
CO2	<b>Describe</b> the different phenomena regarding Waves and Oscillations,	PO-1	C1		1	T, F						

	Optics, Modern etc.	Mechanics, Electricity, physics and Thermal physics												
CO3	Constru individu differen Waves Mechan	<b>act</b> experiments by an all or by a group to determine t phenomena regarding and Oscillations, Optics, ics, Electricity, Modern and Thermal physics etc	PO	9		С	3	-		-	2		T, F	
CO4	Prepare work.	e a report for an experimental	PO-	10		C	2	-		-	2		R	
	(CP- Co Quiz; A	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)												Q –
	COURSE CONTENT													
	<ul> <li>Quantitative measurement of different parameters in the field of Waves and Oscillations, Optics, Mechanics, Electricity, Modern physics and Thermal physics such as:</li> <li>Specific resistance of materials, high resistance, Electrochemical equivalent (ECE) of copper, wavelength of light, focal length of lens, specific rotation of sugar, conductivity of a bad conductor, acceleration due to gravity, spring constant, the rigidity modulus, conservation of linear momentum, Young's modulus, Planck's constant, specific heat of a liquid</li> </ul>													
	SKILL		I IIIG)											
	No.	Course Learning Outcome	e 1	2	P 3	ROG	RAM (	OUTO 7	<u>CON</u> 8	1ES 9	(PO) 10	11	12	
	CO1	<b>Define</b> the different parame regarding Waves Oscillations, Optics, Mechan Electricity, Modern physics Thermal physics etc.	ters and ics, 3 and						-					
	CO2	<b>Describe</b> the different phenom regarding Waves Oscillations, Optics, Mechan Electricity, Modern physics Thermal physics etc.	ena and ics, 3 and											
	CO3	<b>Construct</b> experiments by individual or by a group determine different phenom regarding Waves Oscillations, Optics, Mechan Electricity, Modern physics Thermal physics etc.	an to ena and ics, and							2				
	CO4	<b>Prepare</b> a report for experimental work.	an								1			
	(3 – Hig	h, 2- Medium, 1-low)												
JUSTIFICA	TION F	OR CO-PO MAPPING												

Mapping	Corresponding Level of Matching	Justification						
CO1-PO1	3	The conceptual knowledge of the natural sciences appending discipline	plicable to the					
CO2-PO1	3	The descriptive knowledge of the natural sciences app engineering discipline	plicable to the					
CO3-PO9	2	Able to do work or complete a task as an individual and	as a team					
CO4-PO10	1	Capable to write a report on an experimental work						
TEACHING	LEARNING STRAT	EGY						
Teaching and	l Learning Activities		Engagement (hours)					
	Face-to-Face Learning							
	Lecture		10					
	Practical / Exp	periment	18					
	Student-Centr	ed Learning	-					
	Self-Directed Learning		10					
	Preparation of	Lab Reports	18					
	Preparation of	Lab-test	25					
	Preparation of	Quiz	9					
	Freparation of	viva	9					
	Continuous A	ssassmant	2					
	Ouiz	ssessment	2					
	Final lab exan		3					
	Total		95					
TEACHING	<b>METHODOLOGY</b>							
Lecture follow Method	wed by practical experin	nents and discussion, Co-operative and Collaborative Metho	d, Design Based					
COURSE SO	CHEDULE							
Weeks		Topics	Remarks					
Week-1	Orientation and Introdu	uctory lecture						
Week-2	Introductory class: Bi course, evaluation sys laboratory, introduction	rief discussion on total syllabus, basic requirements of the term of the course, grouping, visit different section of the n to different basic equipment	ne -					
Week-3	Determination of specific resistance of materials of a wire by using Meter Bridge / Determination of focal length of a concave lens by auxiliary lens method.							
Week-4	Determination of a hig specific heat of a liquid	gh resistance by the method of deflection/ Determination d by the method of cooling	of					
Week-5	Determination of ECE Young's modulus of ba	of copper by using copper voltameter / Determination of that by bending method,	ne					
Week-6	Determination of the fo	ocal length of a plano-convex lens by Newton's ring method	đ					
Week-7	Determination of the s	pecific rotation of sugar by polarimeter						

Week-8	Determination of the acceleration due to gravity by means of compound pendulum	
Week-9	Determination of the spring constant and the rigidity modulus of a spiral spring	-
Week-10	Determination of the Planck's constant using photoelectric effect	
Week-11	Revision class and final lecture	
Week-12	Final exam & viva voce	
Week-13	Final exam & viva voce	-
Week-14	Quiz exam	

	Components	Grading	СО	Blooms Taxonomy			
Continuous	Class performance	10%	CO1	C1			
Assessment (40%)	Report Writing	30%	CO4	C2			
Einel Even	Lab test	30%					
r = 111 a E X a H I	Viva	10%	CO1, CO2, CO3	C1, C3			
(00%)	Quiz	20%					
Total Marks	100%						

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

- 1. G. L. Squires, *Practical Physics*, 4th Edition, Cambridge University Press, 2001.
- 2. Dr Giasuddin and Md. Sahabuddin, Practical Physics.
- 3. C. L Arora, B.Sc. Practical Physics, 13 th Edition, S. Chand, 1969.
- 4. S.L. Gupta and V. Kumar, *Practical Physics*.

### **REFERENCE SITE**

### <u>Chemistry</u>

### Level 1 Term II

	COURSE INFORMATION		
Course Code	: CHEM 101	Lecture Contact Hours	: 3.00

Course Title	: Fundamentals of Chemistry		Credit Hours			: 3.00						
	PRE-REQUISITE											
	None											
	CURRICULUM STRUCTUR	E										
	Outcome Based Education (OBE	E)										
	SYNOPSIS/ RATIONALE											
	This course is the basic chemistry course will be emphasized on th which can be applicable in a wid	y in the field of ino le basic concepts, le spectrum of eng	rganic, organ theories and t ineering disci	ic and o solv plines.	physic e quar	al che ntitativ	mistry. The re problems					
	OBJECTIVES	OBJECTIVES										
	<ol> <li>To define the different parameter and concepts of inorganic chemistry and physical chemistry.</li> <li>To explain basic reaction mechanism of selective organic reactions.</li> <li>To solve numerical problems of inorganic, organic and physical chemistry.</li> </ol>											
	LEARNING OUTCOMES											
	Upon completion of the course, the students will be able to											
	<ol> <li>Define different basic paramilier, atomic structure, periodequilibrium, thermo-chemist</li> <li>Explain different basic theorier reduction, Substitution, Add</li> <li>Solve quantitative problems solutions, thermochemistry,</li> </ol>	eters in the field of odic table, chemi- try and different ty ies in the field of se ition, Polymerizati in the field of inco- chemical kinetics,	f inorganic, o ical bonding, pes of solutio elective organ ion, Alkylatio organic, organ electrical pro	rganic acids ons, pha ic reac on react ic and operties	and p s and ase rul tions s tions e physi s of so	hysica bases le etc. uch as etc. cal ch <u>lution</u>	al chemistry c, chemical Oxidation- emistry i.e. etc.					
	COURSE OUTCOMES & GE	NERIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
CO1	<b>Define</b> different basic parameters in the field of inorganic, organic and physical chemistry i.e., atomic structure, periodic table, chemical bonding, acids and bases, chemical equilibrium, thermo- chemistry and different types of solutions, phase rule etc	PO-1	C1	-	-	1	T, F, MT					
CO2	<b>Explain</b> different basic theories in the field of selective organic reactions such as Oxidation-reduction, Substitution, Addition,	PO-1	C2 -		-	1	T, F, MT					

	Polymer	ization Alkylation													
	reactions	s etc.													
CO3	Solve q in the organic chemistr thermock kinetics, of solution	uantitative problems field of inorganic, and physical ry i.e. solutions, hemistry, chemical electrical properties on etc.	PO-1				C3		_		-	2	2	T, F, AS	MT, SG
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)														
	COURSE CONTENT														
	<ul> <li>Course content</li> <li>Atomic Structure: Concepts of atomic structure, Different atom models, quantum theory and electronic configurations, Heisenberg's uncertainty principle</li> <li>Periodic Table: Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases</li> <li>Chemical Bonding: Types and properties of chemical bonding, Lewis theory, VBT, MOT, Hybridization and shapes of molecules</li> <li>Selective organic reactions: Oxidation-reduction, Substitution, Addition, Polymerization, Alkylation reactions</li> <li>Phase Rule: Basic terms and phase rule derivation, Phase diagram of water and carbon dioxide</li> <li>Solutions: Solutions and their classification, Unit expressing concentration, Colligative properties and dilute solutions, Raoult's law, Van't Hoff's law of osmotic pressure</li> <li>Thermochemistry: Laws of thermochemistry, Enthalpy, Hess's law, Heat of formation, Kirchoff's equations, Heat of neutralization, Heat of reaction</li> <li>Chemical Kinetics: Order and rate of reaction, Pseudo and zero order reaction, Half-life, Determination and factors affecting the rate of a reaction, First order reaction, Second order reaction, Collision theory, Transition state theory</li> <li>Chemical Equilibrium: Equilibrium law/constant, Kp and Kc, Homogeneous and heterogeneous equilibrium, Van't Hoff's reaction isotherm, Le Chatelier's principle</li> <li>pH &amp; Buffer Solution: Different concepts of acids-bases, Buffer solution, Mechanism of buffer solution, Henderson-Hasselbalch equation, Water chemistry and pH of water</li> <li>Electrical properties of solution: Conductors &amp; nonconductors, difference between electrolytic and metallic conduction, electrolytic conductance, Factors influencing the</li> </ul>										and rties IOT, tion, xide ative tion, -life, order and n of tween g the				
	SKILL	MAPPING (CO-PO M	(APPING)												
	No	Course Learning Ou	itcome			P	ROG	RA	МО	OUT	СОМ	ES (	(PO)		
	CO1	<b>Define</b> different basic pa in the field of inorganic and physical chemis atomic structure, period chemical bonding, ac bases, chemical equ	arameters c, organic try i.e., dic table, cids and ailibrium, different	1 3	2	3	4	5	6	7	8	9	10	11	12
		types of solutions, phase	rule etc.												

	CO2 Explain di the field reactions reduction, Polymeriz: reactions e	fferent basic theories in of selective organic such as Oxidation- Substitution, Addition, ation, Alkylation tc.	3												
	CO3 Solve quar field of i physical c thermoche kinetics, e solution et	titative problems in the norganic, organic and hemistry i.e. solutions, mistry, chemical electrical properties of c.	3												
	(3 – High, 2- Medium	n, 1-low)													
JUSTIFICAT	ION FOR CO-PO M	IAPPING													
Mapping	Corresponding Level of Matching Justification														
CO1-PO1	3	The conceptual kr engineering discip	nowle line	edge	e of	the	nat	ural	scie	ences	s apj	plica	ble to	the	
CO2-PO1	3	The theory-based and engineering discipation	know line	led	ge o	f the	e na	tura	l sci	ence	es ap	plica	ble to	o the	
CO3-PO1	3	The numerical ar applicable to the end	The numerical analysis-based knowledge of the natural sciences applicable to the engineering									nces			
<b>TEACHING I</b>	LEARNING STRAT	EGY													
Teaching and I	Learning Activities											Engagement (hours)			
	Face-to-Face Learn	ing												/	
	Lecture	c									42				
	Practical / 7	Futorial / Studio										-			
	Student-Ce	ntred Learning											-		
	Self-Directed Learn	ing											0.4		
	Non-face-te	o-face learning											84		
	Formal Assessment										-		21		
	Continuous	Assessment											2		
	Mid-Term												1		
	Final Exam	ination											3		
	Total												153		
TEACHING N	METHODOLOGY														
Lecture and Di	scussion, Co-operativ	ve and Collaborative M	etho	<b>1, P</b> 1	roble	em I	Base	ed M	letho	bc					
COURSE SCI	HEDULE														
Weeks	Topics										Remarks				
	Concepts of atom	c structure, Different	ator	n n	node	els									
Week-1	Concepts of atom	c structure, Different	ator	n n	node	els					Class Tost 1				
	Quantum numbers	s, Electronic configur	ation	ıs									E:	nal	
Week 2	Hydrogen spectra	l lines, Heisenberg's u	ince	rtai	nty	prin	cip	le					Fv Fv	am	
W CCK-2	Classification of e	Classification of elements according to electronic configurations										ĽA	a111		

	Periodic classification of elements		
	Periodic properties of elements, Properties and uses of noble gases		
Week-3	Periodic properties of elements, Properties and uses of noble gases		
	Chemical bonding (types, properties, Lewis theory, VBT)		
	Molecular orbital theory (MOT)		
Week-4	Molecular orbital theory (MOT)		
	Hybridization and shapes of molecules		
	Hybridization and shapes of molecules		
Week-5	Hybridization and shapes of molecules	Class	
	Oxidation-reduction, Substitution	Test 2,	
	Addition, Polymerization, Alkylation		
Week-6	Phase Rule: Basic terms and phase rule derivation		
	Phase diagram of water and carbon dioxide		
	Different concepts of acids-bases		
Week-7	Buffer solution, Mechanism of buffer solution		
	Henderson-Hasselbalch equation		
	Solutions and their classification,		
Week 9	Units of expressing concentration		
week-o	Effect of temperature and pressure on solubility, Validity and limitations of		
	Henry's law	Mid	
	Colligative properties and dilute solutions	Term,	
Week-9	Raoult's law, deviation from Raoult's law, Elevation of boiling point	Final	
	Freezing point depression, Van't Hoff's law of osmotic pressure	Exam	
	Laws of thermochemistry, Enthalpy		
Week-10	Hess's law, Heat of formation, Kirchoff's equations		
	Heat of neutralization, Heat of reaction		
	Reversible reactions, Characteristics of chemical equilibrium, Law of		
Week-11	mass action, Equilibrium constant, Units of equilibrium constant		
WEEK II	Relation between K _p & K _C , Van't Hoff's reaction isotherm		
	Free energy and its significance Heterogeneous equilibrium		
	Le Chatelier's principle		
	Reaction rate, Units of rate, Rate laws, Order of reaction, Molecularity of a		
Week-12	reaction, Pseudo-order reaction		
	Reaction rate, Units of rate, Rate laws, Order of reaction, Molecularity of a	Class	
	reaction, Pseudo-order reaction	Test 3	
	First order reactions, 2nd order reactions, units of rate constant, half-life	Final	
	of a reaction		
Week-13	Collision theory of reaction rates, Effect of increase of temperature on		
	reaction rate, Determination and factors affecting the rate of a reaction		
	energy and catalysis		
	Conductors & nonconductors Difference between electrolytic and		
Week-14	metallic conduction. Electrolytic conductance		
	Factors influencing the conductivity of electrolytes Kohlrausch Law		
	Conductometric titrations		

Components		Grading	CO	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment	20%	CO1, CO3	C1, C3
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO3	C3
	Mid term	10%	CO1, CO2, CO3	C1, C2, C3
Final Examination (60%)		60%	CO1, CO2, CO3	C1, C2, C3
Total Marks		100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. S. Z. Haider, Modern Inorganic Chemistry, 1st Edition, Friends International, 2005
- 2. J. D. Lee, Concise Inorganic Chemistry, 5th Edition, Wiley India Pvt. Limited, 2008
- 3. Arun Bahl And B. S. Bahl, A Textbook of Organic Chemistry, 16th Edition, Chand, 1997
- 4. Morrison and Boyd , Organic Chemistry, 6th Edition, Prentice Hall, 1998
- 5. Haque and Nawab , Principles of Physical Chemistry , 1st Edition, Nawab Publications, 2005
- 6. Bahl and Tuli, *Essentials of Physical Chemistry*, Revised Edition, S. Chand Limited, 2000
- 7. Atkins , Physical Chemistry , Revised Edition, OUP Oxford, 2010

### **REFERENCE SITE**

### Level 1 Term II

	COURSE INFORMATION					
Course Code	: CHEM 102	Lecture Contact Hours	: 3.00			
Course Title	: Chemistry Sessional	Credit Hours	: 1.50			
	PRE-REQUISITE					
	None					
	CURRICULUM STRUCTURE					
	Outcome Based Education (OBE)					
	SYNOPSIS/ RATIONALE					

	This course is a laboratory course chemistry. The course will be en chemistry which can be applicable course will enable students to une team or individual.	for the basic chen nphasized by fund in a wide spectrun derstand basic che	nistry in the f amental expe n of engineeri mistry practio	ield of rrimen ng dis cally a	f inorg ts on c cipline as well	anic a liffere s. This as do	nd physical nt fields of s laboratory work with									
	OBJECTIVES															
	<ol> <li>To develop basic chemistry knowledge practically</li> <li>To practice the use of basic scientific instrument.</li> </ol>															
	LEARNING OUTCOMES															
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Define the different parameters regarding inorganic and physical chemistry.</li> <li>Describe the different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.</li> <li>Construct Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.</li> <li>Prepare a report for an experimental work.</li> </ol>															
	COURSE OUTCOMES & GEN	ERIC SKILLS														
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment									
		103					Wiethous									
CO1	<b>Define</b> the different parameters regarding inorganic and physical chemistry.	PO-1	C1	-	-	1	Q									
CO1 CO2	<b>Define</b> the different parameters regarding inorganic and physical chemistry. <b>Describe</b> the different phenomena regarding acid-base, iodo- iodimetric, complexometric and redox titration etc.	PO-1 PO-1	C1 C1	-	-	1	Q T, F									
CO1 CO2 CO3	Define the different parameters regarding inorganic and physical chemistry. Describe the different phenomena regarding acid-base, iodo- iodimetric, complexometric and redox titration etc. Construct Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo- iodimetric, complexometric and redox titration etc.	PO-1 PO-1 PO-9	C1 C1 C3	-	-	1 1 2	Q T, F F									
CO1 CO2 CO3 CO4	Define the different parameters regarding inorganic and physical chemistry. Describe the different phenomena regarding acid-base, iodo- iodimetric, complexometric and redox titration etc. Construct Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo- iodimetric, complexometric and redox titration etc. Prepare a report for an experimental work.	PO-1 PO-1 PO-9 PO-10	C1 C1 C3 C2	-	-	1 1 2 2	Q T, F F R									
CO1 CO2 CO3 CO4	<ul> <li>Define the different parameters regarding inorganic and physical chemistry.</li> <li>Describe the different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.</li> <li>Construct Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.</li> <li>Prepare a report for an experimental work.</li> <li>(CP- Complex Problems, CA-Compl Quiz; ASG – Assignment; Pr – Preser</li> </ul>	PO-1 PO-1 PO-9 PO-10 ex Activities, KP-K ntation; R - Report; H	C1 C1 C3 C2 nowledge Prof F – Final Exam	- - - ile, T , MT-	- - - Test Mid Te	1 1 2 ; PR - rm Exa	Q T, F F R Project ; Q – am)									
	Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate (C ₂ H ₂ O ₄ .2H ₂ O) Solution.															
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	Standar Solution	dization of Hy	drochloric Acid (H	Cl) So	oluti	on w	vith	Sta	ndaı	rd S	odiu	m H	ydro	kide (	NaOI	(F
	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Carbonate (Na ₂ CO ₃ ) Solution.															
	Determination of Calcium (Ca) Content in a Calcium Chloride dihydrate (CaCl ₂ .2H ₂ O) Solution with Standard Di Sadium Ethylana DiamminaTatus Assid (Als. EDTA) Saluti															
	with Standard Di-Sodium Ethylene DiammineTetraAceticAcid (Na ₂ EDTA) Solution. Standardization of Sodium Thiosulphate Pentahydrate (Na ₂ S ₂ O ₃ .5H ₂ O) Solution with Standard															
	Potassi Estimat	um Dichromate ion of Copper	e ( $K_2Cr_2O_7$ ) Soluti (Cu) Content in a	on. Cop	per	Sulp	ohate	e Po	enta	hyd	lrate	(Cu	SO ₄	5H ₂ O	) (Bl	ue
	Vitriol) (Na ₂ S ₂ C)	Solutions by O ₃ .5H2O) Solu	Iodometric Metho	d wi	th S	stand	lard	So	diu	mЛ	Thios	ulpł	nate ]	Penta	hydra	.te
	Standar	dization of Po	otassium Permanga	nate	(KN	/InO	4) S	Solu	itior	n w	ith S	Stand	lard	Oxali	c Ac	id
	Determ	ination of Fer	rrous (Fe) Content	in	a A	mm	oniu	ım	Fer	rous	s Su	lpha	ite (N	Aohr`	s Sal	lt)
	[FeSO ₄ Determ	[FeSO ₄ .(NH4) ₂ SO ₄ .6H ₂ O] Solution with Standard Potassium Permanganate (KMnO ₄ ) Solution. Determination of Zinc (Zn) Content in a Zinc Sulphate Heptahydrate (ZnSO ₄ .7H ₂ O) Solution with														
	Standard Di-Sodium EDTA (Na ₂ -EDTA) Solution by using Eriochrome black T indicator.															
	SKILL MAPPING (CO-PO MAPPING)															
	No.	Course Le	earning Outcome	1	2	P 3	ROC 4	GRA	M ( 6	DUT 7	CON 8	AES 9	(PO) 10	11	12	
	CO1	<b>Define</b> the diregarding inor chemistry.	ifferent parameters ganic and physical	3												
	CO2	<b>Describe</b> the d regarding a iodimetric, co redox titration	ifferent phenomena acid-base, iodo- omplexometric and etc.	3												
	CO3	<b>Construct</b> Exindividual or determine differentiate regarding a iodimetric, construction redox titration	xperiments by an by a group to ferent phenomena acid-base, iodo- omplexometric and etc.									2				
	CO4	<b>Prepare</b> a experimental w	report for an vork.										1			
	(3 – Hig	h, 2- Medium, 1	-low)													
Mapping	Corr	esponding	AFFING			J	lusti	ifica	atio	n						
1		or matchillig	The conceptual knowledge of the natural sciences applicable to the engineering discipline													
CO1-PO1		3	The conceptual engineering disc	The conceptual knowledge of the natural sciences applicable to the engineering discipline The descriptive knowledge of the natural sciences applicable to the												

CO3-PO9	2	2 Able to do work or complete a task as an individual and as a team										
CO4-PO10	1	Capable to write a report on an experimental work										
TEACHING	G LEARNING STRAT	EGY										
Teaching and	d Learning Activities		Engagement (hours)									
	Face-to-Face Learning Lecture Practical / Ex Student-Centr	g periment red Learning	10 18 -									
	Self-Directed Learning Preparation of Lab Reports Preparation of Lab-test Preparation of Quiz Preparation of viva Formal Assessment											
	Continuous A Quiz Final lab exar Total	n	2 1 3 95									
TEACHING	G METHODOLOGY											
Lecture follo Method	owed by practical experim	nents and discussion, Co-operative and Collaborative Metho	d, Design Based									
Weeks		Tonics	Remarks									
Week-1	Orientation and Introd	luctory lecture										
Week-2	Standardization of Sod dihydrate (C ₂ H ₂ O ₄ .2H	dium Hydroxide (NaOH) Solution with Standard Oxalic Ac I ₂ O) Solution	id									
Week-3	Standardization of H Hydroxide (NaOH) So	Hydrochloric Acid (HCl) Solution with Standard Sodiu olution.	m									
Week-4	Standardization of H Carbonate (Na ₂ CO ₃ ) S	Hydrochloric Acid (HCl) Solution with Standard Sodiu Solution	m									
Week-5	Determination of C (CaCl ₂ .2H ₂ O) Solution Acid (Na ₂ EDTA) Solution	alcium (Ca) Content in a Calcium Chloride dihydra on with Standard Di-Sodium Ethylenediamminetetraacet ution.	te ic -									
Week-6	Mid Term											
Week-7	Standardization of So with Standard Potassi	odium Thiosulphate Pentahydrate ( $Na_2S_2O_3.5H_2O$ ) Solutioum Dichromate ( $K_2Cr_2O_7$ ) Solution.	on									
Week-8	Estimation of Copp (CuSO ₄ .5H ₂ O) (Blue Sodium Thiosulphate	ber (Cu) Content in a Copper Sulphate Pentahydra Vitriol) Solutions by Iodometric Method with Standa Pentahydrate (Na ₂ S ₂ O ₃ .5H ₂ O) Solution.	rd -									
Week-9	Standardization of P Oxalic Acid dihydrate	Potassium Permanganate (KMnO ₄ ) Solution with Standa $e$ (C ₂ H ₂ O ₄ .2H ₂ O) Solution.	rd									

Week-10	Determination of Ferrous (Fe) Content in a Ammonium Ferrous Sulphate (Mohr`s Salt) [FeSO ₄ .(NH ₄ ) ₂ SO ₄ .6H ₂ O] Solution with Standard Potassium Permanganate (KMnO ₄ ) Solution.	
Week-11	Revision class and final lecture	
Week-12	Final exam & viva voce	
Week-13	Final exam & viva voce	-
Week-14	Quiz exam	
1		

Components		Grading	СО	<b>Blooms Taxonomy</b>
Continuous Assessment (40%)	Class performance	10%	CO1	C1
	Report Writing	30%	CO4	C2
Einal Exam	Lab test	30%		
$\Gamma$ IIIaI EXaIII	Viva	10%	CO1, CO2, CO3	C1, C3
(60%)	Quiz	20%		
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edition, Longman Scientific & Technical, 1989
- 2. G. D. Christian., Analytical Chemistry, 6th Edition, Wiley India Pvt. Limited, 2007

# **REFERENCE SITE**

# **Mathematics**

# Level 1 Term I

	COURSE INFORMATION		
Course Code Course Title	: MATH 101 : Differential and Integral Calculus	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		·
	None		

	CURRICULUM STRUCTURE											
	Outcome Based Education (OBF	E)										
	SYNOPSIS/ RATIONALE											
	Purpose of this course is to introduce basic knowledge of Differential Calculus and use it in engineering study.											
	OBJECTIVES											
	<ol> <li>Impart basic knowledge on differential and Integral Calculus to solve engineering problems and other applied problems.</li> <li>Developing understanding some of the important aspects of rate of change, area, tangent, normal and volume.</li> <li>To be expert in imparting in depth knowledge of functional analysis such as increasing, decreasing, maximum and minimum values of a function</li> </ol>											
	LEARNING OUTCOMES											
	<ol> <li>Upon completion of the course, the students will be able to-</li> <li>Define the limit, continuity and differentiability of functions, identify the rate of change of a function with respect to independent variables and describe the different techniques of evaluating indefinite and definite integrals.</li> <li>Apply the concepts or techniques of differentiation and integration to solve the problems related to engineering study.</li> <li>Calculate the length, area, volume, center of gravity and average value related to engineering study.</li> </ol>											
	COURSE OUTCOMES& GEN	NERIC SKILLS										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
CO1	<b>Define</b> the limit, continuity and differentiability of functions, <b>identify</b> the rate of change of a function with respect to independent variables and <b>describe</b> the different techniques of evaluating indefinite and definite integrals.	effine the limit, continuity and fferentiability of functions, entify the rate of change of a nction with respect to dependent variables and scribe the different chniques of evaluatingPO-1				3	T, F, ASG					
CO2	<b>Apply</b> the concepts or techniques of differentiation and integration to solve the problems related to engineering study.	PO-1	C3	1		3	T, Mid Term Exam, F					
CO3	Calculatethelength,area,volume,centerofgravityandaveragevaluerelatedtorelated1averagestudystudystudy3											
	(CP- Complex Problems, CA-Comp Quiz; ASG – Assignment; Pr – Pres	plex Activities, KP-I sentation; R - Report	Knowledge Pro ; F – Final Exa	file, T ım, M7	– Test Г- Mid	; PR – Term I	Project ; Q – Exam)					
	COURSE CONTENT											

	<ul> <li>Continuity and Differentiability, Successive Differentiation, Leibnitz's Theorem, Rolle's Theorem, Mean Value Theorem, Taylor's theorem, Expansion of Finite and Infinite forms, Lagrange's form of remainder, Cauchy's form of remainder, Expansion of functions differentiation and integration, Indeterminate form, Cartesian differentiation, Euler's theorem, Tangent, sub tangent and Normal, sub normal, Maxima and Minima, Curvature, Asymptotes, Partial differentiation.</li> <li>Integral Calculus: Definition of Integration, Importance of Integration in Eng., Integration by substitution, Integration by parts, Standard integrals, Integration by successive reduction, Definite integrals and its use, Integration as a limit of sum, summing series, Walli's formula, Improper Integrals, beta and gamma function, multiple integral and its application, Area, volume of solid revolution, Area under a plain curve, Area of the region enclosed by two curves, Arc lengths of curves.</li> </ul>														
	SKILL	MAPPING	(CO-PO MAPPING)	1											
		-		<u> </u>							~~`		(2.2)		
	No.	Course	Learning Outcome	1	2	P	ROC	jRA	M (			AES	(PO)	11	12
	CO1 CO2 CO3	Define diffein the fieldand physicalstructure, pebonding,chemical echemistry asolutions, plExplain diffthe field ereactions esreduction, SPolymerizatreactions etcSolve quantfield of inephysical chekinetics, ele	Learning Outcome erent basic parameters of inorganic, organic l chemistries., atomic eriodic table, chemical acids and bases, equilibrium, thermo- nd different types of hase rule etc. ferent basic theories in of selective organic such as Oxidation- bubstitution, Addition, ion, Alkylation c. itative problems in the organic, organic and emistry i.e. solutions, histry, chemical ectrical properties of	1 3 3 3	2	3	4	5	6	7	8	9	10	11	12
	(3 – Hig	h, 2- Medium,	1-low)					]					l	l	<u> </u>
IUSTIFICAT	ION FO	R CO.PO M	APPING												
Mapping	Corr	esponding of Matching				Jus	tific	ati	on						
CO1-PO1		3	The knowledge of mathematics, science and engineering sciences has to be applied to describe the complete concept of differential and integral calculus.												
CO2-PO1		3	To apply proper and the knowledge of r required.	imp nathe	rope emat	r int ics,	egra scie	l in ence	the an	fiel nd e	d of ngin	eng leeri	ineer ng so	ing st cience	udy, es is

CO3-PO1	3	In order to calculate volume, average, center of gravit solid revolution object, the knowledge of mathematics sciences is needed.	y and area of any s, and engineering					
<b>TEACHING I</b>	LEARNING STRATE	EGY						
Teaching and I	Learning Activities		Engagement (hours)					
	Face-to-Face Learnin	ng						
	Lecture		42					
	Practical / T	utorial / Studio	-					
	Student-Cen	tred Learning	-					
	Self-Directed Learning	ng						
	Non-face-to-	-face learning	84					
	Revision		21					
	Formal Assessment							
	Continuous .	Assessment	2					
	Mid-Term		l					
	Final Exami	nation	3					
	Total		153					
TEACHING N	METHODOLOGY							
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method						
COURSE SCI	HEDULE							
Weeks		Topics	Remarks					
	Introduction to Diffe	rential Calculus for Engineering study, Limit of a function	on					
	and its properties.							
Week-1	Basic limit theorems	s with proofs, Limit of infinity and infinite limit, Sandy	wich					
WCCK-1	(Squeezing) theorem with problems.							
	Concept of Different	tiation, definition, classification of discontinuity and solv	ving Class					
	problems		— Test 1.					
	Basic concept of	Differentiability, definition, derivative of a function	ⁿ , <b>Final</b>					
Week-2	differentiable function	n.						
	Differentiability – or	ne sided derivatives (R.H.D and L.H.D), solving problem	<u>s</u>					
	Successive differenti	ation – Concept and problem solving						
	Leibnitz's theorem a	nd its applications						
Week-3	Determination of $(y_n)$							
	Mean Value theorem	a, Taylor theorem						
	Expansion of finite	and infinite forms, Lagrange's and Cauchy's form	of					
Week-4	remainder.							
	Indeterminate forms	- concept and problem solving,						
	L'Hospital's rules wi		Liass					
	Partial differentiation	n - partial derivatives of a function of two variables	and Test 2,					
	problems	n montial desiructions of a home survey for the	<u> </u>					
Week-5	variables Euler's 4	n - partial derivatives of a nomogeneous function of	two Exam					
	Portial differentiation	portial derivatives of a homogeneous function of any	voral					
	variables Fuler's the	n - partial ucrivatives of a nonlogeneous function of several (three and m) variables and problem solv	ving					
	I randonos, Later s the	orem for several (unce and m) variables and problem sor	1111					

	Addition, Polymerization, Alkylation	
Week-6	Phase Rule: Basic terms and phase rule derivation	
	Phase Diagram of water and carbon dioxide	
	maxima and minima of functions of single variables – concept, Increasing and	
Weels 7	decreasing function, Concave up and down with problems	
week-/	Curvature	
	Asymptotes	
	Introduction to integral calculus	
Week-8	Standard integrals – concept of definite and indefinite integrals, applications.	
	Indefinite integrals – Method of substitution, Techniques of integration	
	Indefinite integrals – Integration by parts, Special types of integration, integration	Mid
W 1.0	by partial fraction,	Term,
week-9	Integration by the method of successive reduction	Final
	Definite integrals – definite integrals with properties and problems	Exam
	Definite integrals – Reduction formula, Walli's formula	
Week-10	Definite integrals – definite integral as the limit of the sum	
	Beta function – concept and problem solving	
	Gamma function - concept and problem solving	
Week 11	Relation between beta and gamma function, Legendre duplication formula,	
WCCK-11	problems and applications	
	Multiple integrals – double integrals	
	Multiple integrals – triple integrals	
Week-12	Multiple integrals – successive integration for two and three variables	Class
	Area in Cartesian	Test 3,
	Area in polar	Final
Week-13	Volume of solid revolution	Exam
	Area under a plain curve in Cartesian and polar coordinates	
	Area of a region enclosed by two curves in Cartesian and polar coordinates	
Week-14	Arc lengths of curves in Cartesian coordinates	
	Arc lengths of curves in polar coordinates	

	Components	Grading	CO	Blooms Taxonomy		
	Class Test/ Assignment	200/	CO1, CO2	C1, C2		
Continuous	Class Test/ Assignment	20%	CO 2	C3		
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO 3	C3		
	Mid term	10%	CO 2, CO3	C3		
			CO 1	CO 1		
	Final Exam	60%	CO 2	CO 2		
			CO 3	CO 3		
	Total Marks	100%				

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- Howard Anton, Irl C. Bivens, Stephen Davis, *Calculus*, 10th Edition, Wiley, 2012
   Morris Kline, *Calculus: An Intuitive and Physical Approach*, , 2nd Edition, Courier Corporation, 2013

# **REFERENCE SITE**

# Level 1 Term II

	COURSE INFORMATION												
Course Code Course Title	: MATH 103 : Differential Equations and Matr	rix	Lecture Conta Credit Hours	act Hour	rs	: 3.00 : 3.00	)						
	PRE-REQUISITE												
	MATH 101												
	CURRICULUM STRUCTURE												
	Outcome Based Education (OBE)												
	SYNOPSIS/ RATIONALE												
	Purpose of this course is to introduce basic knowledge to identify and solve differential equations and concept of matrix.												
	OBJECTIVES												
	<ol> <li>To impart basic knowledge on ordinary and partial differential equations.</li> <li>Developing understanding some of the important aspects of ordinary and partial differential equations.</li> <li>To provide knowledge on using concept of Differential equations and matrix in engineering problems and solve other applied problems.</li> <li>To be expert in imparting in depth knowledge on inverse matrix.</li> </ol>												
	LEARNING OUTCOMES												
	<ul> <li>Upon completion of the course, the students will be able to</li> <li>1. Define various types of differential equations and identify the classifications of partial differential equations.</li> <li>2. Apply the knowledge and solve ordinary and partial differential equations.</li> </ul>												
	COURSE OUTCOMES & GE	NERIC SKILLS	5										
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	<b>Define</b> various types of differential equations and <b>identify</b> the classifications of ordinary and partial differential equations.	POs       ne     various     types     of       rential equations and identify     PO 1       lassifications of ordinary and     al differential equations.					T, F, ASG						

CO2	Apply th and solv differenti	e knowledge to identify ve ordinary and partial al equations.	PO	l			C3		1				3	T, N	1T, F
CO3	Apply th inverse system of	e technique to obtain the matrix that <b>solve</b> the f linear equations.	PO 1	l			C3		1				3	MT, F	F, ASG
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)													et;Q-	
	COURS	SE CONTENT													
	<b>Differential Equations:</b> Introduction & Formulation of DE in Eng, Degree and order of ODE, solution of first order but higher degree DE by various methods, solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs, Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial, linear first order PDE, Non-linear first order PDE, Standard form DEs of higher order and wave equation, particular solutions with boundary and initial condition, Non-linear PDE of order one, Charpit's method, Linear PDE with constant coefficients, Applications of DE. <b>Matrix:</b> Definition of Matrix, different types of matrices, Algebra of Matrices, Transpose and adjoint of a matrix and inverse matrix, rank and elementary transformation, solution of linear equation or System of Linear Equation, Matrix polynomials determination characteristic roots and vectors, characteristic subspace of matrix and Eigen values and Eigen Vectors, Cayley Hamilton theorem														
	SKILL MAPPING (CO-PO MAPPING)														
	No.	Course Learning Ou	tcome	1	2	P 3	ROG	RAN		UTC	COM	IES 9	(PO) 10	11	12
	CO1	<b>Define</b> different basic pa in the field of inorganic and physical chemistries structure, periodic table, bonding, acids and chemical equilibrium, chemistry and different solutions, phase rule etc.	arameters , organic , atomic chemical bases, thermo- types of	3	2		T	<u> </u>		,	0	<u> </u>	10		12
	CO2	<b>Explain</b> different basic the field of selective reactions such as O reduction, Substitution, A Polymerization, A reactions etc.	neories in organic xidation- Addition, lkylation	3											
	CO3	<b>Solve</b> quantitative proble field of inorganic, org physical chemistry i.e. s thermochemistry, kinetics, electrical prop solution etc.	ms in the anic and solutions, chemical erties of	3											
JUSTIFICAT	(3 – High	n, 2- Medium, 1-low) R CO-PO MAPPING		_											

Mapping	Corresponding Level of Matching	Justification					
CO1-PO1	3	The knowledge of mathematics, science and engineering sciences has to be applied to describe the complete concept of differential and integral calculus.					
CO2-PO1	3	To apply proper and improper integral in the field of e the knowledge of mathematics, science and engine required.	ngineering study, ering sciences is				
CO3-PO1	3	In order to calculate volume, average, center of gravi solid revolution object, the knowledge of mathematic sciences is needed.	ity and area of any es, and engineering				
<b>TEACHING I</b>	LEARNING STRATE	EGY					
Teaching and I	earning Activities		Engagement (hours)				
	Face-to-Face Learnir Lecture Practical / Tr Student-Cen	ng utorial / Studio tred Learning	42				
	Self-Directed Learning Non-face-to-face learning Revision						
Formal Assessment Continuous Assessment Mid-Term Final Examination							
Total							
TEACHING N	METHODOLOGY						
Lecture and Di	scussion, Co-operative	and Collaborative Method, Problem Based Method					
COURSE SCI	HEDULE						
Weeks		Topics	Remarks				
	Introduction & Form	ulation of DE in Eng. Degree and order of ODE					
Week-1	Introduction & Form	ulation of DE in Eng. Degree and order of ODE					
	Introduction & Form	ulation of DE in Eng. Degree and order of ODE					
	Solution of first orde	r but higher degree DF by various methods					
Week 2	Solution of first orde	r but higher degree DE by various methods	Class				
W CCK-2	Solution of first orde	r but higher degree DE by various methods	Test 1				
	Solution of general	DEs of second and higher order. Solution of Ful	er's Final				
	homogeneous linear	DEs	Exam				
	Solution of general	DEs of second and higher order, Solution of Eu	ıler's				
Week-3	homogeneous linear	DEs					
	Solution of general homogeneous linear	DEs of second and higher order, Solution of Eu DEs	uler's				
	Solution of DEs by	methods based on factorization Frobenious metho	ods.				
	Bessel's functions L	egendre's polynomial	Class				
Week-4	Solution of DEs by n	hethods based on factorization. Frobenious methods. Bes	ssel's Test 2.				
	functions, Legendre's	s polynomial					

	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	Final Exam			
	Linear first order PDE, Non-linear first order PDE	LAIII			
Week-5	Standard form DEs of higher order and wave equation				
	Standard form DEs of higher order and wave equation				
_	Particular solutions with boundary and initial condition, Non-linear PDE of				
	order one: Charpit's method				
Wester C	Particular solutions with boundary and initial condition, Non-linear PDE of order				
Week-6	one: Charpit's method				
	Particular solutions with boundary and initial condition, Non-linear PDE of order				
	one: Charpit's method				
	Linear PDE with constant coefficients, Applications of DE				
Week-7	Linear PDE with constant coefficients, Applications of DE				
	Linear PDE with constant coefficients, Applications of DE				
	Wave equations				
Week-8	Particular solutions with boundary and initial conditions				
	Particular solutions with boundary and initial conditions				
	Second order PDE and classifications to canonical (standard)- parabolic, elliptic,				
	hyperbolic solution by separation of variables,				
Week 0	Second order PDE and classifications to canonical (standard)- parabolic, elliptic,	Term,			
Week-9	hyperbolic solution by separation of variables,				
	Second order PDE and classifications to canonical (standard)- parabolic, elliptic,				
	hyperbolic solution by separation of variables,				
	Application of OD and PDE in Eng study				
Week-10	Definition of Matrix, different types of matrices, Algebra of Matrices,				
	Transpose and adjoint of a matrix and inverse matrix				
	Solution of linear equation or System of Linear Equation				
Week-11	Solution of linear equation or System of Linear Equation				
	Solution of linear equation or System of Linear Equation				
	Solution of linear equation using Inverse Matrix				
Week-12	Rank, Nullity and elementary transformation				
	Rank, Nullity and elementary transformation	Class			
	Dependent and independent of vectors	Test 3,			
Week-13	Dependent and independent of vectors with examples	Final			
	Matrix polynomials determination characteristic roots and vectors	Exam			
	Characteristic subspace of matrix and Eigen values and Eigen Vectors,				
Week-14	Characteristic subspace of matrix and Eigen values and Eigen Vectors,				
	Cayley Hamilton theorem and its application. Finding inverse matrix using this theorem				

Components		Grading	СО	<b>Blooms Taxonomy</b>
Continuous Assessment (40%)	Class Test/ Assignment	20%	CO1, CO2	C1, C2
		2070	CO 2	C3
	Class Participation and Class attendance	5+5= 10%	CO 3	C3

	Mid term	10%	CO 2, CO3	C3			
			CO 1	C1, C2			
Fii	nal Exam	60%	CO 2	C3			
			CO 3	C3			
То	tal Marks	100%					
(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS							
1. Howard Anto 2019	<ol> <li>Howard Anton, Chris Rorres, Anton Kaul, <i>Elementary Linear Algebra</i>, 12th Edition, John Wiley &amp; Sons, 2019</li> </ol>						
2. Dr. M.D. Rais	singhania , <i>Ordinary and F</i>	Partial Differentia	l Equations, S.Chano	l Publishing, 2013			
<b>REFERENCE SIT</b>	ГЕ						

# Level 2 Term I

	COURSE INFORMATION						
Course Code Course Title	: MATH 201 : Vector Analysis, Laplace Transform and Coordinate Geometry	Lecture Contact Hours Credit Hours	: 3.00 : 3.00				
	PRE-REQUISITE						
	MATH 101 and MATH 103						
	CURRICULUM STRUCTURE						
	Outcome Based Education (OBE)						
	SYNOPSIS/ RATIONALE						
	Purpose of this course is to introduce basic knowledge to identify and solve vector mathematical problems, to demonstrate practical applications of Laplace Transform and analyze co-ordinate geometry.						
	OBJECTIVES						
	<ol> <li>To impart basic knowledge on the vector analysis, Laplace transform and geometry.</li> <li>To familiarize the students with straight lines, pair of straight lines, circles, conics in 2D and 3D co-ordinate systems.</li> <li>To find the length, volume and area of objects related to engineering study by using vector, application of Laplace transforms to ordinary differential equations and also solve the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.</li> </ol>						

	LEARNING OUTCOMES							
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Know the physical explanation of different vector notation and Define Laplace transform, inverse Laplace transform, different types of matrices, and their properties.</li> <li>Explain the characteristics of conics and familiarize with straight lines, pair of straight lines, circles, radical axis and center in 2D and 3D co-ordinate systems.</li> <li>Calculate length, volume and area of objects related to engineering study by using vector, Apply Laplace transform to ODE and PDEs and the knowledge of geometry in engineering study. Solve the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.</li> </ol>							
	COURSE OUTCOMES & GE	NERIC SKILLS		1	T	1		
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods	
CO1	<b>Know</b> the physical explanation of different vector notation and <b>Define</b> Laplace transform, inverse Laplace transform, different types of matrices, and their properties.	PO-1	C1-C2	1	-	3	T, F, ASG	
CO2	<b>Explain</b> the characteristics of conics and familiarize with straight lines, pair of straight lines, circles, radical axis and center in 2D and 3D co-ordinate systems.	PO-1	C2	1	-	3	T, MT, F	
CO3	Calculate length, volume and area of objects related to engineering study by using vector, Apply Laplace transform to ODE and PDEs and the knowledge of geometry in engineering study. Solve the problems of the pair of straight lines, circles, system of circles, parabola, ellipse etc.	PO-1	C3	1	-	3	MT, F, ASG	
	(CP- Complex Problems, CA-Comp Quiz; ASG – Assignment; Pr – Pres	plex Activities, KP-l sentation; R - Report	Knowledge Pro ; F – Final Exa	ofile, T m, MT	- Test - Mid	t ; PR - Term I	– Project ; Q – Exam)	
	COURSE CONTENT							

**Vector Analysis:** Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation, Triple products and multiple products, Linear dependence and independence of vectors, Differentiation of vectors, Gradient of scaler functions, Divergence and curl of point functions, physical significance of gradient, divergence and curl, Definition of line, surface and volume integral, Integration of Vectors, Green's theorem and its application, Stoke's theorem and its application, Gauss theorem and its application in Engineering.

**Laplace Transform:** Definition of LT and Application of LT for Engineering , LT of some elementary functions and properties of LT, Sufficient condition for existence of LT, Inverse LT, LT of derivatives, Unit step function, Periodic function, Some special theorems on LT, Partial fraction, Solution of DEs by LT, Heaviside expansion formula, Convolution theorem, Evaluation of improper integral, Application of LT.

**Co-ordinate Geometry:** Introduction to geometry for Engineering and Rectangular coordinates, Transformation of co-ordinates, changes of axes, pair of straight lines, general equation of second degree and reduction to its standard forms and properties, circles (tangents, normal, chord of contact, pole and polar), Equation of conics, homogeneous equations of second degree, angle between straight lines, pair of lines joining the origin to the point of intersection of two given curves, equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points), Three dimensional co-ordinate system, direction cosines, projections, the plane (angle between two planes, parallel & perpendicular plane, distance of a point from a plane) and the straight line (coplanar lines, shortest distance between two given straight lines), standard equation of sphere, ellipsoid, hyperboloid straight lines, standard equation of coincides, sphere and ellipsoid.

#### SKILL MAPPING (CO-PO MAPPING)

JU

No Course Learning Outcome	PROGRAM OUTCOMES (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12
<ul> <li>Know the physical explanation of different vector notation and</li> <li>Define Laplace transform, inverse Laplace transform, different types of matrices, and their properties.</li> </ul>	3											
CO2 <b>Explain</b> the characteristics of conics and familiarize with straight lines, pair of straight lines, circles, radical axis and center in 2D and 3D co-ordinate systems.	3											
<ul> <li>Calculate length, volume and area of objects related to engineering study by using vector,</li> <li>Apply Laplace transform to ODE and PDEs and the knowledge of geometry in engineering study.</li> <li>Solve the problems of the pair of straight lines, circles, system of interval of the straight lines.</li> </ul>	3											

Mapping	Corresponding Level of Matching	Justification					
CO1-PO1	3	The knowledge of mathematics, science and engineering sciences has to be applied to describe the complete concept of differential and integral calculus.					
CO2-PO1	3	To apply proper and improper integral in the field of e the knowledge of mathematics, science and engine required.	Fo apply proper and improper integral in the field of engineering study, the knowledge of mathematics, science and engineering sciences is required				
CO3-PO1	3	In order to calculate volume, average, center of gravity and area of any solid revolution object, the knowledge of mathematics, and engineering sciences is needed.					
<b>TEACHING I</b>	LEARNING STRATE	GY					
Teaching and I	Learning Activities		Engagement (hours)				
	Face-to-Face Learning	g					
	Lecture		42				
	Practical / Tu	torial / Studio	-				
	Student-Cent	red Learning	-				
	Self-Directed Learning						
	Non-race-to-race learning						
	Formal Assessment		21				
	Continuous Assessment						
	Mid-Term						
	Final Examin	ation	3				
	Total		153				
TEACHING N	METHODOLOGY						
Lecture and Di	scussion, Co-operative	and Collaborative Method, Problem Based Method					
COURSE SCI	HEDULE						
Weeks		Topics	Remarks				
	Definition of Vector a	nd scalers & vector algebra, Scaler and vector products	s of				
	two vectors and their	geometrical interpretation					
Week-1	Definition of Vector and scalers & vector algebra, Scaler and vector products of						
	two vectors and their	geometrical interpretation					
	Definition of Vector a	and scalers & vector algebra, Scaler and vector produc	ts of				
	Triple products and m	geometrical interpretation	Class				
	vectors Differentiation	in of vectors	<b>Test 1,</b>				
Week-2	Gradient of scaler fun	ctions Divergence and curl of point functions	— Final				
	Physical significance	of gradient, divergence and curl	Exam				
	Definition of line. sur	face and volume integral. Integration of Vectors. Gree	en's				
	theorem and applicati	on	-				
Week-3	Definition of line, su	rface and volume integral, Integration of Vectors, Gr	een's				
	theorem and applicati	on					
	Green's theorem and it's application						

	Gauss theorem and application in Engineering					
Week-4	Stoke's theorem and it's application.					
WCCK-4	Introduction to geometry for Engineering and Rectangular co-ordinates,					
	Transformation of co-ordinates					
Week-5	Introduction to geometry for Engineering and Rectangular co-ordinates,					
	Transformation of co-ordinates, changes of axes, pair of straight lines, general					
	equation of second degree and reduction to its standard forms and properties					
	Changes of axes, pair of straight lines, general equation of second degree and					
	reduction to its standard forms and properties					
	Changes of axes, pair of straight lines, general equation of second degree and					
	reduction to its standard forms and properties					
	Circles (tangents, normal, chord of contact, pole and polar), Equation of	Class				
	conics, homogeneous equations of second degree, angle between straight lines,	Test 2,				
	pair of lines joining the origin to the point of intersection of two given curves	Final				
	Circles (tangents, normal, chord of contact, pole and polar), Equation of conics,	Exam				
Week-6	homogeneous equations of second degree, angle between straight lines, pair of					
	lines joining the origin to the point of intersection of two given curves					
	Circles (tangents, normal, chord of contact, pole and polar), Equation of conics,					
	homogeneous equations of second degree, angle between straight lines, pair of					
	Circles (tensents, normal, shard of contrast, nole and noles). Equation of					
	Circles (tangents, normal, chord of contact, pole and polar), Equation of					
	comes, nonogeneous equations of second degree, angle between straight lines,					
Weels 7	Equations of parabola allings in Contacion and polar acardinates, guatem of simples					
Week-/	redicel avec coavial circles limiting points					
	Faustions of parabola allipso in Cartagian and polar coordinates, system of circles					
	(radical axes, coaxial circles, limiting points					
	Fauations of parabola ellipse in Cartesian and polar coordinates system of					
	circles (radical axes, coaxial circles, limiting points					
	Equations of parabola ellipse in Cartesian and polar coordinates system of circles					
Week-8	(radical axes, coaxial circles, limiting points					
	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles					
	(radical axes, coaxial circles, limiting points					
	Three dimensional co-ordinate system, direction cosines, projections, the plane					
	(angle between two planes, parallel & perpendicular plane, distance of a point					
	from a plane) and the straight line (coplanar lines, shortest distance between two					
	given straight lines), standard equation of sphere, ellipsoid, hyperboloid	Mid				
	Three dimensional co-ordinate system, direction cosines, projections, the plane	Term,				
Weels 0	(angle between two planes, parallel & perpendicular plane, distance of a point	Final				
Week-9	from a plane) and the straight line (coplanar lines, shortest distance between two	Exam				
	given straight lines), standard equation of sphere, ellipsoid, hyperboloid					
	Three dimensional co-ordinate system, direction cosines, projections, the plane					
	(angle between two planes, parallel & perpendicular plane, distance of a point					
	from a plane) and the straight line (coplanar lines, shortest distance between two					
	given straight lines), standard equation of sphere, ellipsoid, hyperboloid					
	Three dimensional co-ordinate system, direction cosines, projections, the plane					
Week-10	(angle between two planes, parallel & perpendicular plane, distance of a point					
WCCK-10	from a plane) and the straight line (coplanar lines, shortest distance between					
	two given straight lines), standard equation of sphere, ellipsoid, hyperboloid					

	Definition of LT and Application of LT for Engineering, LT of some elementary	
	functions and properties of LT	
	Definition of LT and Application of LT for Engineering, LT of some elementary	
	functions and properties of LT	
	Sufficient condition for existence of LT	
Week-11	LT of derivatives and it's application	
	LT of Integration with application, LT of sine and cosine integral	
	Unit step function and it's application	
Week-12	Periodic function with examples, LT of some special function.	
	Definition of inverse Laplace Transform and it's properties	
	Partial fraction and it's application in inverse Laplace Transform	
Week-13	Heaviside formula and it's application	
	Convolution theorem, Evaluation of improper integral, Application of LT	Exam
	Solve ODE s by Laplace transform	
Week 14	Solve DDE a hy Laplace transform	
week-14		
	Application of LT in Eng study	

Co	omponents	Grading	СО	Blooms Taxonomy
	Class Test/ Assignment	20%	CO1, CO2	C1, C2
Continuous	1-3	20%	CO 2	C3
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO 3	C1-C3
	Mid term	10%	CO2, CO3	C1, C2
			CO1	C1, C2
Final Exam		60%	CO2	C2
			CO3	C3
Te	otal Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, *Vector Analysis*, USA: McGraw-Hill Education, 2009.
- 2. Spiegel, Murray R., and José D. Arias Páez. "Schaum's outline of laplace transformsTransformadas de laplace" *Schaum*, 1998..
- 3. Kandasamy, P., K. Thilagavathy, and K. Gunavathy. *Engineering Mathematics*. India:S. Chand, 1986.

#### **REFERENCE SITE**

# Level 2 Term II

	COURSE INFORMATION										
Course Code Course Title	: MATH 209 : Fourier Analysis, Complex Variabl Statistics	e and Lec Cre	Lecture Contact Hours: 3.00Credit Hours: 3.00								
	PRE-REQUISITE										
	MATH 101 and MATH 103										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	To teach the students the basic concepts and principles of complex variables, Fourier transform and statistics. It is targeted to provide a basic foundation for mathematics areas Complex number system, Fourier expansion, grouped sample data hypothesis etc. Finally, this course is designed to develop a capability of solving real life problems through complex variable, Fourier integrals and statistics.										
	OBJECTIVES										
	<ol> <li>To understand basic knowledge of complex runnoer system, Fourier transformation off feat and complex function and also be expert in recognizing about frequency distribution, Graphical representation of data including stem, moments, Skewness, Kurtosis, grouped sampled data, Estimation, Tests of hypothesis.</li> <li>To familiarize the students with the principle terms such as complex variables, fourier transform and statistics.</li> <li>To provide a physical interpretation of the boundary value problem, Complex Variable and calculating sample data, skewness, kurtosis and related hypothesis test. And also be expert in applying Fourier Analysis, Complex Variables, statistics and their methods of solution in</li> </ol>										
	LEARNING OUTCOMES										
	<ol> <li>Upon completion of the course, the students will be able to</li> <li>Recognize and define complex number system, complex variable, Fourier expansion and express the definition and use of the statistical properties.</li> <li>Interpreting the complex function, the integrals of complex functions, Fourier integral and explaining the concept of a frequency distribution, moments, Skewness, Kurtosis, grouped sampled data etc.</li> <li>Measure the integrals of complex functions, Fourier integral and solving the differential equations using Fourier transform, complex engineering problem using them and also implement engineering problem based on frequency and statistical sampling distribution and determine null and alternative hypothesis.</li> </ol>										
No.	Course Learning Outcome	Correspondin	g Bloom's	СР	CA	KP	Assessment				
CO1	<b>Recognize and define</b> complex number system, complex variable, Fourier expansion and <b>express</b> the	POs PO1	C1-C2	1		1	Methods T, F, ASG				

	definitio	n and use of the statistical													
CO2	Integrals integral a a freque Skewnes data etc.	<b>eting</b> the complex function, the of complex functions, Fourier and <b>explaining</b> the concept of ency distribution, moments, as, Kurtosis, grouped sampled	PO1			C2		1		-	1, 2	T, M	T, F		
CO3	Measure functions the differ transforr problem impleme on frequ distributi alternativ	e the integrals of complex s, Fourier integral and <b>solving</b> rential equations using Fourier n, complex engineering using them and also <b>ent</b> engineering problem based lency and statistical sampling ion and <b>determine</b> null and we hypothesis		(	C2-C3		1		-	1, 2	МТ	, F			
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)														
	COURS	COURSE CONTENT													
	<ul> <li>Fourier Analysis: Real and complex form. Finite transform: Fourier Integral. Fourier transforms and their uses in solving boundary value problems.</li> <li>Complex Variables. Complex number system, General functions of a complex variable, Limits and continuity of a function of complex variable and related theorems, Complex function, differentiation and the Cauchy-Riemann Equations. Line integral of a complex function, Cauchy's Integral Formula, Liouville's Theorem, Taylor's and Laurent's Theorem, Singular Residues, Cauchy's Residue Theorem.</li> </ul>											urier able, plex plex ent's			
	Statisti scores, Box Pl groupe	Frequency distribution, Gra ot, moments, Skewness, I d sampled data, Estimation	ndency, s aphical re Kurtosis. , Tests of	stand prese Elen hypo	ard enta nent othe	deviat tion of tary sa	ion, data impl gress	Che ing ing	ebyc cludi theo and	ing sory,	s th stem Tre relat	tion	n, z- f and nt of		
	SKILL	MAPPING (CO-PO MAPP	PING)												
						PROGR	AM	OUT	COM	ES (F	PO)				
	No.	Course Learning Outcome	1	2	3	4 5	6	7	8	9	10	11	12		
	CO1	<b>Recognize and define</b> con number system, complex van Fourier expansion and <b>expre</b> definition and use of the stat properties.	mplex riable, ss the 3 istical												
	CO2	<b>Interpreting</b> the complex func- the integrals of complex func- Fourier integral and <b>explainin</b> concept of a frequency distrib moments, Skewness, Ku grouped sampled data etc.	nction, ctions, ng the pution, rtosis,												

	CO3 Mu so us en als pro sta de hy (3 – High, 2-1	Measure the integrals of complex functions, Fourier integral and solving the differential equations using Fourier transform, complex engineering problem using them and also implement engineering problem based on frequency and statistical sampling distribution and determine null and alternative hypothesis 2- Medium, 1-low)												
JUSTIFICAT	ION FOR C	O-PO M	APPING											
Mapping	Correspon Level of M	ding atching	Justification											
CO1-PO1	3	3 In order to be able to <b>infer/illustrate</b> the physics of se and the operation of different electronic component fundamental idea about basic electronics, the knowled natural science, engineering fundamentals and specialization to the solution of complex engineer applied.						of ser onen owlee and ineer	f semiconductor devices onents for strengthening owledge of mathematics, and an engineering neering problems is to					
CO2-PO1	3	3 In order to be able to compare the input and out different electronic components, the knowledge of science, engineering fundamentals and an engineering solution of complex engineering problems is to appli							outpo of n ering pplie	utput characteristics of of mathematics, natural ing specialization to the plied.				
CO3-PO1	3		In order to be able to system models to ex knowledge of mathem an engineering spec problems is to applied	anal plor natic ializ d.	yse e pr s, na atioi	basio actic atura n to	c ele cal c l scie the	ctroni omple ence, solut	c circ ex en engin tion (	cuits gine leerin of co	cons ering ng fu ompl	iderin g prol ndam lex en	ng exi blems nental ngine	isting s, the s and ering
<b>TEACHING</b>	LEARNING	STRATE	EGY											
Teaching and I	Learning Acti	vities									]	Engaş (hc	geme ours)	nt
	Face-to-Fac	ce Learnir	ıg										10	
	Leo Pra	cture actical / Ti	utorial / Studio									2	+2 -	
	Stu	ident-Cen	tred Learning										-	
	Self-Direct	ed Learnin	ng											
	No Re	n-face-to- vision	face learning									2	54 21	
	Formal Ass	sessment										2	-1	
	Co	ntinuous A	Assessment										2	
	Mi Fin	Mid-Term Final Examination										1 3		
	Total											1	53	
TEACHING	METHODO	LOGY												
Lecture and D	soussion Co	operativa	and Collaborative Ma	thed	Der	bla	n De	need N	lothe	d				
	Scussion, CO	-operative		uiod	, 170	Joiei	пБа	iseu N	remo	u				
COURSE SCI	HEDULE													

Weeks	Topics	Remarks					
	Basic idea about Fourier Series						
Week-1	Real form of Fourier Series						
	Complex form of Fourier Series, Fourier expansion of different functions						
	Finite transform: Finite Fourier sine transform						
Week-2	Finite Fourier cosine transform	Class Test					
	Infinite Fourier cosine and sine transforms, Fourier Integrals	I, Final					
	Complex form of Fourier Integrals, Convolution function and Convolution theorem						
Week-3	Fourier transforms in solving boundary value problems						
	Fourier transforms in solving boundary value problems with physical interpretation						
	Complex number system, Complex Variables						
Week-4	Basic operations on complex numbers						
	Basic operations on complex variables						
	Absolute value property, Complex conjugate						
Week-5	Graphical presentation of complex number and variable						
	Polar form of complex numbers	Class Test					
	Graphical representation in polar form	2, Final					
Week-6	Euler formula, De Moivre's Theorem						
	Roots of complex number						
	General functions of a complex variable						
Week-7	Limits of a function of complex variable and related theorems						
	Continuity of a function of complex variable, Continuity of a function of complex variable and related theorems						
	Differentiation of a complex function						
Week-8	The Cauchy-Riemann Equation	Mid Term Final					
	Line integral of a complex function, Cauchy's Integral Formula						

	Cauchy's Residue Theor	Cauchy's Residue Theorem, Liouville's Theorem											
Week-9	Taylor's Theorem												
	Laurent's Theorem												
	Singular Residues												
Week-10	Introduction to Statistics	8											
	Measure of central tende	ency, Standard de	eviation										
	Chebychev's theorem, Z	Z-scores											
Week-11	Frequency distribution												
	Graphical representation	Graphical representation of data including stem											
	Leaf and Box Plot												
Week-12 Skewness – concepts													
	Moments– concepts C												
	Moments- problems				<b>3</b> , Final								
Week-13	Kurtosis – concepts, pro	blems											
	Estimation												
	Regression and correlati	on – concepts											
Week-14	Regression and correlati	on – problems											
	Tests of hypothesis												
ASSESSMEN	Г STRATEGY												
	Components	Grading	- CO	Blooms Ta	ixonomy								
	Class Test/	Grading	CO1. CO2	C1. 0	C2								
Continuous	Assignment 1-3	20%	CO3	C2, 0	C3								
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1, CO2, CO3	C1, C2	2, C3								
	Mid term	10%	CO 2, CO3	C1, C2	2, C3								
	Einel Energy (0)( CO 1 CO 1												
	Final Exam	60%	CO 2	CO	2								
			CO 3	CO	3								
	Total Marks	100%											

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

- 1. Murray R. Spiegel, *Fourier Analysis with Applications to Boundary Value Problems* Schaum's Out-line Series.
- 2. Murray R. Spiegel, *Complex variable* (2nd ed) Schaum's Out-line Series.
- 3. B. Praba, Aruna Chalam and Sujatha, Statistics and Random Processes
- 4. Scheaffer & McClave, Probability and Statistics for Engineers
- 5. John J. Schiller Jr, John J. Schiller Jr and Murray R. Spiegel, *Probability and Statistics* Schaum's Outline, 4th Edition

#### **REFERENCE SITE**

### **Humanities**

### Level 1 Term II

	COURSE INFORMATION											
Course Code	: GEBS 101	Lecture Contact Hours	: 2.00									
Course Title	: Bangladesh Studies	Credit Hours	: 2.00									
	PRE-REQUISITE											
	None											
	CURRICULUM STRUCTURE											
	Outcome Based Education (OBE)	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE											
	This course has been designed for undergrad the rich history of Bangladesh, and to prov events which eventually led to the forr Bangladesh, current trends in economic dev aspects which will make them responsible c	duate engineering students to ride them with basic knowled nation of Bangladesh and elopment, legislation, citizen ritizen.	help them learn dge of historical constitution of charter, cultural									
	OBJECTIVES											
	<ol> <li>To equip students with factual knowled of Bangladesh.</li> <li>To trace the historical roots of Banglad social, cultural and economic develo independence.</li> <li>To promote an understanding of the dev</li> <li>To create an awareness among the stude and Culture of Bangladesh.</li> </ol>	<ol> <li>OBJECTIVES</li> <li>To equip students with factual knowledge that will enable them to learn the history of Bangladesh.</li> <li>To trace the historical roots of Bangladesh as an independent state focusing on the social, cultural and economic development those have taken place since its independence.</li> <li>To promote an understanding of the development of Bangladesh and its culture.</li> <li>To create an awareness among the students about the Geography, Economy, Politics</li> </ol>										

	LEARNING OUTCOMES												
	Upon completion of the course the st	udents will be a	ble to										
	<ol> <li>Identify specific stages of 1 medieval, colonial and post- cultural identities of Banglade</li> <li>Explain the economy and pa quantitative analysis.</li> </ol>	Bangladesh's p colonial perio sh. atterns of econ	political his ods and crit	tory, ically ges th	throu anal rough	igh tl yze p qual	he ancient, plurality of litative and						
	COURSE OUTCOMES & GENE	RIC SKILLS		1	T	1							
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	IdentifyspecificstagesofBangladesh'spoliticalhistory,throughtheancient,medieval,colonialand post-colonialperiodsandcriticallyanalyzepluralityofculturalidentitiesofBangladesh.DeDe												
CO2	<b>Explain</b> the economy and patterns of economic changes through qualitative and quantitative analysis.	PO-6	C2	-	-	-	T, F, MT						
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)												
	COURSE CONTENT												
	<ol> <li>COURSE CONTENT</li> <li>Bangladesh Geography: Location, Area, Boundary, Physiography, River system, Forest and Climate, Demography of Bangladesh, Maritime zones.</li> <li>History: Overview of the ancient Bengal; anthropological identity of the Bengali race; main trends in the history of medieval Bengal; Bengal under the East India Company; religious and social reform movements; nationalist movements, division of the Indian sub-continent; language movement 1948-1952; education movement of 1962; six-point movement of 1966; mass uprising of 1969; war of independence and emergence of Bangladesh in 1971, Constitution of Bangladesh, Political Development and Democratic Transition (1971-1990), Political Development (1991- Present), Bangladesh's contribution to world peace and its security, engineering development in Bangladesh (Kaptai Dam, Padma bridge, power plants, Karnaphuli River Tunnel etc ) and its impact on socio-economic aspect .</li> <li>Environment, Economy and Culture: Land, Characteristics of tropical monsoon climate, Forests and biomass, Fish, Minerals, Health, Education, Agriculture, Industries, NGOs, Population, Sociological and Cultural aspects of Bangladesh, Economy and National development, Development and Progress of the Millennium Development Goals (MDGs),</li> </ol>												
	Resources, Bangladesh and Inter	mational Relatio	ns.										

	No.	Course	Learning Outcome	1		Pl	ROC	GRA	M (	DUT	COM	1ES	(PO)	11	10
	CO1	Identify Bangladesh through th colonial and and critical cultural ider	specific stages of s political history, e ancient, medieval, d post-colonial periods y <b>analyze</b> plurality of utities of Bangladesh.	1	2	3	4	5	6	/	8	9	10	11	12
	CO2	<b>Explain</b> the of econom qualitative analysis.	economy and patterns hic changes through and quantitative						1						
	(3 – Hig	(3 – High, 2- Medium, 1-low)													
JUSTIFICA	TION F	OR CO-PC	MAPPING												
Mapping	Corresp	oonding f Matching	Justification												
CO1- PO6		1	In order to identify spe ancient, medieval, co plurality of cultural ide contextual knowledge t the consequent response solutions to complex er	ecifio lonia ntitie o ass sibili ngine	c stag al ar es of ess s ties eering	ges o d po Bang ociet celev g pro	f Ba ost-c glade al, h ant blen	angl colo esh, iealt to p ns is	ades nial app th, sa profe s req	sh's per licat afety ession uireo	ooliti iods ion o , lega nal e 1.	ical l and f rea al and ngin	nistory criti soning d cultu eering	y, thro cally g info ural is g prac	ough th analyz rmed b sues ar tice ar
CO2- PO6		1	In order to explain the qualitative and quant contextual knowledge to the consequent response solutions to complex er	ne e itativ o ass sibili ngine	cono ve a sess s ties ering	my a nalys ociet relev g pro	and is, cal, h ant blen	pat app lealt to p ns is	terns licat th, sa profe s req	s of ion afety ession uireo	econ of 1 , lega nal e 1.	nomi easo al ano ngin	c cha ning d cultu eering	inges infor ural is g prac	throug med t sues ar tice ar
TEACHING		NC STDAT	EGY												
	LEARNI	NGSIKAI													
Teaching and	LEARNI Learning	Activities											E	ngago (hou	ement irs)
Teaching and	LEARNI Learning Face-to	Activities -Face Learni Lecture Practical / 7 Student-Ce	ng Sutorial / Studio Stred Learning										E	ngago (hou 28 -	ement irs) 3
Teaching and	LEARNI Learning Face-to Self-Di	Activities -Face Learni Lecture Practical / 7 Student-Cerritory rected Learn Non-face-to Revision	ng Futorial / Studio htred Learning ing b-face learning										E	ngago (hou - - - 50 14	ement irs) 3 5 4
Teaching and	LEARNI Learning Face-to Self-Di Formal	Activities -Face Learni Lecture Practical / 7 Student-Cer rected Learn Non-face-to Revision Assessment Continuous Mid-Term Final Exam	ng Futorial / Studio ntred Learning ing o-face learning Assessment ination										E	ngag (hou - - 50 14 1 1 3	ement irs) 3 5 4
Teaching and	LEARNI Learning Face-to Self-Di Formal Total	Activities -Face Learni Lecture Practical / T Student-Cer rected Learn Non-face-to Revision Assessment Continuous Mid-Term Final Exam	ng Futorial / Studio <u>ntred Learning</u> ing -face learning Assessment ination										E	ngag (hou - - 50 14 1 1 3 10	ement urs) 3 5 4 3

COURSE SCI	HEDULE	
Weeks	Topics	Remarks
Week-1	Bangladesh Geography: Location, Area, Boundary, Physiography, River System, Forest and Climate. The People of Bangladesh, Demography of Bangladesh.	Class Test
Week-2	History: Overview of the ancient Bengal; anthropological identity of the Bengali race: main trends in the history of medieval Bengal	1, Final
Week-3	Bengal under the East India Company; religious and social reform movements; nationalist movements, division of the Indian sub-continent	Exam
Week-4	Language movement 1948-1952; education movement of 1962; six-point movement of 1966: mass uprising of 1969	
Week-5	War of independence and emergence of Bangladesh in 1971	Class Test
Week-6	Constitution of Bangladesh, Political Development and Democratic Transition (1971-1990)	2, Final Exam
Week-7	Political Development (1991-Present), Bangladesh's contribution to world peace and its security	
Week-8	Environment, Economy and Culture: Land, Characteristics of tropical monsoon climate, Forests and biomass, Engineering development in Bangladesh (Kaptai Dam, Padma bridge, power plants, Karnaphuli River Tunnel etc ) and its impact on socio-economic aspect	Mid Term
Week-9	Fish, Minerals, Health, Education, Agriculture, Industries, NGOs, Population, Sociological and Cultural aspects of Bangladesh	, Final Exam
Week-10	Economy and National development, Development and Progress of the Millennium Development Goals (MDGs), Public Administration in Bangladesh, State of Good Governance in Bangladesh	
Week-11	Art and Literature, Main traditional cultural events	
Week-12	Vision-2021, Digitalization, Tourism and Natural Resources	Class Test
Week-13	Bangladesh and International Relations	Exam
Week-14	Revision	

	Components	Grading	CO	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1- 3)	20%	CO1, CO2	C1, C2
Assessmen t (40%)	Class Participation and Class attendance	5+5=10%	CO1	C1, C2
	Mid term	10%	CO1, CO2	C1, C2
Final Examination		60%	CO1, CO2	C1, C2
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

# **REFERENCE BOOKS**

- 1. Md. Shamsul Kabir Khan and Daulatunnahar Khanam, Bangladesh Studies
- 2. The Constitution of the People's Republic of Bangladesh
- 3. Akbar Ali Khan, Discovery of Bangladesh
- 4. Sirajul Islam, History of Bangladesh, vols: 1-3
- 5. R C Majumdar, History of Modern Bengal, vol: 1
- 6. Dr. Abdul Mumin Chowdhury, Dynastic History of Bengal
- 7. William Van Schendel, A History of Bangladesh
- 8. Harun Er Rashid, *Geography of Bangladesh*
- 9. Sirajul Islam, Banglapedia: National Encyclopedia of Bangladesh, vols: 1-10
- 10. R. A. Chandra, *History of Bengal (Mughall Period 1526-1765)*
- 11. Nitesh Sengupta , Land of Two Rivers
- 12. A History of Bangladesh: Cambridge University Press

#### **REFERENCE SITE**

# Level 1 Term II

	COURSE INFORMATION	[	Γ								
Course Code	: LANG 102	Lecture Contact Hours	: 3.0								
Course Title	: Communicative English-I	Credit Hours	: 1.5								
	PRE-REQUISITE		•								
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	The English language course is designed for the communication skills for academic purposes em- writing. The approach will be communicative an and group work. Students will be exposed to diffe- skill. Reading will also involve activities and discu- incorporates a wide range of reading texts to deve- the most essential elements required to write a particularly put on the various forms of essay writ compare-contrast, and argumentative. Upon comp be able to communicate at various situations, par speech for academic, professional and social purp instructions to provide guidelines on presentation course emphasizes on providing constructive feed	ne students to develop the phasizing in speaking, read d interactive and will involve rent types of texts to develop assions leading to effective we elop students' critical thinking good piece of academic writing such as descriptive, narra- poletion of this course, studen ticipate in group activities an poses. This course also incor- ns and communication skills back on students' oral perfor	ir competence in ing, listening and ve individual, pair p efficient reading writing. The course ng which is one of ting. Emphasis is tive, cause-effect, tts are expected to and prepare formal porates classroom s. In addition, the rmances.								
	OBJECTIVES										

	<ol> <li>To develop English language skills to communicate effectively and professionally.</li> <li>To strengthen students' presentation skills.</li> <li>To develop competency in academic reading and writing.</li> </ol>												
	LEARNING OUTCOMES												
	Upon completion of the course, the	e students will be a	able to										
	<ol> <li>Understand the techniques of academic reading and become familiar with technical terms and develop competency in academic reading, preparing report written communication/presentation.</li> <li>Analyse any problem critically, analyse and interpret data and synthesize information to provide valid conclusions.</li> <li>Communicate effectively within the shortest possible time to present their reports and academic writing.</li> <li>Apply the techniques to find out the main points of any long article within a very limited time as well as know the techniques of any effective writing.</li> </ol>												
	COURSE OUTCOMES & GENERIC SKILLS												
No.	Course Learning OutcomeCorresponding POsBloom's TaxonomyCPCAKPAssessment Methods												
COI	<b>Understand</b> the techniques of academic reading and become familiar with technical terms and <b>develop</b> competency in academic reading, preparing report written communication/presentation.	PO - 1	C2	-	-	1	ASG, Q						
CO2	<b>Analyze</b> any problem critically, analyze and interpret data and synthesize information to provide valid conclusions.	PO - 1	C3	-	-	1	ASG/ Pr, Q						
CO3	<b>Communicate effectively</b> within the shortest possible time to present their reports and academic writings	PO -10	C4	-	-	1	Pr, Q						
CO4	<b>Apply</b> the techniques to find out the main points of any long article within a very limited time as well as know the techniques of any effective writing.	PO -10	C5	-	-	2	ASG/ Pr, Q						
	(CP- Complex Problems, CA-Comple Quiz; ASG – Assignment; Pr – Presen	ex Activities, KP-K atation; R - Report; I	nowledge Prof F – Final Exam	file, T , MT-	– Test Mid Te	; PR – erm Ex	- Project ; Q – am)						
	COURSE CONTENT												
	COURSE CONTENT           Speaking         Introduction to Language: Introducing basic skills of language.           English for Science and Technology         Self-introduction and introducing others: How a speaker should introduce himself to any stranger           / unknown person / a crowd.         Name, family background, education, experience, any special quality/interest, likings/disliking, etc.           Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and												

	<ul> <li>/apologies/complaints</li> <li>Describing personality, discussing and making plans(for a holiday or an outing to the cinema),</li> <li>Describing pictures / any incident / event</li> <li>Practicing storytelling, Narrating personal experiences/Anecdotes</li> <li>Telephone conversations (role play in group or pair)</li> <li>Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)</li> <li>Listening and understanding: Listening, note taking and answering questions; Students will listen to recorded text, note down important information and later on will answer to some questions</li> <li>Difference between different accents: British and American accents;</li> <li>Documentaries from BBC and CNN will be shown and students will try to understand</li> <li>Listening to short conversations between two persons/meres/meres/accents/</li> </ul>																
	Docum Listenii	entaries from H	BC and CNN were sations between the set of t	will be een tv	e sh vo p	owr oerso	anc ns/1	l stu nore	dent e tha	s wi n tw	ll try o	y to	unc	lersta	ind		
	Readin Readin	g techniques: s g Techniques: a	canning, skimm analysis, summa	ing, p arizin	ored g an	ictir 1d in	ıg, iı iterp	nfere retat	ence ion	; of te	exts						
	Writing Introductory discussion on writing, prewriting, drafting; Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture,																
	narrating an event Paragraph writing Compare-contrast and cause- effect paragraph																
	Paragraph writing, Compare-contrast and cause- effect paragraph         SKILL MAPPING (CO-PO MAPPING)																
	SKILL MAPPING (CO-PO MAPPING)																
	No.	Course Le	earning Outcome	-	1	2	Р 3	ROC 4	GRA	<u>M O</u> 6	UTC 7	2 <u>ON</u> 8	1ES 9	(PO) 10	11	12	
	CO1	Listen, unde English quick the techniques	rstand and sp ly and smartly us learnt in the class	<b>beak</b> sing s.	3												
	CO2	Understand academic rea writing	the techniques ding and acade	of emic	3												
	CO3	<b>Communicate</b> the shortest po ideas and opin	e effectively wi ssible time to pre ions	ithin esent										2			
	CO4	<b>Develop</b> con written communication	npetency in on n/presentation	oral,										1			
	(3 – Hig	h, 2- Medium, 1	-low)														
JUSTIFICA	TION F	OR CO-PO M	IAPPING														
Mapping	Corr Level	esponding of Matching	The section of the	4	. 1.		]	lusti	fica	tion						1	
CO1-PO1		3	In order to lis answering quest fundamentals a engineering pro	tions, und and blems	the $1$ of $1$	rstar knov ngine o apj	id, a vledg erin plied	ind I ge of g sp	earn mat ecial	the hema	tecl tics on t	hnic , na to t	ues tural the	of n scien solutio	ote ta ice, ei on of	aking nginee com	and ering plex
CO2-PO1		3	In order to listen, understand, and learn the techniques of note taking and answering questions, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences are required														
CO3-PO10		2	In order to com their ideas and engineering act such as being	nmunio opinio ivities able	cate ons, wit to	effe it is h the com	ctive s req e eng preh	ely w uirec ginee end	rithin l to ring and	n the comi com writ	shoi muni mun te_e	rtest icate ity	t pos e eff and ctive	sible fective with s repo	time ely or societ rts_a	to pre 1 com y at la nd_de	esent plex arge, esign

		documentation, make effective presentations, and give instructions.	and receive clear				
CO4-PO10	1	In order to develop competency in reading, writing and oral communication /presentation, it is required to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.					
TEACHING	LEARNING STRAT	EGY					
Teaching and	Learning Activities		Engagement (hours)				
	Face-to-Face Learning						
	Lecture		-				
	42						
	Student-Centred Learning						
	Self-Directed Learnin	g					
	Non-face-to-f	ace learning	-				
	Revision		-				
	Formal Assessment						
	Continuous A	ssessment	4				
	Mid-Term		-				
	Final Examin	ation	-				
	Total		88				
TEACHING	METHODOLOCV						

Discussion, Participation, Pair Work, Group Presentation, Co-operative and Collaborative and student-centered Learning Method

### **COURSE SCHEDULE**

Weeks	Topics	Remarks
	Introduction to Language: Introducing basic skills of language; English for Science	
	and Technology	
	Self-introduction and introducing others: How a speaker should introduce himself	
Weals 1	to any stranger / unknown person / a crowd; Name, family background, education,	
week-1	experience, any special quality/interest, likings/disliking, etc.	
	Self-introduction and introducing others: How a speaker should introduce himself	
	to any stranger / unknown person / a crowd; Name, family background, education,	
	experience, any special quality/interest, likings/disliking, etc.	
	Asking and answering questions, Expressing likings and disliking; (food, fashion	-
	etc.) Asking and giving directions	
W/1- 0	Asking and answering questions, Expressing likings and disliking; (food, fashion	
week-2	etc.) Asking and giving directions	
	Asking and answering questions, Expressing likings and disliking; (food, fashion	
	etc.) Asking and giving directions	
W/1- 2	Discussing everyday routines and habits, Making requests/ offers/ invitations/	
Week-3	excuses/ apologies/ complaints	

	Discussing everyday routines and habits, Making requests/ offers/ invitations/					
	excuses/ apologies/ complaints					
	Discussing everyday routines and habits, Making requests/ offers/ invitations/					
	excuses/ apologies/ complaints					
	Describing personality, discussing and making plans(for a holiday or an outing to					
	the cinema), Describing pictures / any incident / event					
Week-4	Describing personality, discussing and making plans(for a holiday or an outing to					
	the cinema), Describing pictures / any incident / event					
	Describing personality, discussing and making plans(for a holiday or an outing to					
	the cinema), Describing pictures / any incident / event					
	Practicing storytelling, Narrating personal experiences/Anecdotes					
Week-5	Practicing storytelling, Narrating personal experiences/Anecdotes					
	Practicing storytelling, Narrating personal experiences/Anecdotes					
	Telephone conversations (role play in group or pair); Situational talks / dialogues:					
	Practicing different professional conversation (role play of doctor-patient					
	conversation, teacherstudent conversation)					
	Telephone conversations (role play in group or pair)					
Week-6	Situational talks / dialogues: Practicing different professional conversation (role	-				
	play of doctor-patient conversation, teacherstudent conversation)					
	Telephone conversations (role play in group or pair); Situational talks / dialogues:					
	Practicing different professional conversation (role play of doctor-patient					
	conversation, teacher –student conversation)					
	Listening and understanding: Listening, note taking and answering questions;					
	Students will listen to recorded text, note down important information and later on					
	will answer to some questions					
	Listening and understanding: Listening, note taking and answering questions;					
Week-7	Students will listen to recorded text, note down important information and later on					
	will answer to some questions					
	Listening and understanding: Listening, note taking and answering questions;					
	Students will listen to recorded text, note down important information and later on					
	will answer to some questions					
	Difference between different accents: British and American accents; Documentaries					
	from BBC and CNN will be shown and students will try to understand					
Week-8	Difference between different accents: British and American accents; Documentaries					
Week o	from BBC and CNN will be shown and students will try to understand					
	Difference between different accents: British and American accents; Documentaries					
	from BBC and CNN will be shown and students will try to understand	_				
	Listening to short conversations between two persons/more than two					
Week-9	Listening to short conversations between two persons/more than two					
	Listening to short conversations between two persons/more than two					
	Reading techniques: scanning, skimming, predicting, inference;					
Week-10	Reading techniques: scanning, skimming, predicting, inference;					
	Reading techniques: scanning, skimming, predicting, inference					

	Reading Techniques: analysis, summarizing and interpretation of texts								
Week-11	Reading Techniques: analysis, summarizing and interpretation of texts								
	Reading Techniques: analysis, summarizing and interpretation of texts								
	Introductory discussion on writing, prewriting, drafting;								
Week-12	Introductory discussion on writing, prewriting, drafting;								
	Introductory discussion on writing, prewriting, drafting								
	Topic sentence, paragraph development, paragraph structure, describing a								
	person/scene/picture, narrating an event								
Wook 13	Topic sentence, paragraph development, paragraph structure, describing a								
WCCK-13	person/scene/picture, narrating an event								
	Topic sentence, paragraph development, paragraph structure, describing a								
	person/scene/picture, narrating an event								
Week-14	Paragraph writing, Compare-contrast and cause- effect paragraph								
	Paragraph writing, Compare-contrast and cause- effect paragraph								
	Paragraph writing, Compare-contrast and cause- effect paragraph								

0	Components	Grading	СО	Blooms Taxonomy				
	Class Participation	20%	CO1, CO2, CO4	C2, C3, C5				
Assessment	Reading Test	15%	CO1, CO2, CO4	C2, C3, C5				
(40%)	Listening Test	15%	CO1, CO3, CO4	C2, C4, C5				
	Public Speaking	20%	CO2, CO3, CO4	C3-C5				
Group Presentation		30%	CO1-CO4	C2-C5				
Total Marks		100%						

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

- 1. Langan, J., College Writing Skills with Readings, 6th Edition, McGraw-Hill Publication, 2005.
- 2. John Langan, Interactions 1 (Reading), Latest edition, McGraw-Hill Publication
- 3. Jones, L. *Functions of English.* (Student's Book, 2nd Ed.) Melbourne, Australia: Cambridge University Press. (1981).
- 4. Dixon, R.J., *Complete course in English*. (Book 4). New Delhi, India: Prentice Hall of India. (For book presentation), (1987).
- 5. Maurice Imhoof and Herman Hudson, From Paragraph to Essay
- 6. Headway Series Advanced Level (2 parts with CDs): Oxford University Press Ltd.
- 7. James C. Humes, Speak like Churchill stand like Lincoln
- 8. Cambridge IELTS Practice Book
- 9. Selected Sample Reports and Selected Research Articles

#### **REFERENCE SITE**

#### Level 2 Term I

	COURSE INFORMATION								
Course Code Course Title	: LANG 202Lecture Contact Hours: 3.0: Communicative English -IICredit Hour: 1.5								
	PRE-REQUISITE								
	LANG 102, Communicative English -I								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	The English language course is designed for the students to develop their competence in communication skills for academic purposes emphasizing in speaking, reading, listening and writing. The approach will be communicative and interactive and will involve individual, pair and group work. Students will be exposed to different types of texts to develop efficient reading skill. Reading will also involve activities and discussions leading to effective writing. The course incorporates a wide range of reading texts to develop students' critical thinking which is one of the most essential elements required to write a good piece of academic writing. Emphasis is particularly put on the various forms of essay writing such as descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, students are expected to be able to communicate at various situations, participate in group activities and prepare formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. In addition, the course emphasizes on providing constructive feedback on students' oral performances.								
	1. To develop English language skills to communicate offerting have foreign 11								
	<ol> <li>To develop English language skins t</li> <li>To strengthen students' presentation</li> <li>To develop competency in academic</li> </ol>	skills.	writing	y and p	JUICS	sionai	ıy.		
	LEARNING OUTCOMES		i wiitting.						
			11 0						
	<ol> <li>Condensation the techniques of academic reading and become familiar with technical terms and develop competency in academic reading, preparing report written communication/presentation.</li> <li>Analyze any problem critically, analyse and interpret data and synthesize information to provide valid conclusions.</li> <li>Communicate effectively within the shortest possible time to present their reports and academic writings.</li> <li>Apply the techniques to find out the main points of any long article within a very limited time as well as know the techniques of any effective writing.</li> </ol>								
	COURSE OUTCOMES & GENERIC	SKILLS							
No.	Course Learning Outcome	Correspond ing POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Understand</b> the techniques of academic reading and become familiar with technical terms and <b>develop</b> competency in academic reading, preparing report written communication/presentation.	PO - 1		-	-	-	ASG		

CO2	Analyze and in informat	e any problem critically, analyze terpret data and synthesize tion to provide valid conclusions.	PO	- 10									A	SG/ P	r
CO3	Commu shortest reports a	<b>nicate</b> effectively within the possible time to present their and academic writings.	PO	-10					-		-	-		Pr	
CO4	Apply the points of limited technique	the techniques to find out the main of any long article within a very time as well as know the tees of any effective writing.	РО	-10					-		-	-	A	SG/ P	r
	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)														
	COUR	SE CONTENT													
	<b>Reading-</b> Reading Comprehension: Practice using different techniques, Academic reading: comprehension from departmental or subject related passages; Vocabulary for Engineers (some common Engineering terms for both general and dept specific), Reading subject specific text to develop vocabulary.														
	Writing Writing techniq compar writing writing	g- Writing semi-formal, Formal Cover Letter and Curriculum ues, outlining, revising, editing ison-contrast and cause – effec Analyzing and describing grap	/offic Vita g, pr t, arg ohs or	ial le e; E oofre ume [•] cha	etter ssay eadin ntat rts,	rs, C wr ng; ive Prao	Offic itin Nar and ctici	cial g: rrati op ing	E-m writi ve inion anal	ng and n ex ytic	Ap step des xpres cal a	plyin s, pr script ssion, nd ar	g foi incip ive assi gum	a jo les a writin gnme entati	ob: nd ng: ent ve
	Speakin and Ext presenta point sl	<b>ng</b> - Public Speaking: Basic elemeter empore Speech: How to get read ation: How to be ready for preser ides, etc. Selected books/Selected	ents a y for tatior l stori	nd q any s 1, pre es fo	ualit spee spare r pro	ties ch – e scr esen	of a set ipt tatio	or effor gon.	od p exter good	ubli npo I spe	c sp ore; I eech	eaker ndivi , prep	; Set dual paring	Spee / Gro g pow	ch up ⁄er
	Listeni Listenir differen	<b>ng</b> ng to long lecture on some top it accent	ics; L	ister	ing	and	l ur	nder	stand	ding	g spe	eeche	s/lect	ures	of
	SKILL	MAPPING (CO-PO MAPPIN	G)												
					P		4 <b>U</b>	M			100				
	No.	Course Learning Outcome	1	2	<u>Р</u> 3	4	5	6	7	8	9	10	11	12	
	CO1	<b>understand</b> the techniques o academic reading and become acquainted with technical vocabularies	f e 1 3		-		-	-	-	-		-			
	CO2	<b>understand</b> the techniques o effective academic writing such a research article/report writing	f s 3												
	CO3	communicate effectively within the shortest possible time to presen any report and research work	n t									2			
	CO4	<b>analyze</b> any problem critically analyze and interpret data and	, 1									1			

	synthesize information to provide valid conclusions								
	(3 – High, 2- Medium, 1-low)								
TEACHING	LEARNING STRATEGY								
		Engagement							
Teaching and	Learning Activities	(hours)							
	Face-to-Face Learning								
	Practical / Tutorial / Studio								
Student-Centred Learning									
	Self-Directed Learning								
	Non-face-to-face learning	-							
	Revision	-							
	Formal Assessment								
	Continuous Assessment	4							
	Mid-Term	-							
	Final Examination	-							
	Total	00							
TEACHING	METHODOLOGY								
Discussion, Pa Learning Meth	articipation, Pair Work, Group Presentation, Co-operative and Collaborative and nod	student-centered							
COURSE SC	HEDULE								
COURSE SC Weeks	HEDULE Topics	Remarks							
COURSE SC Weeks	HEDULE Topics Reading Comprehension: Practice using different techniques	Remarks							
COURSE SC Weeks Week-1	Topics         Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques	Remarks							
COURSE SC Weeks Week-1	HEDULE       Topics         Reading Comprehension: Practice using different techniques	Remarks							
COURSE SC Weeks Week-1	HEDULE       Topics         Reading Comprehension: Practice using different techniques         Academic reading: comprehension from departmental or subject related passage	Remarks							
COURSE SC Weeks Week-1 Week-2	HEDULE       Topics         Reading Comprehension: Practice using different techniques         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag	Remarks Remarks							
COURSE SC Weeks Week-1 Week-2	HEDULE       Topics         Reading Comprehension: Practice using different techniques       Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques       Reading Comprehension: Practice using different techniques         Academic reading: comprehension from departmental or subject related passag       Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag       Academic reading: comprehension from departmental or subject related passag	Remarks Remarks							
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COURSE SC Weeks Week-1 Week-2	HEDULE       Topics         Reading Comprehension: Practice using different techniques       Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques       Reading Comprehension: Practice using different techniques         Academic reading: comprehension from departmental or subject related passag       Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag       Academic reading: comprehension from departmental or subject related passag         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)       Academic reading terms for both general a	Remarks Remarks							
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COURSE SC Weeks Week-1 Week-2	HEDULE         Topics         Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)         Reading subject specific text to develop vocabulary         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)	Remarks       Remarks       Image: Search of the sear							
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COURSE SC Weeks Week-1 Week-2 Week-3	HEDULE         Topics         Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques         Reading Comprehension: Practice using different techniques         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag         Academic reading: comprehension from departmental or subject related passag         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)         Reading subject specific text to develop vocabulary         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)         Reading subject specific text to develop vocabulary         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)         Reading subject specific text to develop vocabulary         Vocabulary for Engineers (some common Engineering terms for both general a dept specific)	Remarks       res							

	Writing semi-formal, Formal/official letters, Official E-mail				
Week-4	Writing semi-formal, Formal/official letters, Official E-mail				
	Writing semi-formal, Formal/official letters, Official E-mail				
	Applying for a job: Writing Cover Letter and Curriculum Vitae				
Week-5	Applying for a job: Writing Cover Letter and Curriculum Vitae				
	Applying for a job: Writing Cover Letter and Curriculum Vitae				
	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;				
Week-6	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading:				
	Essay writing: writing steps, principles and techniques, outlining, revising, editing proofreading:				
	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression assignment writing:				
Week-7	Narrative and opinion expression, assignment writing, Narrative and descriptive writing: comparison-contrast and cause – effect,				
	Narrative and opinion expression, assignment writing, Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;				
	Analyzing and describing graphs or charts				
Week-8	Analyzing and describing graphs or charts				
	Analyzing and describing graphs or charts				
	Practicing analytical and argumentative writing				
Week-9	Practicing analytical and argumentative writing				
	Practicing analytical and argumentative writing				
	Public Speaking: Basic elements and qualities of a good public speaker				
Week-10	Public Speaking: Basic elements and qualities of a good public speaker				
	Public Speaking: Basic elements and qualities of a good public speaker				
	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.				
Week-11	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.				
	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore				
Week-12	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected				
	stories for presentation.				
	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.				
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	Individual / Group presentation: How to be ready for presentation, prepare script for good speech, preparing power point slides, etc. Selected books/Selected stories for presentation.				
	Listening to long lecture on some topics				
Week-13	Listening to long lecture on some topics				
	Listening to long lecture on some topics				
	Listening and understanding speeches/lectures of different accents				
Week-14	Listening and understanding speeches/lectures of different accents				
	Listening and understanding speeches/lectures of different accents				

Co	omponents	Grading	СО	<b>Blooms Taxonomy</b>
	Class Participation	20%	CO1, CO2, CO4	C2, C3, C5
Assessment	Reading Test	15%	CO1, CO2, CO4	C2, C3, C5
(40%)	Listening Test	15%	CO1, CO3, CO4	C2, C4, C5
	Public Speaking	iblic Speaking 20% CO2, CO3, CO4		C3-C5
Group Presentation		30%	CO1-CO4	C2-C5
Total Marks		100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

- 1. Langan, John. *College Writing Skills with Readings*,6th edition, New York, United States:Tata McGraw-Hill Education, 2013.
- 2. Jones, L. *Functions of English*. 2nd edition, Melbourne, Australia: Cambridge University Press, 1981.
- 3. Dixon, R.J. Complete course in English. New Delhi, India: Prentice Hall of India, 1987.
- 4. Abdallah, Huda Mohamed. A comparative and Contrastive Study of the Headway Series & Spine Series, London: UK: Oxford University Press Ltd. 2016.
- 5. Humes, James C. *Speak like Churchill, stand like Lincoln: 21 powerful secrets of history's greatest speakers.* New York, United States: Three Rivers Press (CA), 2002.

### **REFERENCE SITE**

	COURSE INFORMATION						
Course Code	: GES 101	L	ecture Contact	Hours		: 2.0	00
Course Title	: Fundamentals of Sociology	C	redit Hours			: 2.0	00
	PRE-REQUISITE						
	None						
	CURRICULUM STRUCTURE	CURRICULUM STRUCTURE					
	Outcome Based Education (OBE)						
	SYNOPSIS/RATIONALE						
	This course has been designed to un psychology in the society and to appl the study of varied societies and cult	nderstand the l y this knowled ures.	human inter-pe lge in the practio	rsonal re cal field	elatio as an	onship 1 engii	and human neer through
	OBJECTIVES						
	<ol> <li>To learn basics, scopes and perspectives of sociology.</li> <li>To understand societal and cultural issues in national, global and environmental context.</li> <li>To synthesis between social problem and social satisfaction in real life.</li> </ol>						
	LEARNING OUTCOMES						
	<ol> <li>Upon completion of the course, the s</li> <li>Understand the basic nature, scoresearch process and methodolog</li> <li>Apply contextual knowledge to context and also environmental of</li> <li>Analyze social problem, social political issues.</li> </ol>	students will be ope and persp gies. assess societ context for sus stratifications,	e able to ective of socio al and cultural tainable develo socialism, cap	logy and issues i pment. italism a	d the in na and e	criter tional	ria of social l and global mic life and
	COURSE OUTCOMES & GENE	RIC SKILLS					
No.	Course Learning Outcome	Corresponding POs	g Bloom's Taxonomy	СР	CA	KP	Assessment Methods
CO1	<b>Understand</b> the basic nature, scope and perspective of sociology and the criteria of social research process and methodologies.	PO10	C1		-	1	T, ASG, F
CO2	<b>Apply</b> contextual knowledge to assess societal and cultural issues in national and global context and also environmental context for sustainable development.	PO6	C2		-	1	Q, F
CO3	<b>Analyze</b> social problem, social stratifications, socialism, capitalism and economic life and political issues.	PO6, PO10	C2			2	MT, F
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presenta	Activities, KP- tion; R - Report	Knowledge Prof ;; F – Final Exam	ile, T – T , MT- M	Гest ; lid Te	PR – rm Ex	Project ; Q – am)

	COURSE CONTENT															
	Main (	Contents: Und	derstanding society, so	ocia	l phe	enon	nena	ı an	d so	cial	cha	nge.				
	<b>Detail Contents:</b> Nature and scope Sociological imagination, Perspectives of sociology, Stages of social research and research method, Culture and civilization, Socialization and self - development, Globalization and social changes, Media and individual, Social organizations and social problems, social stratification; industrial revolution, Capitalism and socialism, Work and economic life, Environment and human activities, Climate change and global risk, Population and human society, Urbanization and city development, Social changes and technology.															
	SKILL	MAPPING	(CO-PO MAPPING)	)												
	No	Course I	astring Outcome			Р	ROC	GRA	AM (	OUT	CON	<b>AES</b>	(PO)			
	NO.	Course I		1	2	3	4	5	6	7	8	9	10	11	12	
	CO1	Understand and perspect the criteria process and r	<b>Understand</b> the basic nature, scope and perspective of sociology and the criteria of social research process and methodologies										1			
	CO2	Apply conta assess societa national and environmenta sustainable d	Apply contextual knowledge to assess societal and cultural issues in national and global context and also environmental context for sustainable development						2							
	CO3	Analyze So stratifications and econom issues.	cial problem, social s, socialism, capitalism ic life and political						2				1			
	(3 – Hig	h, 2- Medium,	1-low)													
JUSTIFICAT	ION FO	R CO-PO M	APPING													
Mapping	Corro Level o	esponding of Matching				Ju	ıstif	icat	tion							
CO1-PO10		3	In order to understand the basic nature, scope and perspective of sociology and the criteria of social research process and methodologies, it is required to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give													
CO2-PO6		2	In order to apply contextual knowledge to assess societal and cultural issues in national and global context and also environmental context for sustainable development, application of reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems is required.													
CO3-PO6		3	In order to analyze Soc economic life and polit knowledge to assess consequent responsibi solutions to complex e	tical p tical soci- ilitie	oroble issue etal, es re neerin	em, s es, ap heal levar ng pr	socia oplic th, s nt to oble	atio atio safe p pr ms	ratifi n of ty, 1 ofes is re	catio rease egal sion quire	ons, s oning and al er ed.	g info cult ngine	lism, ormed ural i eering	capita l by co ssues prac	lism a ontext and tice a	und ual the und
CO3-CO10		2	In order to analyze Soc economic life and pol	cial p litica	orobl il iss	em, s ues,	socia it is	ıl stı req	ratifi Juire	catio d to	ons, s com	ocia mun	lism, icate	capita effect	lism a ively	nd on

TEACHINCI	complex engineering activities with the engineering communit at large, such as being able to comprehend and write effective documentation, make effective presentations, and give a instructions.	ty and with society reports and design and receive clear
Teaching and I	Learning Activities	Engagement
	Face-to-Face Learning	(nours)
	Lecture	28
	Practical / Tutorial / Studio	-
	Student-Centred Learning	-
	Self-Directed Learning	
	Non-tace-to-tace learning	56
	Formal Assessment	14
	Continuous Assessment	1
	Mid-Term	1
	Final Examination	3
	Total	103
<b>TEACHING N</b>	AETHODOLOGY	
Lecture and Di	scussion, Co-operative and Collaborative Method, Problem Based Method	
COURSE SCI	IEDULE	
Weeks		
	Topics	Remarks
Week-1	Topics           Definition, nature and scope of sociology, Sociological imagination	Remarks
Week-1 Week-2	Topics         Definition, nature and scope of sociology, Sociological imagination         Perspectives of sociology, Orientation of sociological theories	Remarks     Class Test     1
Week-1 Week-2 Week-3	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniques	Remarks     Class Test     1, Final     Exam
Week-1 Week-2 Week-3 Week-4	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniquesIntroducing culture and its variations, civilization	Remarks       Class Test       1, Final       Exam
Week-1 Week-2 Week-3 Week-4 Week-5	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniquesIntroducing culture and its variations, civilizationDefining family and its changes, Socialization process and development self	Remarks       Class Test       1, Final       Exam
Week-1 Week-2 Week-3 Week-4 Week-5 Week-6	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniquesIntroducing culture and its variations, civilizationDefining family and its changes, Socialization process and development selfIntroducing globalization and its impact on human life, Factors responsit to globalization	Remarks       Class Test       1, Final       Exam       of       Class Test       ble       Class Test       2, Final       Exam
Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniquesIntroducing culture and its variations, civilizationDefining family and its changes, Socialization process and development selfIntroducing globalization and its impact on human life, Factors responsit to globalizationMedia and its impact in modern society, Addressing social problems Bangladesh	RemarksClass TestImage: Class Test
Week-1 Week-2 Week-3 Week-4 Week-5 Week-6 Week-7 Week-8	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniquesIntroducing culture and its variations, civilizationDefining family and its changes, Socialization process and development selfIntroducing globalization and its impact on human life, Factors responsit to globalizationMedia and its impact in modern society, Addressing social problems BangladeshIntroducing social groups and organizations, Introducing bureaucracy a good governance	RemarksClass Test1, FinalExam $cof$ bleclass Test2, FinalExamof
Week-1 Week-2 Week-3 Week-4 Week-5 Week-5 Week-7 Week-7 Week-8 Week-9	TopicsDefinition, nature and scope of sociology, Sociological imaginationPerspectives of sociology, Orientation of sociological theoriesSocial research and its process, Research designs and techniquesIntroducing culture and its variations, civilizationDefining family and its changes, Socialization process and development selfIntroducing globalization and its impact on human life, Factors responsit to globalizationMedia and its impact in modern society, Addressing social problems BangladeshIntroducing social groups and organizations, Introducing bureaucracy a good governanceIntroducing social stratifications and social inequality, Poverty and its typ and dimensions	RemarksClass Test1, FinalExamcofbleclass Test2, FinalExamofundpesMid Term

Week-11	Capitalism: features and influence, Socialism: features and influence	
Week-12	Environment and human activities, Climate change and global risk	Class Test
Week-13	Population of Bangladesh: problem or prospect, Crime and deviance: a brief analysis	3, Final Exam
Week-14	Review	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1	C1
Assessmen t (40%)	Class Participation and Class attendance	5+5=10%	CO2	C2
	Mid term	10%	CO3	C2
Final Examination		60%	CO1-CO3	C2-C4
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. Brinkerhoff, David B., Suzanne T. Ortega, and Rose Weitz. *Essentials of sociology*. Cengage Learning, 2013.
- 2. Rao, CN Shankar. "Sociology: Primary Principles." New Delhi: S. Chand and Company Ltd (2002).
- 3. Giddens, Anthony, ed. *Human societies: an introductory reader in sociology*. Cambridge, Eng.: Polity Press, 1992.

## **REFERENCE SITE**

# 6.1. b. <u>Department of EECE</u>

	COURSE INFORMATION		
Course Code Course Title	: EECE 119 : Fundamentals of Electrical Circuit Analysis	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE	·	• •
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		

	SYNOPSIS/RATIONALE								
	To learn and familiarize the basics o and AC circuit.	f electric and ma	agnetic circui	t as we	ell as t	he ana	alysis of DC		
	OBJECTIVES								
	<ol> <li>To familiarize students with basic Circuit laws (Ohm, Kirchhoff), techniques (Mesh, Nodal), concepts (Superposition, Source Transformation) and theorems (Thevenin, Norton).</li> <li>To introduce the definition and derivation of AC power (Average power, Instantaneous power) along with other power concepts (Power factor, Complex power, maximum average power transfer).</li> <li>To impart knowledge of AC power conservation and measurements to be applied in practical field.</li> <li>To impart in depth knowledge of balanced and unbalanced 3 phase circuits, their analysis and configurations (Y, Δ).</li> <li>To articulate the concepts of magnetically coupled circuits (mutual inductance, dot convention) three phase and poly phase circuits</li> </ol>								
	LEARNING OUTCOMES								
	<ol> <li>Upon completion of the course the students will be able to</li> <li>Understand the basic circuit laws</li> <li>Apply the circircut theorems to solve the AC and DC circuits</li> <li>Analyse the magnetic circuits and three phase circuits.</li> </ol>								
	<b>COURSE OUTCOMES &amp; GENE</b>	RIC SKILLS							
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods		
CO1	<b>Understand</b> the basic circuit laws	1	C2	-	-	1	T, F, Q		
CO2	AC and DC circuits	2	C2, C4	-		2	T, MT, F		
CO3	Analyse the magnetic circuits and three phase circuits	1	C4	1		2	MT, F, ASG		
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentar	Activities, KP-Kr tion; R - Report; F	nowledge Prof 7 – Final Exam	ile, T - , MT- 1	- Test ; Mid Te	PR – erm Ex	Project ; Q – am)		
	COURSE CONTENT								
	Laws of electric circuit: Ohm's transformation. Electrical networks: network analys voltages, Thevenin's and Norton's th Magnetic concepts and units: magn law, magnetic field intensity, mea characteristic of ferromagnetic mater eddy current and eddy current loss, to Electromagnetic forces: forces upon in a magnetic field. Electromagnetic Lenz's law Bly rule elementary a c	Law, Kirchhof sis methods of br heorems. hetic field, right h asurement of n rials, theory of f otal core loss. In n a current carry: torque; electric generator	ff's voltage anch and loop and rule, mag nagnetic flux erromagnetis troduction to ing conductor motor. Electr	and c p curre gnetic k, ene m, B-1 magn r and c romagn	entrent ents, m flux de rgy o H curv etic cin hargeo netic in	laws ethod ensity, f mag re, hys rcuits. d parti nducti	of node pair Biot-Savart gnetic field, steresis loss, cles moving on and emf;		

	Genera and RL Effectiv Introducircuit a – Theve Balanc three w factor. I	<ul> <li>General concepts and definitions: Instantaneous current, voltage and power, R, L, C, RL, RC and RLC branches.</li> <li>Effective current and voltage: average values, form factor, crest factor, power real and reactive. Introduction to vector algebra. Impedance in polar and Cartesian forms. Sinusoidal single phase circuit analysis. Impedance in series, parallel branches, series-parallel circuits. Network analysis – Thevenin's theorem.</li> <li>Balanced poly phase circuits: three phase, four wire system of generated emfs, three phase, three wire systems, balanced wye loads, balanced delta loads, power in balanced systems, power factor. Balanced three phase circuit analysis and power measurement.</li> </ul>													
	SKILL	MAPPING(C	CO-PO MAPPING)												
	No.	Cour	se Learning Outcome	1	2	PR 3	OGR	AN 5	4 OL 6 7	JTC	CO	MES (	PO) 11	12	
	CO1	Understand th	ne basic circuit laws	3											
	CO2	Apply the circuit and DC circuit	cuit theorems to <b>solve</b> the AC ts		3										ļ
	CO3	Analyse the m circuits	agnetic circuits and three phase	3											
	(3 – Hig	h, 2- Medium, 1	-low)												
JUSTIFICAT	ION FO	R CO-PO MA	PPING												
Mapping	Corr Level	esponding of Matching		Jı	isti	ific	atio	1							
CO1-PO1		3	The knowledge of mathematics applied to learn the operation a	s, sci nd c	ieno ons	ce a stru	nd en	ngi of	neeri elec	ng tric	fur al r	ndamei machir	ntals l nes.	has to be	e
CO2-PO2		3	In order to understand the desi ac machines need to be identified	gn f ed a	eat nd	ures ana	s of a lyzec	IC 1 1.	nach	ine	s, t	the cha	racte	ristics o	f
CO3-PO1		3	In order to analyze basic electr to explore practical comple mathematics, science and electr	onic ex rical	c ci eng sci	rcui gine ienc	its co ering ce is 1	ns   req	iderii probl uirec	ng e em I.	exis s	sting s the k	ysten nowl	n model edge o	s f
<b>TEACHING I</b>	LEARNI	NG STRATE	GY												
Teaching and L	Learning .	Activities										E	ngag (hoi	ement urs)	
	Face-to	-Face Learning												_	
		Lecture Practical / Tu	torial / Studio										4	2	
		Student-Centr	red Learning										-	•	
	Self-Di	rected Learnin	g												
		Non-face-to-f	ace learning										8	4 1	
	Formal	Assessment											2	1	
		Continuous A	ssessment										2	2	
		Mid-Term Final Examin	ation										]	2	
	Total		ation										15	, 53	
TEACHING N	METHO	DOLOGY													
Lecture and Di	scussion	Co-operative	and Collaborative Method Pr	oble	em	Ba	sed 1	Me	ethor	1					

COURSE SCI	HEDULE			
Weeks	Topics	Remarks		
Week-1	<b>Laws of electric circuit:</b> Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation.	Class Test		
Week-2	<b>Laws of electric circuit:</b> Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation (2)	1, Final		
Week-3	Electrical networks: network analysis methods of branch and loop currents	Exam		
Week-4	Electrical networks: network analysis methods of branch and loop currents			
Week-5	Method of node pair voltages, Thevenin's and Norton's theorems.			
Week-6	Magnetic concepts and units: magnetic field, right hand rule, magnetic flux density,	<b>2, Final</b>		
Week-7	Biot-Savart law, magnetic field intensity, measurement of magnetic flux, energy of magnetic field, characteristic of ferromagnetic materials, theory of ferromagnetism	Exam		
Week-8	B-H curve, hysteresis loss, eddy current and eddy current loss, total core loss. Introduction to magnetic circuits.	Mid		
Week-9	<b>Electromagnetic forces:</b> forces upon a current carrying conductor and charged particles moving in a magnetic field.	Term, Final		
Week-10	Electromagnetic torque; electric motor. Electromagnetic induction and emf; Lenz's law, Blv rule, elementary a.c. generator.	Exam		
Week-11	<b>General concepts and definitions:</b> Instantaneous current, voltage and power, R, L, C, RL, RC and RLC branches.			
Week-12	<b>Effective current and voltage:</b> average values, form factor, crest factor, power real and reactive. Introduction to vector algebra. Impedance in polar and Cartesian forms. Sinusoidal single phase circuit analysis. Impedance in series, parallel branches, series-parallel circuits. Network analysis – Thevenin's theorem.	Class Test 3, Final		
Week-13 <b>Balanced poly phase circuits:</b> three phase, four wire system of generated emfs,				
Week-14	Three phase, three wire systems, balanced wye loads, balanced delta loads, power in balanced systems, power factor. Balanced three phase circuit analysis and power measurement.			

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1- 3)	20%	CO1- CO3	C2, C4, C5
Assessmen t (40%)	Class Participation and Class attendance	5+5=10%	CO1	C2
	Mid term	10%	CO3	C4
Final Examination		60%	CO1-CO3	C2, C4, C5
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

1. R.L. Boylestad, Introductory Circuit Analysis, 13th Edition, Pearson, 2015

2. James. W. Nilson, *Introductory Circuits for Electrical & Computer Engineering*, Prentice Hall of India Private Ltd.

3. Fitzgerald, Basic Electrical Engineering, McGraw-Hill International.

4. Mary Atwater, *Electricity and Magnetism*, Macmillan/McGraw-Hill School Publishing Company, 1993

5. Robert P. Ward, Introduction to Electrical Engineering, Prentice Hall of India Private Ltd.

6. Richard C. Dorf & James A. Svoboda, Introduction to Electric Circuits, John Wiley & Sons Inc.

### **REFERENCE SITE**

	COURSE INFORMATION													
Course Code Course Title	: EECE 120 : Fundamentals of Electrical Circuit A Sessional	Analysis	Lecture Con Credit Hour	ntact Hours s	:1.5 : 0.7	0 75								
	PRE-REQUISITE				1									
	EECE 119													
	CURRICULUM STRUCTURE													
	Outcome Based Education (OBE)	Dutcome Based Education (OBE)												
	SYNOPSIS/RATIONALE													
	To learn and familiarize the basics of electrical machines as well as the analysis of electronic circuit.													
	OBJECTIVES													
	<ol> <li>To learn the basic of electrical m</li> <li>To study the different electronic problem.</li> </ol>	achines, their ap	oplications an oply those in	d unit. solving com	plex e	engineering								
	LEARNING OUTCOMES													
	<ol> <li>Upon completion of the course, the s</li> <li>Apply the knowledge of basic ele</li> <li>Vary circuit parameters in order</li> <li>Design different elementary circuit</li> <li>COURSE OUTCOMES &amp; GENEL</li> </ol>	tudents will be a ectrical compon- to achieve optin uit related projec <b>RIC SKILLS</b>	able to ents and netw nized circuit o cts using circu	orks practica operation.	ally. and co	omponents								
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP CA	KP	ASG								
CO1	Apply the knowledge of basic electrical components and networks practically.	PO1, PO5	C3		2	R,Q,T								
CO2	<b>Vary</b> circuit parameters in order to achieve optimized circuit operation.	PO3, PO5	P6	1	5	R,Q,T								

CO3	Design related theorem	different eler projects is and compo	nentary circuit using circuit nents	]	PO3	}		(	25		1		1	3	R	k,Q,T	
	(CP- Co Quiz; A	mplex Problen SG – Assignme	ns, CA-Complex a ent; Pr – Presentat	Activit tion; R	ies, - Re	KP-	Knov ;; F -	wled - Fina	ge I al E	Profi xam	le, T , MT	' – T '- M	est ; id Te	PR – rm Ey	Proje (am)	ct ; Ç	<u>)</u> –
	COUR	SE CONTEN	T														
	<ol> <li>Con</li> <li>Ven</li> <li>Ven</li> <li>Ven</li> <li>Ven</li> <li>Ven</li> <li>Ven</li> <li>Fra</li> <li>Lab</li> </ol>	<ul> <li>Construction and operation of simple electrical circuits</li> <li>Verification of KVL</li> <li>Verification of KCL</li> <li>Verification of Thevenin's theorem</li> <li>Verification of Norton's theorem.</li> <li>Practice Lab-02</li> <li>Lab Test-02</li> </ul>															
	SKILL	MAPPING	(CO-PO MAPI	PING)	)												
	No.	Course I	Learning Outcome	e	1	2	P	ROC	GRA	M (			AES	(PO)	11	10	-
	CO1	CO1 Apply the knowledge of basic electrical components and networks					3	4	2	0	/	8	9	10	11	12	-
		practically.															_
	CO2	CO2 Vary circuit parameters in order to							2								
	CO3	Design differ related pro theorems and	rent elementary c jects using c l components	ircuit ircuit			3										
	(3 – Hig	h, 2- Medium,	1-low)														
JUSTIFICATI	ON FOR	<u>R CO-PO MA</u>	APPING														
Mapping	Level o	of Matching					Ju	istifi	cat	ion							
CO1-PO1		1	For constructing engineering kno	g simp wledge	ole e e is i	electi equi	onic	circ (e.g.	cuits und	s in ersta	brea andir	idboa 1g se	ard, ries-	minin paralle	um 1 el circ	evel uitrv	of ).
CO1-PO5		2	In some cases, electronic circui too.	studen it and t	ts fa hose	ce s con	ome nplez	desi x pro	gn blei	relat ns n	eed p eed t	robl to be	ems attai	while ned b	cons y the	tructi nselv	ng res
CO2-PO3		2	By doing project would be formed	et work d.	k, ał	oility	to c	lesig	n so	omet	hing	that	t mee	ets spo	ecifie	d nee	ds
CO2-PO5		2	To study the simulation, know needed.	perforr wledge	nano e of 1	ce c mode	hara ern e	cteris engin	stics eeri	s of ng t	the ools	des used	signe l in tl	d sys ne pra	tem ctice	throu areas	gh is
CO3-PO3		3	In order design knowledge is ne	n a co eded tl	omm hat s	unic uppo	ation orts e	n sy engin	sten leeri	n w ing c	ith c lesig	lefin n in	ed o a pra	lesign ctice a	para area	imete	rs,
TEACHING L	EARNIN	NG STRATE	GY					Ť		Ť			<b>^</b>				
Lecture and Dis	cussion,	Co-operative	and Collaborativ	ve Me	tho	l, Pr	oble	em B	lase	d M	letho	od					
<b>TEACHING L</b>	EARNIN	NG STRATE	GY														
Teaching and L	earning A	Activities													Enga <u>t (</u> h	.gem ours)	en )
	Face-t	o-Face Learn	ing														

Lecture	14
Practical / Tutorial / Studio	28
Student-Centred Learning	-
Self-Directed Learning	
Preparation of Lab Reports	14
Preparation of Lab Test	10
Preparation of presentation	0
Preparation of Quiz	7
Engagement in Group Projects	
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	90

## **COURSE SCHEDULE**

Weeks	Topics	Remarks
Week-1	Construction and operation of simple electrical circuits	
Week-2	Verification of KVL	
Week-3	Verification of KCL	
Week-4	Verification of Thevenin's theorem	
Week-5	Verification of Norton's theorem	
Week-6	Practice Lab	
Week-7	Lab Test	

# ASSESSMENT STRATEGY

	Components	Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Conduct of Lab Tests/Class Performance	25%	CO1, CO2	C3, C5
	Report Writing/ Programming	15%	CO1, CO2	C3, C5
	Mid-Term Evaluation (exam/project/assignment)	20%	CO1, CO2	C3, C5
	Viva Voce	10%	CO1, CO2	C3, C5
	Final Evaluation (Lab Quiz)	30%	CO1, CO2	C3, C5
Total Marks		100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

- 1. Stephan J. Chapman, Electrical Machinery Fundamental, McGraw-Hill.
- 2. B.L Theraja& A.K. Theraja, A Text Book of Electrical Technology (AC, DC Machines), S. Chand & Company Ltd.
- 3. Nagrath and Kothan , *Electrical Machines* , McGraw-Hill.
- 4. Stephan J. Chapman, *Electrical Machinery Fundamental*, McGraw-Hill.
- 5. Adel S. Sedra & Keneth C. Smith, *Micro Electronics Circuits*, Oxford University Press.
- 6. MD. H. Rashid, Power Electronics (Circuits, devices & Application), Prentice Hall of India.

## **REFERENCE SITE**

## Level 2 Term II

	COURSE INFORMATION										
Course Code	: EECE 221	Lecture Contact Hours	: 3.00								
Course Title	: Electrical and Electronics Technology	Credit Hours	: 3.00								
	PRE-REQUISITE										
	EECE 119										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	To develop a strong foundation in the basic operating principle, constructions, character features, applications etc. of AC electrical machinery like synchronous generator, synchron motor and three phase and single-phase induction motors and special motors. The emphasis been given on both physical insight and analytical techniques. The subject material covered will provide the basis for understanding many real-world electric machinery applications as as the foundation for advanced courses in electric machinery design and control. To teach students the concepts, principles and working of basic electronic circuits (Diodes, BJTs). targeted to provide a basic foundation for technology areas like electronics devices (rectif voltage regulators and amplifiers), industrial electronics as well as instrumentation, con systems and various electronic circuit design. Finally, this course is designed to develop designing campbility involving real life practical problems.										
	OBJECTIVES										
	<ol> <li>To impart basic knowledge on the physics of semiconductor along with the types, specifical and standard values of passive and active components of electronic circuits.</li> <li>To develop a strong foundation on AC electrical machines (synchronous machines, induct machines, universal machines etc) with a special focus on operating principle, identification parts and accessories, constructional features, types etc</li> <li>To familiarize with basic electronic circuits (rectifiers, voltage regulators and amplifiers), tworking principles, design criteria and system components.</li> <li>To develop a broad idea on application of machines in practical industrial and domestic field.</li> </ol>										

	LEARNING OUTCOMES											
	Upon completion of the course, the s	students will be a	able to									
	<ol> <li>Explain the fundamental operation, basic construction and classification of different AC and DC machines</li> <li>Interpret and analyze the performance characteristics of different electrical machines e.g. transformers, DC and AC machines</li> <li>Analyze basic electronic circuits considering existing system models to explore practical complex engineering problems.</li> <li>Design various electronic circuits using both passive and active components to solve the real-life engineering problems.</li> </ol>											
	COURSE OUTCOMES & GENERIC SKILLS											
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods					
CO1	Explain the fundamental operation, basic construction and classification of different AC and DC machines1C21, 2T, F											
CO2	Interpretandanalyzethe performancecharacteristicsof characteristics2C2, C41-3differentelectricalmachinese.g. transformers, DC and AC machines2C2, C41-3											
CO3	Analyzebasicelectroniccircuitsconsidering existing system models to explore practical complex engineering problems.2C41-3MT, F											
CO4	Design various electronic circuits using both passive and active components to solve the real-life engineering problems.	3	C6	1		3-5	ASG, Pr					
	(CP- Complex Problems, CA-Complex A Quiz; ASG – Assignment; Pr – Presenta	Activities, KP-Kn tion; R - Report; F	owledge Profil ⁷ – Final Exam	e, T – , MT-	Test ; I Mid Te	PR – Pr erm Ex	roject ; Q – am)					
	COURSE CONTENT											
	COURSE CONTENTTransformer: Principles, types, performances and characteristics and Introduction to Auto TransformerDC generators: Principles, types, performances and characteristics. DC Motors: Principles, types, performances and characteristics. Speed control and starters of motors, Permanent Magnet Brushless dc (BLDC) Motor Drives AC Machines: Principles of three phase induction motor and equivalent circuits. Introduction to synchronous machines.Electronics: Introduction, characteristics of semiconductor diodes, Diode Applications, Characteristics of BJT and their DC Biasing and Introduction to FET, MOSFET, IGBT, SCR.											
	SKILL MAPPING (CO-PO MAPI	PING)										

	No.	Co	ourse Learning Outcome			PR	.00	GRA	M	OU	TC	ON	1ES (1	PO)	10
	1.01			1	2	3	4	5	6	7	8	9	10	11	12
	CO1	<b>Explain</b> the	e fundamental operation, basic	2											
	COI	and DC mac	and classification of different AC	3											
		Interpret	and <b>analyze</b> the performance						_						
	CO2	characteristic	es of different electrical machines		3										
		e.g. transform	ners, DC and AC machines		-										
	-	Analyze bas	ic electronic circuits considering												
	CO3	existing system	tem models to explore practical		3										
		complex eng	ineering problems.												
	004	Design varie	bus electronic circuits using both			2									
	C04	passive and a	ctive components to solve the real-			2									
		ine engineer	ing problems.												
	(3 – Hig	h, 2- Medium,	1-low)			_			_		_				
JUSTIFICAT	ON FOR CO-PO MAPPING														
Mapping	Corre Level o	esponding f Matching	J	lus	tific	ati	ion								
		8	In order to be able to infer/illustra	te t	he p	hys	sics	of s	em	ico	ndı	icto	r devi	ces ar	nd the
			operation of different electronic co	om	pone	ents	s fo	r stı	eng	gthe	enir	ng f	undar	nenta	l idea
CO1-PO1		3	about basic electronics, the ki	now	led	ge .	of	ma	athe	ema	atic	5, 1	natura	ıl sci	ence,
			engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied												
			complex engineering problems is t	to a	ppli	ed.	d c	tn		aha	<b>r</b> 0.0	orio	tion	f 4:f	Coront
		_	electronic components, identification, formulation, research literature and analysis												
CO2-PO2		3	of complex engineering problems	rea	achi	ng	sub	stan	tiat	ted	coi	nclu	sions	using	g first
			principles of mathematics, natural	sci	ence	es a	nd	engi	nee	erin	g s	cien	ices a	re req	uired
			In order to be able to analyze basic	e ele	ectro	onic	c cii	rcuit	ts c	ons	ide	ring	g exist	ting sy	/stem
CO2 DO2		2	models to explore practical complex engineering problems, identification,												
CO3-PO2		3	formulation, research literature and analysis of complex engineering problem											olems	
			sciences and engineering sciences	are	rea	uire	st p ed	inc	ipi	05 0	ЛІ	lau	icinat	105, 11	aturai
			In order to be able to design vari	ious	s ele	ctr	oni	c cii	cui	its	usiı	ng t	oth p	assiv	e and
			active components to solve the re-	real life engineering problems, , it is required to											
CO4-PO3		2	design solutions for complex	eng	ginee	erin	g	proł	oler	ns	an	d c	lesigr	n sys	tems,
			components or processes that meet	t sp	ecifi	ied	nee	eds v	vith	ı ap	pro	pria	ate co	nside	ation
			for public health and safety, cultur	ai,	soci	etal	, ar		<u>nvi</u>	ron	me	ntal	consi	lderat	lons
TEACHING I	EARNI	NG STRATI	EGY												
Teaching and L	earning A	Activities											Eng	agem	ent
	Face-to	-Face Learnin	α									-	(1	iours	)
	1 acc-10	Lecture	ιδ											42	
		Practical / Tutorial / Studio												- -	
												_			
	Self-Di	Self-Directed Learning													
		Non-face-to-face learning												84	
		Revision												21	
	Formal	Formal Assessment											-		
		Continuous .	Assessment											2	
		Mid-Term												1	

	Final Examination	3						
	Total	153						
TEACHING	METHODOLOGY							
Lecture and D	viscussion, Co-operative and Collaborative Method, Problem Based Method							
COURSE SC	HEDULE							
Weeks	Topics	Remarks						
Week-1	Transformer: Principles, types, Auto Transformer	Class						
Week-2	Transformer: Performances and characteristics.	Test 1,						
Week-3	DC generators: Principles, types	Final						
Week-4	DC generators: Performances and characteristics.							
Week-5	DC Motors: Principles, types: Magnet Brushless dc (BLDC) Motor Drives							
Week-6	DC Motors: Performances and characteristics	Final						
Week-7	DC Motors: Speed control and starters of motors.							
Week-8	AC Machines: Principles of three phase induction motor and equivalent circuits	5						
Week-9	AC Machines: Introduction to synchronous machines and fractional horse power motors.	Term						
Week-10	AC Machines: Introduction to synchronous machines and fractional horse power motors Part II	Final						
Week-11	Electronics: Characteristics of semiconductor diodes							
Week-12	Electronics: Diode Applications	Class Test 3,						
Week-13	Characteristics of BJT and Introduction to FET, SCR, IGBT	ASG/ Pr Final						
Week-14	DC Biasing of BJT							
		•						

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2	C2, C4
Assessmen t (40%)	Class Participation and Class attendance	5+5=10%	CO3, CO4	C4, C6
. ,	Mid term	10%	CO3	C4
	Final Examination	60%	CO1-CO4	C2, C4, C6
	Total Marks	100%		

### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

#### **REFERENCE BOOKS**

1. R.L. Boylestad, Introductory Circuit Analysis, 13th Edition, Pearson, 2015

2. James. W. Nilson, *Introductory Circuits for Electrical & Computer Engineering*, Prentice Hall of India Private Ltd.

3. Fitzgerald, Basic Electrical Engineering, McGraw-Hill International.

4. Mary Atwater, *Electricity and Magnetism*, Macmillan/McGraw-Hill School Publishing Company, 1993

5. Robert P. Ward, Introduction to Electrical Engineering, Prentice Hall of India Private Ltd.

6. Richard C. Dorf & James A. Svoboda, Introduction to Electric Circuits, John Wiley & Sons Inc.

## **REFERENCE SITE**

## Level-2 Term-II

	COURSE INFORMATION	COURSE INFORMATION											
Course Code	: EECE 222		Lecture Conta	ct Hour	S	: 3.0	)0						
Course Title	: Electrical and Electronic Technolog	gy Sessional	Credit Hours			: 1.5	50						
	PRE-REQUISITE												
	EECE 221												
	CURRICULUM STRUCTURE												
	Outcome Based Education (OBE)												
	SYNOPSIS/RATIONALE												
	To learn and familiarize the basics of electrical machines as well as the analysis of electronic circuit.												
	OBJECTIVES												
	<ol> <li>To learn the basic of electrical m</li> <li>To study the different electronic problem.</li> </ol>	achines, their c circuits and	applications an apply those in	d unit. solving	g con	nplex	engineering						
	LEARNING OUTCOMES												
	Upon completion of the course, the s	tudents will be	e able to										
	<ol> <li>Practically analyze and evaluate performance characteristics of different electrical machines</li> <li>Construct different fundamental electronic circuits and relate the theoretical knowledges to justify the performance of different electronic devices</li> <li>Apply the acquired knowledge to design and construct a real-life based project in group</li> </ol>												
	COURSE OUTCOMES & GENE	RIC SKILLS											
No.	Course Learning Outcome	Corresponding POs	g Bloom's Taxonomy	СР	CA	KP	Assessment Methods						
CO1	Practically <b>analyze</b> and <b>evaluate</b> performance characteristics of different electrical machines	PO2, PO5	C4, C5	1	-	1- 3,6	R,Q,MT,T						

CO2	Constru- electron theoreti the po- electron	uct different ic circuits a cal knowled erformance ic devices	fundamental nd <b>relate</b> the ges to justify of different	PO2	e, PC	05		C3		1	-	1 3,	- ,6	R,Q	Q,T
CO3	Apply design based p	the acquired and <b>constru</b> roject in grou	knowledge to <b>ict</b> a real-life p	РО3 РО9,	, PO PO	5, 10	(	C3, C6	5	1	1	1 6	-	PR,	, Pr
	(CP- Co Quiz; AS	mplex Problen SG – Assignme	ns, CA-Complex ent; Pr – Presentat	Activiti tion; R -	es, K Rep	XP-Ki ort; I	now! F – F	ledge F Final Ex	Profil xam,	e, T - MT-	- Test Mid T	t ; PF Гerm	t − F Exa	roject m)	; Q –
	COUR	SE CONTEN	ЛТ												
	<ol> <li>Study the characteristic of DC generators.</li> <li>Study the characteristic of DC motors.</li> <li>Study the characteristic of three phase induction motor.</li> <li>Study the characteristic of synchronous generator.</li> <li>Lab Test-01</li> <li>Study the characteristic of diode in DC.</li> <li>Study the characteristic of diode in AC with the introduction to oscilloscope.</li> <li>Study the characteristic of BJT.</li> <li>Study the DC biasing of BJT.</li> </ol>														
	SKILL	MAPPING	(CO-PO MAPI	PING)											
	No.	Course I	Learning Outco	ome	1	2	F 3	PROGE	$\frac{\text{RAM}}{5 6}$	OUT 7	COM	ES (. 9	<u>PO)</u> 10	11	12
	CO1	Practically performance different ele	analyze and eva e characteristic ectrical machine	<b>aluate</b> cs of s		3		3	3						
	CO2	<b>Construct</b> electronic c theoretical the perfor electronic d	different fundar ircuits and <b>rela</b> knowledges to j mance of dif evices	mental te the justify fferent		3		3	3						
	CO3	Apply the a design and based project	cquired knowle construct a re ct in group	dge to al-life			2		2			2	2		
	(3 – Hig	h, 2- Medium,	1-low)												
JUSTIFICAT	ION FO	R CO-PO M	APPING												
Mapping	Level o	esponding of Matching					Jus	tificat	ion						
CO1-PO2		3	The knowledge be applied to communication	of math find ou system.	emat t the	ics, s sig	scien nal	ce and to nois	elect se ra	trical tio a	engin nd cł	eerin 1anne	g sci :1 ca	ences pacity	has to of a
CO1-PO5		3	To study the simulation, known needed.	perform wledge	nance of m	e cha oder	aract n en	eristics gineeri	s of ng to	the ols u	desig sed ir	ned 1 the	syste prac	em th tice ar	rough eas is

CO2-PO2	3	In order to construct different fundamental electronic circuits theoretical knowledges to justify the performance of different ele the knowledge of mathematics and engineering science must be a	s and relate the ectronic devices, pplied.
CO2-PO5	3	To study the performance characteristics of the designed simulation, knowledge of modern engineering tools used in the needed.	system through practice areas is
CO3-PO3	2	In order design electronic system with defined design parameter needed that supports engineering design in a practice area	rs, knowledge is
CO3-PO5	2	To study the performance characteristics of the designed simulation, knowledge of modern engineering tools used in the needed.	system through practice areas is
CO3-PO9	2	In order to apply the acquired knowledge to design and construct project in group effort must be taken in individual or in group	a real-life based
CO3-PO10	2	In order to apply the acquired knowledge to design and construct project in group and to present it communication skill is needed	a real-life based
<b>TEACHING</b>	METHODOLOGY		
Lecture and Di	scussion, Co-operative	e and Collaborative Method, Problem Based Method	
TEACHING	LEARNING STRAT	EGY	
Teaching and I	Learning Activities		Engagement (hours)
	Face-to-Face Lean Lecture Practical	ning / Tutorial / Studio	28 28
	Student-C	Centred Learning	-
	Self-Directed Lea Preparatio Preparatio	rning on of Lab Reports on of Lab Test	28 21
	Preparatio	on of presentation	14
	Engageme	ent in Group Projects	
	Formal Assessmen	nt	
	Continuo Final Oui	us Assessment	14
	Total	L	120
COURSE SCH	EDULE		
Weeks	Topics		Remarks
Week-1	Study the characteris	stic of single and three phase transformers.	
Week-2	Study the characteris	stic of DC generators.	
Week-3	Study the characteris	stic of DC motors.	
Week-4	Study the characteris	stic of three phase induction motor.	
Week-5	Study the characteris	stic of synchronous generator.	
Week-6	Lab Test-01		
Week-7	Study the characteris	stic of diode in DC.	

Week-8	Study the characteristic of diode in AC with the introduction to oscilloscope.	
Week-9	Study the characteristic of BJT.	
Week-10	Study the DC biasing of BJT	
Week-11	Quiz	
Week-12	Practice Lab-02	
Week-13	Lab Test-02	
Week-14	Viva Voce	

	Components	Grading	СО	Blooms Taxonomy
Continuous	Conduct of Lab Tests/Class Performance	25%	CO1, CO2	C3, C4, C5 A3, A5, P2, P4
Assessment	Report Writing/ Programming	15%	CO1, CO2	C3, C4, C5 A3, A5, P2, P4
(40%)	Mid-Term Evaluation (exam/project/assignment)	20%	CO1	C4, C5 A3, A5
	Viva Voce	10%	CO1, CO2, CO3	C3, C4, C5, C6 A3, A5, A6, P2, P4
	Final Evaluation (Lab Quiz)	30%	CO1, CO2, CO3	C3, C4, C5, C6 A3, A5, A6, P2, P4
Total Marks		100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

1. Chapman, Stephen J. *Electric machinery and power system fundamentals*. USA: McGraw-Hill,2002.

- 2. Theraja, B. L., and A. K. Theraja. "*A Text Book of Electrical Technology, AC & DC Machines in SI*." Systems of Unit, S. Chand & Company Ltd, Ram Nagar, New Delhi, India,2002.
- 3. Stephan J. Chapman , *Electrical Machinery Fundamental*, USA: McGraw-Hill, 2004.
- 4. Sedra, Adel S., et al. *Microelectronic circuits*. New York, USA: Oxford University Press, 1998.

### **REFERENCE SITE**

### 6.1. c. Department of CSE

	COURSE INFORMATION		
Course Code Course Title	: CSE 121 : Introduction to Computer Science and Programming Language	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		

	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	To develop strong programming fu of real world by writing computer p	To develop strong programming fundamentals for learners who want to solve complex problems of real world by writing computer programs.								
	OBJECTIVES									
	<ol> <li>To understand the basics of Con</li> <li>To understand the basics of con</li> <li>To solve elementary programm</li> </ol>	<ol> <li>To understand the basics of Computers</li> <li>To understand the basics of computer programming in C.</li> <li>To solve elementary programming problems.</li> </ol>								
	LEARNING OUTCOMES									
	Upon completion of the course, the	students will be a	able to							
	<ol> <li>Explain the features of procedural language.</li> <li>Apply C programming concepts such as control flow, conditional statements, composition of structures, array, function etc. to solve real world problem.</li> <li>Design algorithms in a systematic way to solve any problem which can be implemented using C.</li> <li>Develop the communication skill by presenting topics on programming phenomena.</li> </ol>									
	COURSE OUTCOMES & GENERIC SKILLS									
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	Assessment Methods						
CO1	<b>Explain</b> the features of procedural language.	PO1	C2	1	-	3	T, MT, F			
CO2	<b>Apply</b> C programming concepts such as control flow, conditional statements, composition of structures, array, function etc. to solve real world problem.	PO2	C3	1	1	3	T, MT, F			
CO3	<b>Design</b> algorithms in a systematic way to solve any problem which can be implemented using C.	PO3	C6	1	2	5	T, MT, F			
CO4	<b>Develop</b> the communication skill by presenting topics on programming phenomena.	P10	A2			5	Pr, Q			
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Present	x Activities, KP-K ation; R - Report; I	nowledge Prof F – Final Exam	ïle, T , MT-	– Test Mid Te	; PR – erm Ex	Project ; Q – am)			
	COURSE CONTENT									
	Number system binary octal hexadecimal, binary arithmetic, Basic programming concepts; Program development stages; Logic charts, Algorithm; Introduction to structured programming; Data types and expressions, Operators, Libraries and keywords, Statements, Arrays and strings, Functions, Control statements, Input and output systems and structure.									
	SKILL MAPPING (CO-PO MAR	PPING)								

No	Course Learning Outcome			ł	PRO	GRAN	M OI	JTC	OMI	ES (F	PO)		
INO.	Course Learning Outcome	1	2	3	4	5	6	7	8	9	10	11	12
CO1	<b>Explain</b> the features of procedural language.	3											
CO2	Apply C programming concepts such as control flow, conditional statements, composition of structures, array, function etc. to solve real world problem.		3										
CO3	<b>Design</b> algorithms in a systematic way to solve any problem which can be implemented using C.			3									
CO4	<b>Develop</b> the communication skill by presenting topics on programming phenomena.										2		

(3 – High, 2- Medium, 1-low)

JUSTIFICA	JUSTIFICATION FOR CO-PO MAPPING							
Mapping	Corresponding Level of Matching	Justification						
CO1-PO1	3	Achieving depth of knowledge on programmer complex engineering problem and understanding a programming languages.	ning by solving of the features of					
CO2-PO2	3	Applying different concepts of C/MATLAB pro- the solution of complex problems.	gramming to find					
CO3-PO3	3	Designing algorithm, identifying the problem statement and formulating the problem to solve it.						
CO4-PO10	2	Developing Communication skill on programming through qui and presentation.						
TEACHING	<b>LEARNING STRA</b>	TEGY						
Teaching and	l Learning Activities		Engagement (hours)					
	Face-to-Face Learnin	ıg						
	Lecture		42					
	Practical / Tu	torial / Studio	-					
	Student-Cent	red Learning	-					
	Self-Directed Learnin	ng						
	Non-face-to-f	face learning	84					
	Revision		21					
	Formal Assessment							
	Continuous A	Assessment	2					
	Mid-Term		l					
	Final Examin	ation	3					
	lotal		153					

# **TEACHING METHODOLOGY**

Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method

## **COURSE SCHEDULE**

Weeks	Topics	Remarks
Week-1	Introduction to computers system	Class
Week-2	Number system: binary, octal, hexadecimal, Binary arithmetic	Test 1, Final
Week-3	Basic programming concepts	Exam
Week-4	Program development stages	Class
Week-5	Logic charts, Algorithm	Test 2,
Week-6	Introduction to structured programming	Final
Week-7	Data types, Keywords, C Input/output: printf, scanf statements	Exam
Week-8	Operators & Expressions	
Week-9	Control statements: if else, if - else if - else ladder, nested if else	Mid Term
Week-10	Control statements: switch, while Loop, do -while	1 cr m
Week-11	Control statements: Nested Loop	Class
Week-12	Arrays & Strings	Test 3,
Week-13	Function	Final
Week-14	Input and output systems and structure	Exam

# ASSESSMENT STRATEGY

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO3	C2, C3, C6
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO1	C2
· · ·	Mid term	10%	CO2, CO3	C2, C6
Fir	nal Examination	60%	CO1-CO3	C2, C3, C6
	Total Marks	100%		

# (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

- 1. Herbert Schildt, *Teach Yourself C*, 3rd Edition
- 2. Programming with C Schaums Outline Series
- 3. Holly Moore, MATLAB for Engineers, Pearson Education Inc, 2018
- 4. Peter Norton, Computer Fundamentals, 6th Edition McGraw-Hill Education, 2004
- 5. Herbert Schildt, *C*, *The Complete Reference*, 4th Edition
- 6. Dennis M. Ritchie, C Programming Language, 2nd Edition
- 7. David Houcque, Introduction to Matlab for Engineering Students, version-1.2

# **REFERENCE SITE**

### Level-1 Term-II

	COURSE INFORMATIO	N					
Course Code Course Title	: CSE 122 : Introduction to Comput Programming Language Sea	er Science and ssional	Lecture Cont Credit Hours	:	1.50 0.75		
	PRE-REQUISITE						
	None						
	CURRICULUM STRUCT	TURE					
	Outcome Based Education (	(OBE)					
	SYNOPSIS/RATIONALE	1					
	To practically develop stro complex problems of real w	ong programming orld by writing co	fundamentals omputer progra	s for le ams.	arners	who v	want to solve
	OBJECTIVES						
	<ol> <li>To demonstrate the basi</li> <li>To discuss how to th programming language.</li> </ol>	c concepts of cor ink about the p	nputer progran roblems, their	nming i • soluti	n C ons ar	nd tran	uslate it to a
	LEARNING OUTCOMES	5					
	Upon completion of the cou	rse, the students	will be able to				
	<ol> <li>Apply knowledge of alg</li> <li>Apply knowledge of C</li> </ol>	gorithm to find ro concepts to imple	admap to solve	e proble ogram.	ems.		
	COURSE OUTCOMES &	GENERIC SKI	ILLS				
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	СР	CA	KP	Assessment Methods
CO1	<b>Apply</b> knowledge of algorithm to find roadmap to solve problems.	PO1	C3, A2	1	1	4	ASG, Q, OE
CO2	<b>Apply</b> knowledge of C concepts to implement solver program.	PO2	C3, A2	1	1	4	ASG, Q, OE

(CP- Cor Assignme	nplex Prot ent; Pr – Pr	blems, CA-Complex Activ resentation; R - Report; F –	ities, KI Final Ex	P-Kno kam, l	wled MT- N	ge Pr Mid T	ofile, erm H	T – Exam	Test , OE-	; PR Onlin	– Pro e Exa	oject ; m)	; Q – (	Quiz; A	ASG –
		COURSE CONTEN	T												
		<ol> <li>Orientation with 2</li> <li>Problem solving 3</li> <li>Problem solving 4</li> <li>Problem solving 5</li> <li>Pattern printing u</li> <li>Problem solving 7</li> <li>Problem solving 8</li> <li>Problem solving 9</li> <li>SKILL MAPPING (C</li> </ol>	IDE, B with Va with "in using fo sing ne using A using F using F CO-PO	uildi ariab f-else or loe ested Array Funct File II MAH	ng F le an e if" op, v loop s and ion nput/ <b>PPIN</b>	irst F Id co ladd vhile d Stri <u>(Out</u> G)	Progr nstar er, sv Loo ing put a	ram, nts, c witch p, do	Comperation constructs	apile ators, se, ile ture	and , exp	Run ressio	ons, if	-else	
							PR	OGR	AM	OUT	COM	ES (PO	0)		
No.	0	Course Learning Outcome		1	2	3	4	5	6	7	8	9	10	11	12
CO1	<b>Apply</b> k roadmap	nowledge of algorithm to solve problems.	edge of algorithm to find lve problems. 3												
CO2	Apply 1 implement	knowledge of C conce nt solver program.	pts to		3										
(3 – High	, 2- Mediu	m, 1-low)													
JUSTIF	ICATIO	N FOR CO-PO MAPPI	ING												
Map	ping	Corresponding Level of Matching						Ju	stific	atior	1				
CO1	-PO1	3	In orde prograi	er to f	ind o g, kno	ut the owled	roadı ge of	map o algor	of a co rithm	omple is cru	ex eng cial.	gineer	ing pro	blem u	sing c
CO2	-PO2	3	In orde of C sh	er to i ould	dentif be ap	y and plied	form prope	nulate rly.	the p	oroble	em foi	solve	er prog	ram co	ncepts
TEACH	ING LEA	ARNING STRATEGY													
Teaching	g and Lea	rning Activities											E	ngagei (hour	ment s)
		Face-to-Face Learning													
		Lecture	. 1 / 0	. 11										21	
		Practical / Tute	orial / S	tudio	)									-	
		Self-Directed Learning		ung										-	
		Non-face-to-fa	, ace learr	ning										42	
		Revision	iouri											21	
		Formal Assessment													
		Continuous As	ssessme	nt										2	
		Mid-Term												1	
		Final Examina	tion											3	

	Total	90
TEACHING ME	THODOLOGY	
Lecture and Discu	ssion, Co-operative and Collaborative Method, Problem Based Method	
COURSE SCHE	DULE	
Weeks	Topics	Remarks
Week-1	Orientation with IDE, Building First Program, Compile and Run	
Week-2	Problem solving with Variable and constants, operators, expressions, if-else	
Week-3	Problem solving with "if-else if" ladder, switch-case,	Online
Week-4	Problem solving using for loop, while Loop, do while Pattern printing using nested loop	Exams, Quiz and
Week-5	Problem solving using Arrays and string	Evaluation
Week-6	Problem solving using Function	
Week-7	Problem solving using File Input/ Output and structure	

	Components	Grading	СО	<b>Blooms Taxonomy</b>
Continuous	Lab participation and Report	10%		
Assessment (40%)	Online-1, Online-2	50%	CO1, CO2	C3, A2
	Class Evaluation	20%	CO2	C3, A2
	Lab Quiz	20%	CO1, CO2	C3, A2
	Total Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

- 1. Herbert Schildt, Teach Yourself C, 3rd Edition
- 2. Programming with C Schaums Outline Series
- 3. Peter Norton, Computer Fundamentals, 6th Edition McGraw-Hill Education, 2004
- 4. Herbert Schildt, *C*, *The Complete Reference*, 4th Edition
- 5. Dennis M. Ritchie, C Programming Language, 2nd Edition

### **REFERENCE SITE**

# 6.1. d. Department of ME

	COURSE INFORMATION										
Course Code	: ME 180	Lec	cture Contact Ho	ours	: 3.0	00					
Course Title	: Basic Engineering Drawing	Cre	edit Hours		: 1.5	50					
	PRE-REQUISITE										
	None										
	CURRICULUM STRUCTURE										
	Outcome Based Education (OBE)										
	SYNOPSIS/RATIONALE										
	This course is designed for learners to learn engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions and use them to communicate with others through engineering drawings and solve complex problems of real world.										
	OBJECTIVES										
	<ol> <li>To enable students to acquire accurately and clearly community</li> <li>To enable students to acquire for advanced study of engineer</li> </ol>	e and use eng nicating ideas, requisite know ring drawing.	gineering dra , information wledge, techi	wing ski and instr niques an	lls as actions d attitu	a means of .de required					
	LEARNING OUTCOMES										
	<ol> <li>Upon completion of the course the str</li> <li>Understand engineering drawi and techniques.</li> <li>Apply and analyze standard completion</li> </ol>	udents will be a ngs in using e onventions use	able to engineering d ed in engineer	rawing aj ring draw	oparatu ing.	s, materials					
	<b>COURSE OUTCOMES &amp; GENERIC</b>	SKILLS									
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP CA	KP	Assessment Methods					
CO1	<b>Understand</b> engineering drawings in using engineering drawing apparatus, materials and techniques.	PO1	C2	1 2	1	R, Q, T					
CO2	<b>Apply</b> and <b>analyze</b> standard conventions used in engineering drawing.	PO2, PO4	C3, C4	3 3	4, 5	R, MT, T					

	(CP- Complex Problems, CA-Complex Activities, KP-Knowledge Profile, T – Test ; PR – Project ; Q – Quiz; ASG – Assignment; Pr – Presentation; R - Report; F – Final Exam, MT- Mid Term Exam)														
	COURS	E CONTENT													
	Introduction; Instruments and their uses; First and third angle projections; Orthographic drawings; Isometric views; Missing lines and views; Sectional views and conventional practices; Auxiliary views.														
	SKILL I	SKILL MAPPING (CO-PO MAPPING)													
	No.     Course Learning Outcome     PROGRAM OUTCOMES (PO)       1     2     3     4     5     6     7     8     9     10									(PO)	11	12	]		
	CO1	<b>Understand</b> engineering drawings in using engineering drawing apparatus, materials and techniques.	3	2	3	4	5	U	/	0	7	10	11	12	
	CO2	Apply and analyze standard conventions used in engineering drawing.		3		3									
	(3 – High, 2- Medium, 1-low)														
TEACHING LI	TEACHING LEARNING STRATEGY														
Lecture and D	iscussio	n, Co-operative and Collaborati	ve N	Aeth	od,	Pro	ble	m E	Base	d M	leth	od			
<b>TEACHING I</b>	LEARNI	NG STRATEGY													
Teaching and I	Learning A	Activities											Enga (ho	geme ours)	nt
	Face-to	o-Face Learning Lecture Practical / Tutorial / Studio Student-Centred Learning											,	28 28 -	
	Self-D	irected Learning Preparation of Lab Reports Preparation of Lab Test Preparation of presentation Preparation of Quiz Engagement in Group Projects												28 21 14	
	Forma	l Assessment Continuous Assessment Final Quiz												14 1	
	Total								1	20					
COURSE SCHI	EDULE														
Weeks		Торі	cs										Re	mar	ks
Week-1	Introduc	ction											Mi	d-te	rm

Week-2	First and third angle projections	
Week-3	Orthographic drawings	
Week-4	Orthographic drawings	
Week-5	Isometric views	
Week-6	Isometric views	
Week-7	Mid-term Exam	
Week-8	Sectional views and conventional practices	
Week-9	Solid Works Practice – Orthographic Drawing	
Week-10	Solid Works Practice – Orthographic Drawing	
Week-11	Solid Works Practice – Orthographic Drawing	Final Exam
Week-12	Actual drawing reading practice – Power plant layout, Cooling tower sectional view, Steam generator sectional view	
Week-13	Actual drawing reading practice – Pump cut sectional view, Welding joints ISO symbol, Fluid power and control ANSI symbol	
Week-14	Final Exam	

Com	ponents	Grading	СО	Blooms Taxonomy
	Class Participation	5%	CO1	C2
Continuous Assessment (60%)	Conduct of Lab Test	20%	CO2	C2-C4
	Report Writing	15%	CO1, CO2	C2-C4
	Mid term	20%	CO2	C2-C4
Final	Exam	30%	CO1	C4
Evaluation (40%)	Viva Voce/ Presentation	10%	CO2	C3
Total	Marks	100%		

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

## **REFERENCE BOOKS**

- 1. Paul Wallah, Metric Drafting, Publisher Glenceo Publishing Co, Inc; 1994.
- 2. William P. Spence, *Drafting Technology and Practice*, Publisher Chas A. Bennett Co, Inc, 1989.
- 3. Giesecke, Frederick Ernest, et al. *Technical drawing*. Macmillan, 1998.

### **REFERENCE SITE**

# Level 2 Term II

	COURSE INFORMATION									
Course Code	: ME 253	Lec	ture Contact He	ours		: 3.0	0			
Course Title	: Engineering Mechanics	Cre	dit Hours			: 3.0	0			
	PRE-REQUISITE									
	None									
	CURRICULUM STRUCTURE									
	Outcome Based Education (OBE)									
	SYNOPSIS/RATIONALE									
	This course provides an introduction to the essential theoretical basis of Engineerin Mechanics and its application to a range of problems of relevance to practical engineerin									
	OBJECTIVES									
	<ol> <li>To impart the essential theoretical basis of Engineering Mechanics.</li> <li>To explain the Laws of Mechanics to predict forces in and motions of machines and structures.</li> <li>To understand the courses dealing with mechanics of machines, stress analysis and design of mechanical systems.</li> </ol>									
	LEARNING OUTCOMES									
	Upon completion of the course the stu	idents will be ab	ole to							
	<ol> <li>Define the components of a force in rectangular or non-rectangular coordinates.</li> <li>Demonstrate complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.</li> <li>Analyze systems that include frictional forces.</li> <li>Evaluate the second moment of an area and calculate the principal second moments of</li> </ol>									
	COURSE OUTCOMES & GENERIC	SKILLS	1	F T						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods			
CO1	<b>Define</b> the components of a force in rectangular or non-rectangular coordinates.	PO1, PO2	C2		-	1	T, Q, F			
CO2	<b>Demonstrate</b> complete and correct free- body diagrams and write the appropriate	PO1, PO2, PO4	PO1, PO2, PO4 C3 - 2							

	equilibri	ium equations from the free-														
CO3	Analyze	e systems that include frictional	PC PC	D1, H	PO2, PO4			C4				-	4	]	MT, F	7
CO4	Evaluat and cal moment	the the second moment of an area <b>lculate</b> the principal second s of an area.	PC	D2, I PO	PO3, 4		C	5, Cé	5	1		1	5		T, F	
	(CP- Co Quiz; A	mplex Problems, CA-Complex A SG – Assignment; Pr – Presentatio	ctiviti on; R	ies, l - Re	KP-K port	Knov ; F –	vledg Fina	ge Pro al Ex	ofile, am, 1	, T – MT-	Test Mid	; PR Terr	R – Pro m Exa	oject m)	; Q –	
	COURS	SE CONTENT														
	<ul> <li>Basic concepts of mechanics; Statics of particles and rigid bodies; Centroids of lines, areas and volumes; Forces in truss, frames, and cables; Friction; Moments of inertia of areas and masses; Relative motion.</li> <li>Kinetics of particles: Newton's second law of motion; Principles of work, energy, impulse and momentum; System of particles; Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies: forces and acceleration; Principles of work and energy, Basic concepts of Lagrangian and Hamiltonian mechanics.</li> </ul>															
	SKILL MAPPING(CO-PO MAPPING)															
	No.	Course Learning Outcom	ne	1	2	P 3	4 ROC	5	6	7	3ME 8	<u>25 (F</u> 9	10	11	12	
	CO1	<b>Define</b> the components of a force rectangular or non-rectang coordinates.	e in ular	3	3											
	CO2	<b>Demonstrate</b> complete and cor free-body diagrams and write appropriate equilibrium equati from the free-body diagram.	the the	3	3		2									
	CO3	<b>Analyze</b> systems that incl frictional forces.	lude	2	3	1	2									
	CO4	<b>Evaluate</b> the second moment o area and <b>calculate</b> the princ second moments of an area.	f an ipal		2	2	3									
	(3 – Hig	h, 2- Medium, 1-low)														
TEACHING I	EARNIN	IG STRATEGY											1			
Teaching and	d Learnii	ng Activities											Er	ngag (ho	geme urs)	nt
	Face-to-Face Learning													•		
	Lecture Practical / Tutorial / Studio												4	-2		
	Student-Centred Learning											-				
	Self-Directed Learning															
	Non-face-to-face learning											84				
		Revision												2	21	
	Formal Assessment															

Continuous Assessment Mid-Term Final Examination							
	Total	153					
TEACHING N	<b>METHODOLOGY</b>						
Lecture and Co-operative	Discussion, e and Collaborative Method, Problem Based Method						
COURSE SCH	IEDULE						
Weeks	Topics	Remarks					
Week-1	Basic concepts of mechanics	Class					
Week-2	Statics of particles and rigid bodies	— Final					
Week-3	Week-3 Centroids of lines, areas and volumes						
Week-4	Forces in truss, frames, and cables						
Week-5	Week-5 Forces in truss, frames, and cables						
Week-6	Friction; Moments of inertia of areas and masses; Relative motion	Final Exam					
Week-7	Friction; Moments of inertia of areas and masses; Relative motion						
Week-8	Kinetics of particles: Newton's second law of motion	Mid Torm					
Week-9	Principles of work, energy, impulse and momentum	Final					
Week-10	System of particles	Exam					
Week-11	Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies: force and acceleration	es					
Week-12	Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies: force and acceleration	es Class Test 3,					
Week-13	Principles of work and energy, Basic concepts of Lagrangian ar Hamiltonian mechanics	nd Final Exam					
Week-14	Principles of work and energy, Basic concepts of Lagrangian ar Hamiltonian mechanics	nd					
ASSESSMEN	T STRATEGY						

	Components		СО	Blooms Taxonomy
Continuous	Class Test/ Assignment (1-3)	20%	CO1, CO4	C3, C5, C6
Assessment (40%)	Class Participation and Class attendance	5+5=10%	CO2	C1-C3
	Mid term	10%	CO3	C4
Final Examination		60%	CO1-CO4	C1-C6
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

### **REFERENCE BOOKS**

- 1. Ferdinand P. Beer, E RussellJr, *Vector Mechanics for Engineers: Statics. Johnston*, Publisher McGraw-Hill Companies, 5th edition 1988.
- 2. Joseph FShelley, Engineering Mechanics, Statics and Dynamics, USA:McGraw-Hill, 1980.
- 3. Hibbeler, Russell Charles, and Russell C. Hibbeler. *Engineering mechanics: statics & dynamics*. Pearson Education India, 2007.

### **REFERENCE SITE**

### Level 2 Term II

	COURSE INFORMATION								
Course Code	: ME 254	Lecture Contact Hours	: 1.50						
Course Title	: Engineering Mechanics Sessional	Credit Hours	: 0.75						
	PRE-REQUISITE								
	ME 253								
	CURRICULUM STRUCTURE								
	Outcome Based Education (OBE)								
	SYNOPSIS/RATIONALE								
	To learn and familiarize with the basics and operation of engineering mechanics associate with complex problems of practical life.								
	OBJECTIVES								
	To verify practically the theories and conce	pts learned in ME 253.							
	LEARNING OUTCOME								
	Upon completion of the course the students will be able to								
	1. Demonstrate the free-body diagrams and write the appropriate equilibrium equations from the free body diagram								
	<ol> <li>Analyze the engineering systems and ca the principal second moments of an area</li> </ol>	alculate second moment of an	n area as well as						

	COURS	E OUTCOMES & GENERIC	C SKIL	LS										
No.	Co	ourse Learning Outcome	Corre	espon POs	ding	Blo Taxe	om's onomy	, C	ЪЪ	CA	KP	Assessment Methods		
CO1	<b>Demons</b> and write equation	<b>trate</b> the free-body diagrams te the appropriate equilibrium as from the free-body diagram.		PO1			C2		1	2	1	R, Q, T		
CO2	Analyze calculat well as of an are	e the engineering systems and e second moment of an area as the principal second moments ea	PO	02, PC	04	C	5, C6		3	3	4, 5	R, MT, T		
	(CP- Co Quiz; As	mplex Problems, CA-Complex SG – Assignment; Pr – Presenta	Activit tion; R	ies, K - Reț	P-Kn port; I	owled	ge Pro al Exa	ofile, 7 um, M	Г — Т Т- N	Test ; F Aid Te	PR – Pi erm Ex	roject ; Q – am)		
	COURS	SE CONTENT												
	<ol> <li>Study of coefficient of friction by changing angle of inclination.</li> <li>Study of impulse momentum principle</li> <li>Study of rigid body kinematics</li> <li>Study of planar motion of rigid body</li> </ol> Along with the experiments the students will design simple systems in the rest 3 classes using the principles learned in ME 253.													
	SKILL MAPPING (CO-PO MAPPING)													
	No.	Course Learning Outco	me	1	2	$\frac{PRO}{3}$	GRAN	1 OU 6   7	TCO	MES 9	(PO) 10	11 12		
	CO1	<b>Demonstrate</b> the free- diagrams and write the approp equilibrium equations from free-body diagram.	-body priate the	3										
	CO2	Analyze the engineering system and calculate second moment area as well as the principal second moments of an area	stems of an econd		3	3								
	(3 – Hig	h, 2- Medium, 1-low)												
TEACHING LI	EARNIN	G STRATEGY												
Teaching and	Learnin	g Activities									En	gagement (hours)		
	Face-to-Face Learning									1				
		Lecture										21		
		Practical / Tutorial / Studi	0											
		Student-Centred Learning	5								<u> </u>	-		
	Self-Di	Irected Learning												
		Non-face-to-face learning	5									42 11		
1	1										1	11		

Formal Assessment	
Continuous Assessment	-
Mid-Term	1
Final Examination	3
Total	78
TEACHING METHODOLOGY	

Lecture and Discussion,

Co-operative and Collaborative Method, Problem Based Method

### COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction	
Week-2	Study of statics of particles and rigid bodies	
Week-3	Study of forces in truss, frames, and cables	
Week-4	Study of moments of inertia of areas and masses	
Week-5	Study of kinetics of particles	
Week-6	Study of kinematics of rigid bodies	
Week-7	Final Exam	

## ASSESSMENT STRATEGY

	Components	Grading	СО	<b>Blooms Taxonomy</b>
	Class Participation	5%	CO1	C2
Continuous Assessment (60%)	Conduct of Lab Test	20%	CO2	C2-C4
	Report Writing	15%	CO1, CO2	C2-C4
	Mid term	20%	CO2	C2-C4
Final	Exam	30%	CO1	C4
Evaluation (40%)	Viva Voce/ Presentation	10%	CO2	C3
	Total Marks	100%		

## (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)

- 1. William Nash, *Strength of Materials*, 4th edition, USA: Mcgraw-hill International Editions, 2002
- 2. A C Mandal & M. Quamrul Islam *Mechanics of Material with Solved Problems*, published by IUT, OIC, 2011.
- 3. Andrew Pytel , Ferdinand L. Singer. *Strength of Materials* ,4th edition , USA: Mcgraw-hill International Editions ,1990.

### **REFERENCE SITE**

## 6.1. e. Department of Industrial and Production Engineering

	COURSE INFORMATION							
Course Code	: GELM 275		Lecture Contact ]	Hours	: 2.0	00		
Course Title	: Leadership and Management		Credit Hours		: 2.0	00		
	PRE-REQUISITE							
	None							
	CURRICULUM STRUCTURE							
	Outcome Based Education (OBE)							
	SYNOPSIS/RATIONALE							
	The course is designed to make students understand the overlapping connection between engineering and management in an organization through the study of varied management practices and leadership traits as an engineer.							
	OBJECTIVES							
	<ol> <li>To introduce different management functions and approaches.</li> <li>To expose students to different views and styles of leadership.</li> <li>To understand how an organization functions collaboratively with managers and engineers.</li> <li>To understand various personality traits and its impact on leadership and management.</li> <li>To solve real-world management problems as an engineer.</li> </ol>							
	LEARNING OUTCOMES         Upon completion of the course, the students will be able to         1. Familiarize with the fundamental concepts of leadership and management skills.         2. Understand the role and contribution of a leader in achieving organizational goals.         3. Understand the contribution of leadership traits and management skills in decision making and solving real life problems.							
No	COURSE OUTCOMES & GENER	Correspondi	ing Bloom's		VD	Assessment		
INO.	Course Learning Outcome	POs	Taxonomy	CP CA	КĽ	Methods		

CO1 CO2 CO3	Familiarize       with the fundamental concepts of leadership and management skills         Understand the role and contribution of a leader in achieving organizational goals         Understand the contribution of leadership traits and management skills in decision making and solving real life problems         (CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentated         COURSE CONTENT	PO-9,10 PO-9,10,11 PO- 1,8,9,10,11,12 Activities, KP-Kr tion; R - Report; F	C1-C2 C1-C2 C1-C2 nowledge Profile, ' F – Final Exam, M'	T – Test ; T- Mid Te	1 1 1 PR – erm Ex	T, R, F T, ASG, R, F T, ASG, R, F Project ; Q – am)								
CO2 CO3	Understand the role and contribution of a leader in achieving organizational goals Understand the contribution of leadership traits and management skills in decision making and solving real life problems (CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentat	PO-9,10,11 PO- 1,8,9,10,11,12 Activities, KP-Ki tion; R - Report; F	C1-C2 C1-C2 nowledge Profile, ' F – Final Exam, M'	T – Test ; T- Mid Te	1 1 PR – erm Ex	T, ASG, R, F T, ASG, R, F Project ; Q – am)								
CO3	Understand the contribution of leadership traits and management skills in decision making and solving real life problems (CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentat	PO- 1,8,9,10,11,12 Activities, KP-Ki tion; R - Report; F	C1-C2 nowledge Profile, ' F – Final Exam, M'	T – Test ; T- Mid Te	1 PR – erm Ex	T, ASG, R, F Project ; Q – am)								
	(CP- Complex Problems, CA-Complex Quiz; ASG – Assignment; Pr – Presentat	Activities, KP-Kı tion; R - Report; F	nowledge Profile, ' F – Final Exam, M'	T – Test ; T- Mid Te	PR – erm Ex	Project ; Q – am)								
	COURSE CONTENT													
	COURSE CONTENT													
	<ul> <li>Main Contents:         <ul> <li>Leadership; Management, Planning and Control; Organization, Planning and Development; Personnel Planning and HR Management System; Cost and Financial Management; Marketing Management; Operations Management; Information Technology and Management; Case Studies.</li> </ul> </li> <li>Detailed Contents:         <ul> <li>Leadership: Leadership styles, leadership theories, traits of a good leader, conflicts negotiation, engineer as a leader, manpower control, motivation and theories, group dynamics, and participative management, Planning and Control: Management functions, types and roles and responsibilities, management skills, management approaches. Organization, Planning and Development: Organizational planning, organizational development models, research process and diagnostic methods. Personnel Planning and HR Management System: Process of Human Resource Planning, performance management and appraisal. Cost and Financial Management: Elements of costs of products, break-even analysis, investment analysis, net present value, payback period, and benefit-cost ratio. Marketing Management: Marketing concepts &amp; organization, industrial and consumer selling, channel &amp; advertising decisions, and new product strategy. Operation management: Project scheduling, demand and supply forecasting, inventory control, and quality management. Information Technology and Management: Management information system (MIS), enterprise resource planning (ERP). Case Studies: Solving real-world management problems.</li> </ul></li></ul>													
			PROGRAM OUTCOMES (PO)											
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	No.	Course Learning Outcome	1	2	2 3	4	5	6	7	8 9 10			11	12
		<b>Familiarize</b> students with the fundamental concepts of human						-	-		-			
	CO1	resource management, marketing management, operations									3	3		
		management, and financial management.												
	CO2	<b>Understand</b> the role of an engineer as a leader in the business environment.									3	3	2	
	CO3	Analyze real-life complex managerial decision-making problems and solve those using engineering knowledge and management skills.		2						2	3	3	2	2
	(3 – High, 2- Medium, 1-low)													
TEACHING LEARNING STRATEGY														
Teaching and L	nd Learning Activities Engagement (hours)								ement ırs)					
	Face-to-Face Learning								-	·				
	Lecture							28						
	Student-Centred Learning								-					
	Self-Directed Learning													
	Non-face-to-face learning							56						
	Revision							14	4					
	Formal Assessment 1													
	Mid-Term							1						
	Final Examination								3					
	Total									10	3			
TEACHING N	METHO	DOLOGY												
Lecture and Di	scussion,	Co-operative and Collaborative M	etho	d, P	robl	em l	Bas	ed N	Aeth	od				
COURSE SCH	HEDULH	2												
Weeks		Торі	cs										Re	marks
Week 1	<b>Introduction to Leadership and Management:</b> Definition of leadership and management; basic difference between a leader and a manager; relation of leaders and managers with respect to efficiency and effectiveness; qualities of leader and managers with examples from history.								Cla I	ss Test Final				
	Management Fundamentals: Definition of management & manager; levels of management; management functions and skills; Mintzberg's managerial roles; Henri Fayol's management principles; strategic management.								s of oles;	F	xam			

	Leadership & Motivation: Motivation, Maslow's hierarchy needs: theory of X &					
Week 2	Y: motivators and hygiene factors: goal setting theory: reinforcement theory: equity					
	theory expectancy theory					
	Leadership: Leadership styles: leadership trait theory: managerial grid:	-				
	contemporary leadership: conflicts negotiation: leadership issues in 21st century:					
Week 3	contemporary reductship, connects negotiation, reductship issues in 21st century,					
	closs cultural leadership, engineer as a leader and some simple case discussions on					
	leadership (positive and toxic leadership) in the class (interactive Learning).					
Week 4	Case Study – I : Engineer as Great Leaders					
	Organizational Management: Organization; departmentalization; chain of					
Wook 5	command; unity of command; cross functional area; authority; centralization and					
	decentralization; traditional & contemporary organization; matrix project structure;					
week 5	learning structure; organizing collaboration.	Class Test				
	<b>Planning and goal setting:</b> Foundation of planning: goals of plan; types of goal:	Final				
	types of goal & plan: goal setting: MBO: well written goal.	Fnai				
	<b>Control:</b> Controlling process: controlling for organizational performance: types of	Елат				
	control: (feed-forward, feedback & concurrent): balanced scorecard: contemporary					
Week 6	issues in control: workplace concern & workplace violence.					
vi cen o	<b>Change and Innovation:</b> Change and innovation: internal and external for change:					
	changing process: creativity vs innovation					
	Case Study – II : Planning and Goal Setting: A Managerial Approach:					
	Engineer as Great Managers (Interactive Discussions in the Class)					
Week 7	Attitude: Components of Attitude: behavior model and characteristics model:	-				
	behavior vs. attitude: job attitude: job involvement: job satisfaction and customer					
	satisfaction					
	<b>Personality:</b> Personality determinants: heredity and environment: Myers-Briggs					
	Type Indicator: Big five personality model: personality traits (core self-evaluation					
Week 8	Machiavellianism parcissism self-monitoring risk taking proactive personality					
WEEK 0	Percention and Individual Decision Making: Eactors influencing percention:					
	attribution theory errors/biases in attribution					
	Percention and Individual Decision Making: Factors of individual decision	Mid Term				
	making: rational decision making: hounded rationality: satisfice: common errors					
Week 9	in decision making, creativity in decision making					
WEEK 5	Case Study – III : A Case on Decision Making – Involves both leadershin and	-				
	managerial skills (Interactive Discussion in the Class)					
	<b>Understanding Work Team:</b> Work group: work team: problem solving team:	-				
	self-managed work team: cross functional team: virtual team: team effectiveness:					
Week 10	team challenges					
Week IV	<b>HR Management:</b> Process of Human Resource Planning: forecasting demand for	-				
	labor: staffing					
	HB Management: Internal supply of labor: performance appraisal					
Week 11	fix management. Internal suppry of factor, performance appraisal.	-				
WCCK II	<b>Operations Management:</b> Project managing basics; goals and boundary of					
	project; wBS; scheduling a project.	Class Test,				
	<b>Operations Management:</b> Demand and supply forecasting; inventory control.	Final				
Week 12	Exercise – Use of Microsoft Project (MSP) for scheduling a project at student	Exam				
	level					
Week 13	<b>Case Study – IV:</b> A case that covers all relevant theories taught throughout the					
	course and involves both leadership and management issues, e.g., Columbia's Final					

	Mission. (This may be given as group assignment followed by in class short presentations/discussions)	
Week 14	<b>Information Technology and Management:</b> Management Information System (MIS); Enterprise Resource Planning (ERP) - For introductory knowledge.	
	Revision	

### ASSESSMENT STRATEGY

	Assessment strategies		CO	D1
Components		Grading		Bloom's Taxonomy
	Class test 1.2	2004	CO 1	C1-C2, P1
	Class test 1-2	20%	CO 2	C1-C2
Continuous	Class Participation and Class	5 5 100/	CO 1	C1-C2, P1, A1
Assessment	attendance	5+5=10%	CO 2	C1-2, P1-P2, A1
(40%)			CO 1	C1-C2, P1, A1
	Mid Term	10%	CO 2	C1-C2, P1-P2, A1-A2
			CO 3	C1-C2, P1-P2, A1-A2
			CO 1	C1-C2, P1, A1
	Final Exam	60%	CO 2	C1-C2, P1-P2, A1-A2
			CO 3	C1-C2, P1-P2, A1-A2
	Total Marks	100%		

#### (CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain) REFERENCE BOOKS

1. Gupta, A. K. Engineering Management. India, S. Chand Publishing, 2014.

- 2. Telsang, Martand. Industrial Engineering and Production Management: For Undergraduate, Postgraduate Courses and Diploma Programmes in Mechanical, Production and Industrial Engineering Students. A Useful Guide for HE, Management Courses, Professional Engineers and Competitive Examinations for GATE and UPSC and Engineering Services Examinations. S. Chand, 2006.
- 3. Yukl, Gary. Leadership in Organizations, 9/e. Pearson Education India, 1981.
- 4. Whetten, David Allred, Kim S. Cameron, and Mike Woods. *Developing management skills*. Upper Saddle River, NJ: Prentice Hall, 2007.

### **REFERENCE SITE**

# APPENDIX A

# **EQUIVALENCE TABLE**

		Old Courses (2018-2		New Courses (2020-2023)					
Ser	Course Code	Course Name	Cr Hr	Ct Hr	Course Code	Course Name	Cr Hr	Ct Hr	
1.	Hum 106	English and Communication Skill Sessional	1.50	3.00	ENG 102	Communicative English - I	1.50	3.00	
2.	Hum 252	Introduction to Russian Language-I	0.75	1.50	RUS 172	Introduction to Russian Language - I	0.75	1.50	
3.	Hum 254	Introduction to Russian Language-II	0.75	1.50	RUS 174	Introduction to Russian Language - II	0.75	1.50	
4.	NSE 391	Engineering Ethics	2.00	2.00	Gen 377	Engineering Ethics and Morale Philosophy	2.00	2.00	
5.	Phy 151	Structure of Matter, Modern Physics and Wave Mechanics	3.00	3.00	Phy 101	Physics - I	3.00	3.00	
6.	Phy 152	Physics Sessional	1.50	3.00	Phy 102	Physics- I Sessional	1.50	3.00	
7.	Chem 171	Introduction to Chemistry	3.00	3.00	Chem 101	Chemistry - I	3.00	3.00	
8.	Chem 172	Inorganic Quantitative Analysis Sessional	1.50	3.00	Chem 102	Chemistry Sessional - I	1.50	3.00	
9.	Math 191	Differential and Integral Calculus	3.00	3.00	Math 101	Differential and Integral Calculus	3.00	3.00	
10.	Math 193	Differential Equations (ODE & PDE)	3.00	3.00	Math 103	Differential Equations and Matrix	3.00	3.00	
11.	Math 291	Vector Analysis, Matrices and Coordinate Geometry	3.00	3.00	Math 201	Vector Analysis, Laplace Transform and Coordinate Geometry	3.00	3.00	
12.	EECE 119	Fundamental of Electrical Engineering	3.00	3.00	EECE 119	Fundamentals of Electrical Engineering	3.00	3.00	
13.	EECE 120	Fundamental of Electrical Engineering Sessional	0.75	1.50	EECE 120	Fundamentals of Electrical Engineering Sessional	0.75	1.50	
14.	ME 180	Basic Engineering Drawing	1.50	3.00	ME 180	Basic Engineering Drawing	1.50	3.00	
15.	ME 253	Engineering Mechanics	3.00	3.00	ME 253	Engineering Mechanics	3.00	3.00	
16.	ME 254	Engineering Mechanics Sessional	0.75	1.50	ME 254	Engineering Mechanics Sessional	0.75	1.50	

17.	CSE 121	Introduction to Computer Science and Programming Language	3.00	3.00	CSE 121	Introduction to Computer Science and Programming Language	3.00	3.00
18.	CSE 122	Computer Science & Programming Language Sessional	0.75	1.50	CSE 122	Computer Science & Programming Language Sessional	0.75	1.50
19.	NSE 101	Introduction to Nuclear Science and Engineering	3.00	3.00	NE 101	Introduction to Nuclear Engineering	3.00	3.00
20.	NSE 153	Fundamental of Nuclear Physics	3.00	3.00	NE 105	Fundamental of Atomic and Nuclear Physics	3.00	3.00
21.	ME 153	Basic Engineering Thermodynamics	3.00	3.00	NE 141	Fundamental of Thermodynamics	3.00	3.00
22.	NSE 201	Neutron Transport and Rector Physics	3.00	3.00	NE 207	Reactor Theory and Analysis - I	3.00	3.00
23.	NSE 242	Thermal Engineering Sessional	0.75	1.50	NE 244	Fundamentals of Heat Transfer and Thermal Engineering Sessional	1.50	3.00
24.	NSE 273	Introduction to Nuclear and Radio Chemistry	3.00	3.00	NE 203	Introduction to Nuclear and Radio Chemistry	3.00	3.00
25.	NSE 274	Nuclear and Radio Chemistry Lab	0.75	1.50	NE 204	Introduction to Nuclear and Radio Chemistry Sessional	0.75	1.50
26.	NSE 261	Numerical Methods in Nuclear Engineering Analysis	3.00	3.00	NE 261	Numerical Methods in Nuclear Engineering Analysis	3.00	3.00
27.	NSE 262	Modeling and Simulation Sessional	1.50	3.00	NE 262	Numerical Methods in Nuclear Engineering Sessional	1.50	3.00
28.	NSE 281	Nuclear Materials	3.00	3.00	NE 251	Nuclear Materials	3.00	3.00
29.	NSE 282	Nuclear Materials Sessional	1.50	3.00	NE 252	Nuclear Materials Sessional	1.50	3.00
30.	NSE 301	Radiation Detection and Measurement	3.00	3.00	NE 301	RadiationDetectionandMeasurement	3.00	3.00
31.	NSE 302	Radiation Detection and Measurement Sessional	0.75	1.50	NE 302	RadiationDetectionandMeasurementSessional	0.75	1.50
32.	NSE 305	Nuclear Reactor Thermal Hydraulics	3.00	3.00	NE 305	Nuclear Reactor Thermal Hydraulics	3.00	3.00

33.	NSE 306	Nuclear Reactor Thermal Hydraulics Sessional	1.50	3.00	NE 306	Nuclear Reactor Thermal Hydraulics Sessional	1.50	3.00
34.	NSE 309	Nuclear Fuel Cycle and Radioactive Waste Management	3.00	3.00	NE 409	Nuclear Fuel Cycle and Radioactive Waste Management	3.00	3.00
35.	NSE 313	Reactor Instrumentation and Control	3.00	3.00	NE 333	Reactor Instrumentation and Control	3.00	3.00
36.	NSE 325	Fluid Mechanics and Machinery	3.00	3.00	NE 351	Fluid Mechanics and Machinery	3.00	3.00
37.	NSE 326	Fluid Mechanics and Machinery Sessional	0.75	1.50	NE 352	Fluid Mechanics and Machinery Sessional	0.75	1.50
38.	NSE 329	Reactor Operation and Safety	3.00	3.00	NE 321	Reactor Operation and Safety	3.00	3.00
39.	NSE 357	Nuclear Security and Safeguard Engineering	3.00	3.00	NE 317	Nuclear Security and Safeguard Engineering	3.00	3.00
40.	ME 373	Mechanics of Materials	3.00	3.00	NE 353	Mechanics of Materials	3.00	3.00
41.	ME 374	Mechanics of Materials Sessional	0.75	1.50	NE 354	Mechanics of Materials Sessional	0.75	1.50
42.	NSE 375	Automation, Robotics and Control	3.00	3.00	NE 331	Automation, Robotics and Linear Control Systems	3.00	3.00
43.	NSE 393	Reactor Theory and Analysis	3.00	3.00	NE 307	Reactor Theory and Analysis - II	3.00	3.00
44.	NSE 320	Industrial Training	1.00	0.00	NE 320	Industrial Training	1.00	4 Wks
45.	NSE 403	Nuclear Power Plant Engineering	3.00	3.00	NE 427	NuclearPowerPlant Engineering	3.00	3.00
46.	NSE 400	Thesis	6.00	12.00	NE 400	Final Year Design and Research Project	6.00	12.00
47.	NSE 437	NuclearAccidentsAnalysisandRadiologicalEmergency	3.00	3.00	NE 417	Nuclear Accidents Analysis and Radiological Emergency	3.00	3.00
48.	NSE 431	Power Generation and Grid Stability	3.00	3.00	NE 431	PowerSystemEngineeringandGrid Interface withNuclearPowerPlants	3.00	3.00
49.	NSE 459	Computational Fluid Dynamics (CFD)	3.00	3.00	NE 459	Computational Fluid Dynamics (CFD)	3.00	3.00
50.	NSE 433	Fundamentals of Fusion Engineering	3.00	3.00	NE 433	Fundamentals of Fusion Engineering	3.00	3.00

51.	NSE 413	Medical Applications of Nuclear Technology	3.00	3.00	NE 413	Medical Applications of Nuclear Technology	3.00	3.00
52.	NSE 405	NuclearChemicalEngineeringandCorrosion	3.00	3.00	NE 405	Nuclear Chemical Engineering and Corrosion	3.00	3.00
53.	NSE 407	Non-Destructive Testing and Evaluation	3.00	3.00	NE 407	Non-Destructive Testing and Evaluation	3.00	3.00