MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

SYLLABUS
BACHELOR OF SCIENCE IN
NUCLEAR ENGINEERING

MARCH 2024

Department of Nuclear Science and Engineering
Military Institute of Science and Technology
Mirpur Cantonment
Dhaka-1216, Bangladesh

COMMITTEE OF COURSES

References:

A. MIST Letter Number 23.12.0902.002.01.082.23 dated 20 December 2023.
B. BUP Letter Number 23.01.902.858.10.786.124.24.01.24 Dated 31 January 2024.

1. The syllabus of the Department of Nuclear Science and Engineering (NSE) of Military Institute of Science and Technology (MIST) has been reviewed by a committee of courses was formed by BUP. The meetings of the committee were held on 24 and 28 March 2024 to 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 Introduction to MIST

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 Vision and Mission of MIST

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 Salient Features of MIST

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 Faculties

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 Eligibility of Students for Admission in MIST (Subject to review each year)

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 Number of Seats

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:

Allocation of Seats

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.	**A**	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.	**B**	Architecture (Arch)	25
	Total		570

1.8 Admission Procedure

1.8.1 Syllabus for Admission Test. 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
c.	Chemistry	40
d.	English	20
		Total = 200

1.8.2 Final Selection. 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 Medical Checkup. 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 Students Withdrawal Policy

1.9.1 General Policy of Withdrawal

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 Withdrawal on Disciplinary Ground

a. **Unfair Means**. 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. **Influencing Grades.** 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. **Other Indiscipline Behaviours.** 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. **Immediate Action by the Disciplinary Committee of MIST.** 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 Withdrawal on Own Accord

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

b. **Temporary Withdrawal.** 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 Introduction

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 The Course System

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 Number of Terms in a Year

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 Course Pattern and Credit Structure

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

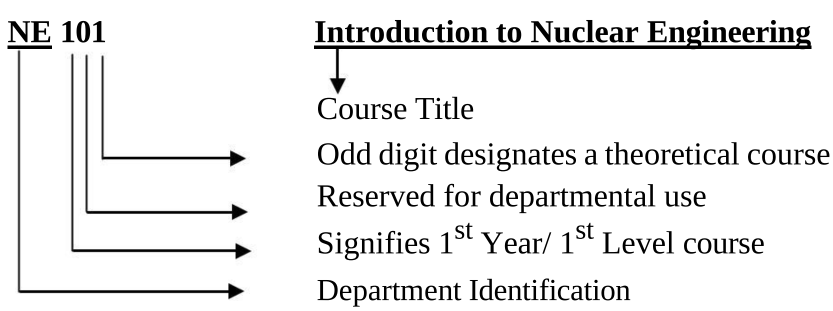
2.6 Course Designation System

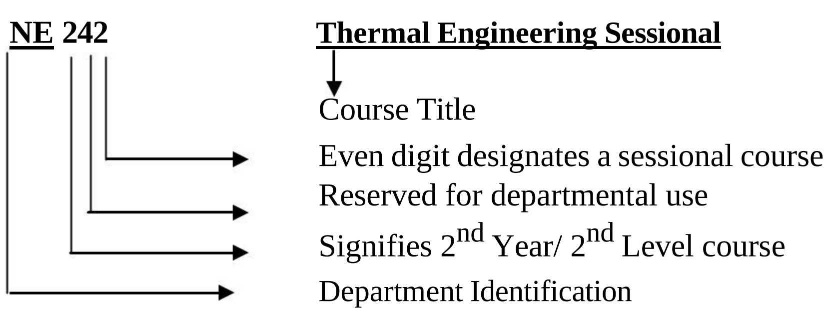
Each course is designated by a maximum of four letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

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:





NE 201 **Neutron Transport and Rector Physics**

Course Title
Odd digit designates a theoretical course
Reserved for departmental use
Signifies 1st Year/ 1st Level course
Department Identification

2.7 Assignment of Credits

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 Types of Courses

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

a. **Core Courses.** 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. **Prerequisite Courses.** 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 Course Offering and Instruction

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 Teacher Student Interaction

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 Students' Adviser

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 Course Registration

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 Registration Procedure

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 Pre-conditions for Registration

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 Registration Deadline

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 Penalty for Late Registration

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 Withdrawal from a Term

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%	A	3.75
70% to below 75%	A-	3.50
65% to below 70%	B+	3.25
60% to below 65%	B	3.00
55% to below 60%	B-	2.75
50% to below 55%	C+	2.50
45% to below 50%	C	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 Continuation
	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 Distribution

2.21.1 Theory. 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 Sessional/Practical Examinations. 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, … , C_n and his grade points in these courses are G_1, G_2, … , 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 TC_1, TC_2, … , TC_n and his GPA in these terms are GPA_1, GPA_2, GPA_n respectively then

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

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	A	3.75	11.250
MATH 209	3.00	B	3.00	9.000
HUM 127	3.00	B-	2.75	8.250
HUM 177	3.00	B	3.00	9.000
PHY 111	3.00	A+	4.00	12.000
CSE 109	1.50	A	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 Minimum Earned Credit and GPA Requirement for Obtaining Degree (Additional Course)

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 eligible 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 Classification of Students

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 Definition of Graduating Student.

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

2.28 Performance Evaluation

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 Time Limits for Completion of Bachelor's Degree

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 Attendance. 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 Conduct and Discipline. 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 Teacher-Student Interaction

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 Recognition of Performance

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 Types of Different Examinations (Subject to change for different academic session)

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

a. **Term Final Examination:** 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. **Supplementary Examination:** 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-I 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 Rules of Different Examinations (Subject to change for different academic session)

2.36.1 Term Final Examination. 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 Supplementary Examination. 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.

l. 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 <u>Irregular Graduation</u>

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 Introduction to the program

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 Vision and Mission of the Program

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 Program Educational Objectives (PEOs)

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 Learning Outcomes (LOs):

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 Generic Skills

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.

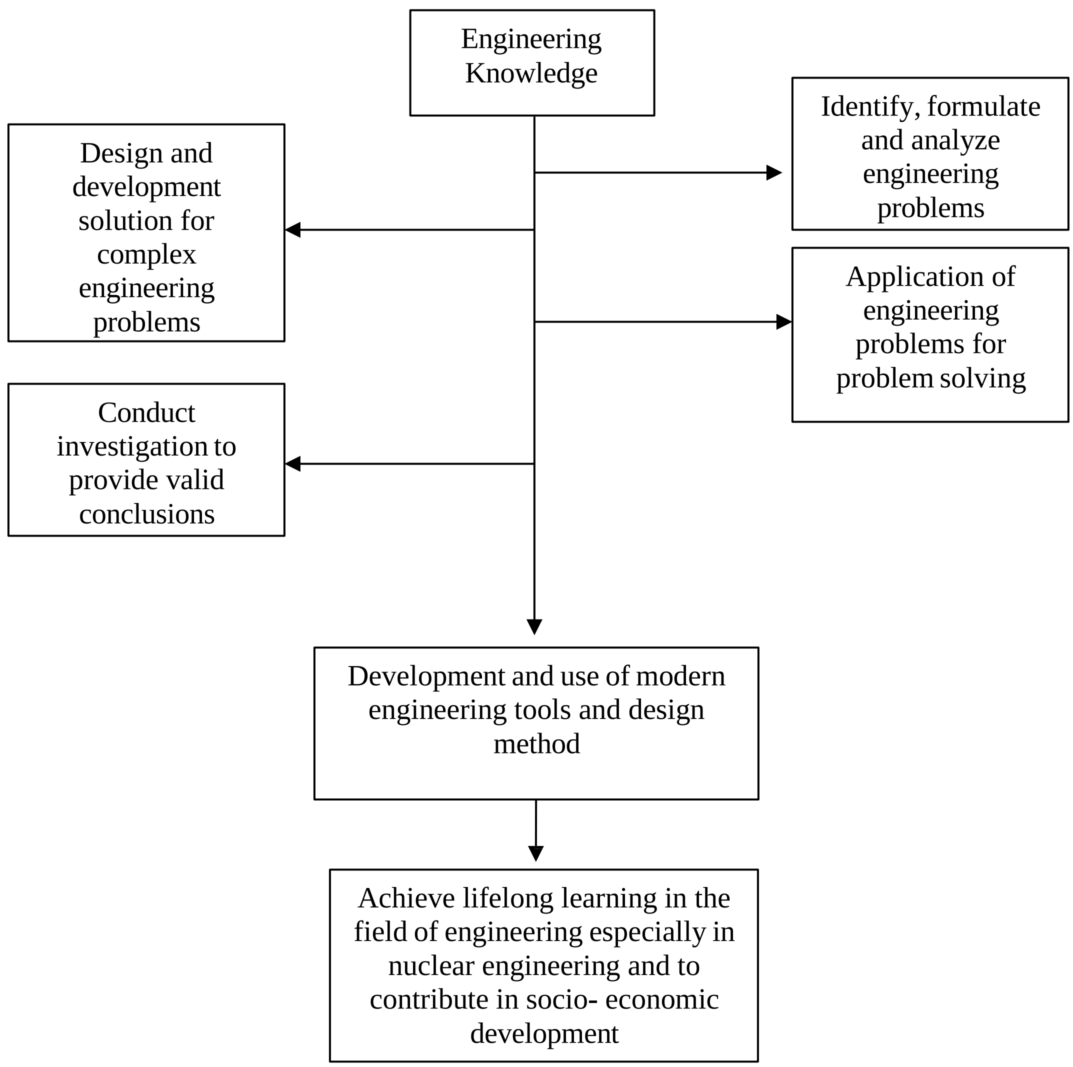
c. Ability to apply critical thinking to solve complex engineering problems and design innovative solutions.

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 Curriculum/ Skill Mapping

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 Introduction

Keeping the above-mentioned program outcome, the following courses are offered for the undergraduate students of Nuclear 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	Radiation Detection and Measurement Sessional	3-I	0.75	1.50
15.	NE 307	Reactor Theory and Analysis - II	3-I	3.00	3.00
16.	NE 317	Nuclear Security and Safeguard Engineering	3-I	3.00	3.00
17.	NE 318	Nuclear Security and Safeguard Engineering Sessional	3-I	0.75	1.5
18.	NE 331	Automation and Control Engineering	3-I	3.00	3.00
19.	NE 355	Nuclear Reactor Thermal Hydraulics	3-I	3.00	3.00

20.	NE 356	Nuclear Reactor Thermal Hydraulics Sessional	3-I	0.75	1.50
21.	NE 305	Fluid Mechanics and Machinery	3-II	3.00	3.00
22.	NE 306	Fluid Mechanics and Machinery Sessional	3-II	1.50	3.00
23.	NE 320	Industrial Training	3-II	1.50	4 Wks
24.	NE 321	Reactor Operation and Safety	3-II	3.00	3.00
25.	NE 333	Reactor Instrumentation and Control	3-II	3.00	3.00
26.	NE 334	Reactor Instrumentation and Control Sessional	3-II	0.75	1.5
27.	NE 353	Mechanics of Materials	3-II	3.00	3.00
28.	NE 354	Mechanics of Materials 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 410	Nuclear Fuel Cycle and Radioactive Waste Management Sessional	4-I	1.00	2.00
32.	NE 415	Radiation Interactions, Shielding and Protection	4-II	2.00	2.00
33.	NE 417	Nuclear Accidents Analysis and Radiological Emergency	4-I	3.00	3.00
34.	NE 423	In-core Fuel Management	4-II	3.00	3.00
35.	NE 424	In-core Fuel Management Sessional	4-II	1.00	2.00
36.	NE 425	Nuclear Reactor Design and Features	4-I	3.00	3.00
37.	NE 426	Nuclear Reactor Design and Features Sessional	4-I	1.5	3.00
38.	NE 427	Nuclear Power Plant Engineering	4-II	3.00	3.00
39.	NE 428	Nuclear Power Plant Engineering Sessional	4-II	0.75	1.50

4.3 List of Elective Courses

Ser	Course Code	Course Name	Level-Term	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-II	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
10.	NE 493	Nuclear Technology for Nonpower Applications	4-I or 4-II	3.0	3.0

4.4 List of Interdisciplinary Courses and General Education Courses

Ser	Course Code	Course Name	Level-Term	Cr Hr	Ct Hr
1.	PHY 137	Waves and Oscillations, Structure of Matter and Quantum Mechanics	1-I	3.0	3.0
2.	PHY 138	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 and Bengali	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	Electrical and Electronics Technology 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

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

a. Level – 1, Term – I

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 101	Introduction to Nuclear Engineering	3.0	3.0
2.	PHY 137	Waves and Oscillations, Structure of Matter and Quantum Mechanics	3.0	3.0
3.	MATH 101	Differential and Integral Calculus	3.0	3.0
4.	EECE 119	Fundamentals of Electrical Circuit Analysis	3.0	3.0
5.	GES 101	Fundamentals of Sociology	2.0	2.0
	Theory Total		**14.0**	**14.0**
6.	LANG 172	Introduction to Russian Language - I	0.75	1.5
7.	PHY 138	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 Total		**4.5**	**9.0**
	Term Total		**18.5**	**23.0**

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 and Bengali	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**	**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		**5.25**	**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	0.75	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 355	Fluid Mechanics and Machinery	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 and Control Engineering	3.0	3.0
6.	GEPM 381	Project Management and Finance	2.0	2.0
	Theory Total		**17.0**	**17.0**
7.	NE 302	Radiation Detection and Measurement Sessional	0.75	1.5
9.	NE 318	Nuclear Security and Safeguard Engineering Sessional	0.75	1.5
10.	NE 356	Fluid Mechanics and Machinery Sessional	0.75	1.5
	Sessional Total		**2.25**	**4.5**
	Term Total		**19.25**	**21.5**

f. Level – 3, Term – II

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 305	Nuclear Reactor Thermal Hydraulics	3.0	3.0
2.	NE 321	Reactor Operation and Safety	3.0	3.0
3.	NE 333	Reactor Instrumentation and Control	3.0	3.0
4.	NE 353	Mechanics of Materials	3.0	3.0
5.	GEEM 351	Engineering Ethics & Moral Philosophy	2.0	2.0
	Theory Total		**14.0**	**14.0**
6.	NE 306	Nuclear Reactor Thermal Hydraulics Sessional	1.5	3
7.	NE 320	Industrial Training	1.5	4 Wks
8.	NE 334	Reactor Instrumentation and Control Sessional	0.75	1.5
9.	NE 354	Mechanics of Materials Sessional	0.75	1.5
10.	GERM 352	Fundamentals of Research Methodology	2.0	4.0
	Sessional Total		**6.5**	**10+ 4 Wks**
	Term Total		**20.5**	**24 + 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	3.0	3.0
4.	-	Elective Course-1	3.0	3.0
5.	-	Elective Course-2	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 410	Nuclear Fuel Cycle and Radioactive Waste Management Sessional	1.0	2.0
8.	NE 426	Nuclear Reactor Design and Features Sessional	1.5	3.0
	Sessional Total		**5.5**	**11.0**
	Term Total		**20.5**	**26.0**

h. Level – 4, Term – II

Ser	Course Code	Course Title	Cr Hr	Ct Hr
1.	NE 415	Radiation Interactions, Shielding and Protection	2.0	2.0
2.	NE 423	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		**14.0**	**14.0**
6.	NE 400	Final Year Design and Research Project	3.0	6.0
7.	NE 424	In-core Fuel Management Sessional	1.0	2.0
8.	NE 428	Nuclear Power Plant Engineering Sessional	0.75	1.50
	Sessional Total		**4.75**	**9.5**
	Term Total		**18.75**	**23.5**

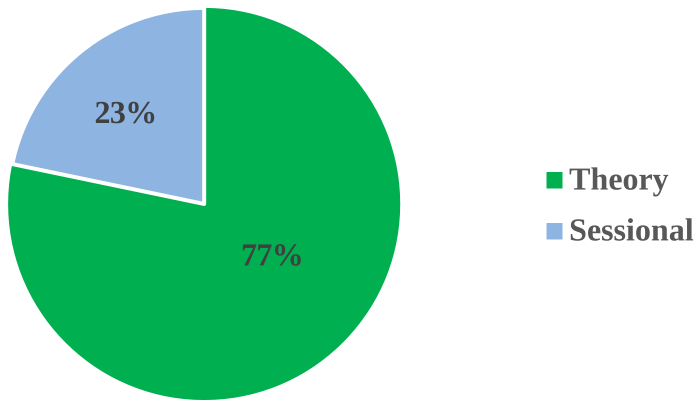
4.6 Summary of Credit Distribution - Level and Termwise

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	21.50	26.0
2-I	15	10.5	20.25	25.5
2-II	17	7.5	20.75	24.5
3-I	17	4.5	19.25	21.5
3-II	14	10 + 4 wks	20.50	24 + 4 wks
4-I	15	11	20.50	26.0
4-II	14	9.5	18.75	23.5
Total	123	71 + 4 wks	160	194 + 4 wks

4.7 Summary of Theory and Sessional Courses- Level and Termwise

Level and Term	Hours/Week		Total Ct Hours	Credits		Total Credits	No. of Courses	
	Theory	Sessional		Theory	Sessional		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	21.50	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	4.5	21.5	17.0	2.25	19.25	6	3
Level-3 Term-II	14	10 + 4 wks	24 + 4 wks	14.0	6.5	20.50	5	5
Level-4 Term-I	15	11	26.0	15.0	5.5	20.50	5	3
Level-4 Term-II	14	9.5	23.5	14.0	4.75	18.75	5	3
Grand Total	123	71 + 4 wks	194 + 4 wks	123	37	160	43	29

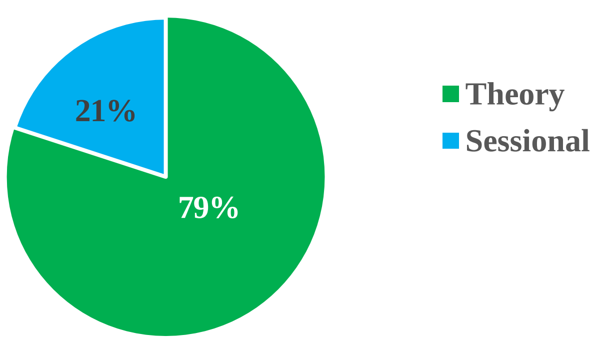
Overall Theory and Sessional Credit Hours Ratio



4.8 Summary of Departmental Theory and Sessional Courses - Level and Termwise

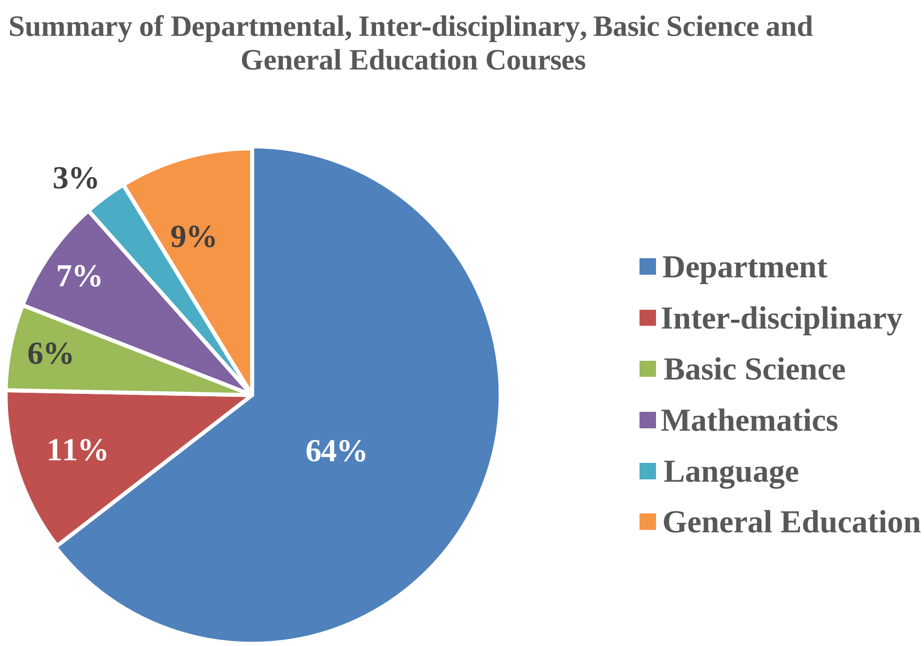
Level/ Term	Theory	Sessional	Total
Level-1 Term-I	3.0	-	3.0
Level-1 Term-II	6.0	-	6.0
Level-2 Term-I	10.0	3.75	13.75
Level-2 Term-II	6.0	1.5	7.5
Level-3 Term-I	15.0	2.5	17.5
Level-3 Term-II	12.0	4.5	16.5
Level-4 Term-I	15.0	5.5	20.5
Level-4 Term-II	14.0	4.75	18.75
Total	**81.0**	**22.25**	**103.25**

Departmental Theory and Sessional Credit Hours Ratio



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

Level/ Term	Dept	Inter-disciplinary	Basic Science	Mathematics	Language	General Education	Total
Level-1 Term-I	3.0	5.25	4.5	3	0.75	2	18.50
Level-1 Term-II	6.0	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	17.5	-	-	-	-	2	20.00
Level-3 Term-II	16.5	-	-	-		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%**



4.10 Teaching Strategy

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 centered 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 Assessment 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 achieved. The assessment strategy is given below:

a. **Theory Based Course**

Ser	Components		Grading
1	Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%
		Class Participation	5%
		Mid-term Exam	15%
2	Final Examination		60%
	Total Marks		100%

b. **<u>Sessional Course</u>**

Ser	Components		Grading
1	Continuous Assessment (60%)	Class Participation	5%
		Conduct of Lab Test	20%
		Report Writing	15%
		Mid term	20%
2	Final Evaluation (40%)	Exam	30%
		Viva Voce/ Presentation	10%
	Total Marks		100%

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

CHAPTER – 5

5. Course Description
5.1 Core Courses Offered

Level-1, Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 101 : Introduction to Nuclear 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 understanding on the basics of nuclear engineering and to introduce a variety of applications of this field.		
	OBJECTIVES		
	1. To provide an introduction on the basics of nuclear engineering and its applications. 2. To familiarize students with different types of nuclear and radiation related phenomenon. 3. To understand the basics of biological, radiological effects of radiation and its shielding principles. 4. 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 students will be able to 1. Understand the basics of nuclear engineering and the variety of applications of this engineering field. 2. Explain different types of nuclear reactions and basic nuclear phenomenon in nuclear reactors. 3. Analyze the biological, radiological effects of radiation and the methods of radiation shielding. 4. Evaluate the characteristics of nuclear power, future research scopes and applications of nuclear engineering.		

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the basics of nuclear reactors and the various of applications of nuclear engineering fields.	PO1	C2			1	T, Q, F

CO2	**Explain** different components of nuclear power plants and basic nuclear phenomena in nuclear reactors.	PO2	C2			1	MT, F
CO3	**Analyze** the nuclear fuel cycle, radioactive waste management and radiation shielding.	PO2	C4			1	ASG, F
CO4	**Evaluate** the necessity of nuclear licensing and safety procedures.	PO1	C5			1	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

Introduction, history and a short review of nuclear reactors, basic concepts of neutron reactions, nuclear material, fissile material, fissionable material, fertile material; ionizing and non-ionizing radiation; nuclear cross sections and reaction probabilities, nuclear fission and fusion, and chain reaction, criticality and multiplication factor, coolant and moderator, types of nuclear reactors, components of nuclear power reactor system, non-nuclear components of nuclear power plants, radiation shielding, basic knowledge of nuclear fuel cycle and radioactive waste management, Basic knowledge of nuclear licensing and safety.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basics of nuclear reactors and the various applications of nuclear engineering fields.	2											
CO2	**Explain** different components of nuclear power plants and basic nuclear phenomena in nuclear reactors.		2										
CO3	**Analyze** the nuclear fuel cycle, radioactive waste management and radiation shielding.		1										
CO4	**Evaluate** the necessity of nuclear licensing and safety procedures.	1											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	In order to apply fundamentals of nuclear engineering and a variety of applications in solving various engineering problems related to nuclear.
CO2-PO2	2	In order to undertake nuclear relevant problem identification, formulation and solution.
CO3-PO2	1	In order to undertake nuclear relevant problem identification, formulation and solution.

CO4-PO1	1	In order to apply fundamentals of nuclear engineering and a variety of applications in solving various engineering problems related to nuclear.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to nuclear engineering, a short review of nuclear physics	**Class Test 1, Final Exam**
Week-2	Basic concepts in neutron reactions	
Week-3	Nuclear reactor safety and licensing, The fission chain reaction	
Week-4	The history of radiation effects, radiation units, exposure	**Class Test 2, Final Exam**
Week-5	Alpha, beta, gamma, neutron radiation	
Week-6	Attenuation formula, attenuation coefficient, half value layer	
Week-7	Interaction of ionizing radiation with matter, radiation effects on human health	
Week-8	The biological effects of radiation, natural and man-made radiation sources	**Mid Term, Final Exam**
Week-9	Non-nuclear components of nuclear power plants, components of nuclear reactors	
Week-10	Radiation dose and biological dose, population dose	
Week-11	Elements of nuclear power reactor system	**Class Test 3, Final Exam**
Week-12	Radiation shielding	
Week-13	Neutron moderation and diffusion	
Week-14	Power reactors, nuclear reactor safety and licensing	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
	Class Participation and Class attendance	5+5= 10%	CO1	C2
	Mid term	10%	CO2	C2
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. 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 knowledge on the basics of Nuclear Physics and principal models of the nuclear study and radioactivity.		

	OBJECTIVES

	1. To introduce the principal models of the nuclear study and radioactivity. 2. To understand the characteristics of the nuclear force, electron scattering, neutrino hypothesis and deuteron properties. 3. To discuss the spontaneous decay of nuclei, nuclear reactions, fission and fusion processes. 4. To understand the nuclear force, nuclear reactions methods and reaction theory.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply the principal models of the nuclear study and radioactivity. 2. Analyze the nuclear force, electron scattering, neutrino hypothesis and deuteron properties. 3. Explain the spontaneous decay of nuclei, nuclear reactions, fission and fusion process. 4. Evaluate the nuclear force, nuclear reactions methods and reaction theory.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the basic properties of atomic physics and nuclei	PO1	C3	-	-	1	T, Q, F
CO2	**Analyze** the nuclear force and models	PO2	C4	-	-	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 fusion in the star.	PO1	C5	-	1	1	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
	Introduction to Atomic Physics, Basic Properties of Atomic Nuclei, Shape of the Nucleus: Electric Moments and magnetic Moment, Nuclear spin, Nuclear Binding Energy, Energy levels, the Semi-Empirical Liquid Drop Nuclear Model, and Mass Parabolas, Stability, Deuteron problem, Nuclear Force and Nuclear Models, Radioactive decay series and radioactive equilibrium, alpha, beta and gamma emission, neutrino hypothesis, positron emission, electron capture , internal conversion, neutrino hypothesis, different types of nuclear reactions, Electromagnetic interactions, Weak interactions, Strong interactions, Symmetries and conservation laws, nuclear astrophysics, Nuclear fusion and reactions in the stars, applications of nuclear physics, Basic concepts of particle accelerators.

	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basic properties of atomic physics and nuclei	2											
CO2	**Analyze** the nuclear force and models		2										
CO3	**Explain** the spontaneous decay of nuclei, nuclear reactions, fission and fusion process.		2										
CO4	**Evaluate** the nuclear fusion in the star.	2											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	In order to apply the principal models of the nuclear study and radioactivity, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to apply.
CO2-PO2	2	In order to analyze the nuclear force, electron scattering, neutrino hypothesis and deuteron properties, 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 explain the spontaneous decay of nuclei, nuclear reactions, fission and fusion process, 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-PO1	2	In order to evaluate the nuclear force, nuclear reactions methods and reaction theory, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered 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	Introduction to Atomic Physics, Basic Properties of Atomic Nuclei	**Class Test 1, Final Exam**
Week-2	Shape of the Nucleus: Electric Moments and magnetic Moment, Nuclear spin	
Week-3	Nuclear Binding Energy, Energy levels, the Semi-Empirical Liquid Drop Nuclear Model	
Week-4	Mass Parabolas, Stability, Deuteron problem	**Class Test 2, Final Exam**
Week-5	Nuclear Force and Nuclear Models	
Week-6	Radioactive decay series and radioactive equilibrium, alpha, beta and gamma emission	
Week-7	Neutrino hypothesis, positron emission, electron capture, internal conversion	
Week-8	Different types of nuclear reactions	**Mid Term, Final Exam**
Week-9	Electromagnetic interactions, Weak interactions, Strong interactions	
Week-10	Symmetries and conservation laws	
Week-11	Nuclear astrophysics, nuclear fusion and reactions in the stars	**Class Test 3, Final Exam**
Week-12	applications of nuclear physics,	
Week-13	Basic concepts of particle accelerators	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, 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, 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 thermodynamics and its application to a range of problems, relevant to practical engineering as well as to equip the students with the basic tools and methodologies for carrying out thermodynamic analysis of engineering systems.		
	OBJECTIVES		
	1. To introduce the fundamentals of thermodynamics and operating principles of energy transfer between systems encountered in engineering. 2. To incorporate the laws of thermodynamics and their corollaries. 3. To understand the thermodynamic cycles. 4. To formulate the thermodynamic relation to various thermodynamic processes. 5. To evaluate psychrometry and psychometric processes.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Define the fundamentals of thermodynamics in solving various engineering problem related to process of energy transfer. 2. Explain the laws of thermodynamics to the thermodynamic cycles and cyclic devices. 3. Interpret psychrometry and psychometric processes. 4. Analyze the thermodynamic relation to various thermodynamic processes using the equation of energy balance and conservation.		

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO1	**Understand** the fundamental properties and relations of thermodynamics in solving various engineering problems related to process of energy transfer.	PO1	C2	-	-	1	T, Q, F
CO2	**Apply** the laws of thermodynamics to various engineering devices.	PO2	C3	-	-	1	ASG, F
CO3	**Explain** refrigeration, psychometry and psychometric processes.	PO2	C3	-	-	1	MT, F
CO4	**Analyze** the thermodynamic cycles to various thermodynamic processes using the equation of energy balance and conservation.	PO2	C4	-	-	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)

COURSE CONTENT

Fundamental concepts; Energy, energy transfer and Laws of Thermodynamics; Properties of gases and vapours, properties of pure substances; Energy analysis of control mass and control volume system, non-flow and flow processes; Entropy and exergy analysis; Thermodynamics relations: Maxwell's equations, relations among thermodynamic properties.

Joule-Thomson effect, Clausius-Clapeyron equation, Ideal gases and their cycles: Ideal cycles – Carnot cycle, Otto cycle, Diesel cycle; Gas power cycles – Brayton cycle; Vapour Power cycles; Refrigeration cycles; Mixture of gases and vapours, Psychrometry and psychometric processes.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the fundamental properties and relations of thermodynamics in solving various engineering problems related to process of energy transfer.	2											
CO2	**Apply** the laws of thermodynamics to various engineering devices.		2										
CO3	**Explain** refrigeration, psychometry and psychometric processes.		2										
CO4	**Analyze** the thermodynamic cycles to various thermodynamic processes using the equation of energy balance and conservation.		2										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR 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 processes, 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 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 STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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

Week-1	Fundamental concepts, energy and energy transfer	**Class Test 1, Final Exam**
Week-2	First Law of Thermodynamics	
Week-3	Properties of gases and vapours	
Week-4	Properties of pure substances	**Class Test 2, Final Exam**
Week-5	Energy analysis of control mass and control volume system	
Week-6	Non-flow and flow processes	
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	**Mid Term, Final Exam**
Week-9	Second Law of Thermodynamics; Entropy and exergy analysis	
Week-10	Thermodynamics relations: Maxwell's equations, relations among thermodynamic properties, Joule-Thomson effect, Clausius-Clapeyron equation	
Week-11	Mixture of gases and vapours	**Class Test 3, Final Exam**
Week-12	Psychrometry and psychometric processes	
Week-13	Psychrometry and psychometric processes	
Week-14	Revision	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C3, C4
	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* , 14 th 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	Lecture Contact Hours Credit Hour	: 1.50 : 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		
	1. To develop the four basics skills of Russian language, i.e. listening, speaking, reading and writing. 2. To develop students' interpersonal skills engaging them in various group interactions and activities. 3. To improve students' pronunciation in order to improve their level of comprehensibility in both speaking and listening. 4. To give the students exposure to different types of texts in Russian language in order to make them informed using different techniques of reading. 5. 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.		
	LEARNING OUTCOME		
	Upon completion of the course, the students will be able to 1. Listen, understand, and learn the techniques of note taking and answering questions. 2. Understand reading techniques and speak Russian language quickly and smartly using the techniques learnt in the class. 3. Communicate effectively within the shortest possible time to present their ideas and opinions. 4. Develop competency in reading, writing and oral communication /presentation.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Listen, **understand**, and **learn** the techniques of note taking and answering questions.	PO1	C2	-	-	1	ASG, Q

CO2	**Understand** reading techniques and speak Russian quickly and smartly using the techniques learnt in the class.	PO1	C3	-	-	1	ASG/ Pr, Q
CO3	**Communicate effectively** within the shortest possible time to present their ideas and opinions.	PO10	C4	-	-	1	Pr, Q
CO4	**Develop** competency in reading, writing and oral communication /presentation.	PO10	C3	-	-	2	ASG/ 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

Introduction to Language: Introducing basic skills of language, Russian language 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 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).
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.
Reading techniques: scanning, skimming, predicting, inference; Reading Techniques: analysis, summarizing and interpretation of texts.
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.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Listen, **understand**, and **learn** the techniques of note taking and answering questions.	3											
CO2	**Understand** reading techniques and speak Russian quickly and smartly using the techniques learnt in the class.	3											
CO3	**Communicate effectively** within the shortest possible time to present their ideas and opinions.										2		
CO4	**Develop** competency in reading, writing and oral communication /presentation.										1		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING		
Mapping	**Corresponding Level of Matching**	**Justification**
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	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 communicate effectively within the shortest possible time to present their ideas and opinions, 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.
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 STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 14 28 -
	Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test	 14 10
	Preparation of presentation Formal Assessment Continuous Assessment	9 14
	Final Quiz	1
	Total	90

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

COURSE SCHEDULE		
Weeks	**Topics**	**Remarks**
Week-1	Introduction to Language: Introducing basic skills of language, Russian for Science and Technology	**Participation/ Assignment, Quiz**
Week-2	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.	
Week-3	Asking and answering questions, expressing likings and disliking (food, fashion etc.); asking and giving directions	

Week-4	Discussing everyday routines and habits, making requests/ offers/ invitations/ excuses/ apologies/ complaints	**Presentation, Quiz**
Week-5	Describing personality, discussing and making plans (for a holiday or an outing to the cinema), describing pictures / any incident / event	
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	**Assignments/ Presentation, Quiz**
Week-12	Reading techniques: analysis, summarizing and interpretation of texts	
Week-13	Introductory discussion on writing, prewriting, drafting; topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
Week-14	Paragraph writing, Compare-contrast and cause- effect paragraph	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Participation/ Assignment	20%	CO1, CO2, CO4	C2, C3
	Reading Test	15%	CO1, CO2, CO4	C2, C3
	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 174 Introduction to Russian Language-II	Lecture Contact Hours Credit Hour	: 1.50 : 0.75
	PRE-REQUISITE		
	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' oral performances.		
	OBJECTIVES		
	1. To develop Russian language skills to communicate effectively and professionally. 2. To strengthen students' presentation skills. 3. To develop competency in academic reading and writing.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Understand the techniques of academic reading and become familiar with technical terms and develop competency in academic reading, preparing report written communication/ presentation. 2. Analyze any problem critically, analyze and interpret data and synthesize information to provide valid conclusions. 3. Communicate effectively within the shortest possible time to present their reports and academic writings. 4. 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.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the techniques of academic reading and become familiar with technical terms and **develop** competency in academic reading,	PO1	C2	-	-	1	ASG, Q

	preparing report written communication/ presentation.						
CO2	**Analyze** any problem critically, analyze and interpret data and synthesize information to provide valid conclusions.	PO1	C4	-	-	1	ASG/ Pr, Q
CO3	**Communicate effectively** within the shortest possible time to present their reports and academic writings.	PO10	C6	-	-	1	Pr, Q
CO4	**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.	PO10	C3	-	-	2	ASG/ 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

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 semi-formal, Formal/official letters, Official E-mail; Applying for a job: Writing Cover Letter and Curriculum Vitae; 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; Analyzing and describing graphs or charts; Practicing analytical and argumentative writing.
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.
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; Listening and understanding speeches/lectures of different accents.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the techniques of academic reading and become familiar with technical terms and **develop** competency in academic reading, preparing report written communication/ presentation.	3											
CO2	**Analyze** any problem critically, analyze and interpret data and synthesize information to provide valid conclusions.	3											
CO3	**Communicate effectively** within the shortest possible time to present their reports and academic writings.										2		
CO4	**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.										1		

(3 – High, 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 become familiar with technical terms and develop competency in academic reading, preparing report written communication/ presentation, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO2-PO1	3	In order to analyze any problem critically, analyze and interpret data and synthesize information to provide valid conclusions, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO3-PO10	2	In order to communicate effectively within the shortest possible time to present their reports and academic writings, 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.
CO4-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 STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 14 28 -
	Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test	 14 10
	Preparation of presentation Preparation of Quiz Engagement in Group Projects	9 - -
	Formal Assessment	
	Continuous Assessment	14
	Final Quiz	1
	Total	90

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

COURSE SCHEDULE		
Weeks	**Topics**	**Remarks**
Week-1	Reading Comprehension: Practice using different techniques	**Participation, Quiz**
Week-2	Academic reading: comprehension from departmental or subject related passages	

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	**Assignment, Quiz**
Week-5	Applying for a job: Writing Cover Letter and Curriculum Vitae	
Week-6	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading	
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	**Presentation, Quiz**
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	
Week-13	Listening to long lecture on some topics	
Week-14	Listening and understanding speeches/lectures of different accents	

ASSESSMENT STRATEGY

Components		**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessment (40%)	Class Participation/ Assignment	20%	CO1, CO2, CO4	C2-C4
	Reading Test	15%	CO1, CO2, CO4	C2-C4
	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 Chemistry	Lecture Contact Hours Credit Hours	: 3.00 : 3.00

PRE-REQUISITE

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

1. To understand the concept of nuclear and radiochemistry.
2. To know about the nature of nuclear reaction and reaction mechanisms.
3. To understand the concepts of stability of nuclear material.
4. To know the application of radioisotope in different sector.
5. To know about separation of radioisotopes and introduce different separation method.

LEARNING OUTCOMES

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

1. Apply fundamental concepts of nuclear reaction and reaction mechanisms, and compare with nuclear and chemical reaction.
2. Analyze stability of nuclear material, activation analysis of radioactive material, chemical analysis using radiotracers, isotope dilution analysis, and decay chain analysis.
3. Explain production of radionuclides, environmental aspects of radionuclide, application of radioisotope in different sector.
4. Evaluate decay law, half-life, mean life, radioactive equilibrium, different separation method like solvent extraction method, ion exchange method etc.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the basic concept of nuclear and radio chemistry.	PO1	C3	1	-	3	T, Q, F
CO2	**Explain** the chemical effects induced by nuclear reactions.	PO1, PO2, PO3	C4	2	-	4, 5	ASG, F
CO3	**Explain** the production of radio-isotopes and activation analyses.	PO1, PO3	C2	1	-	4	MT, F

CO4	**Apply** different separation methods and isotope dilution analysis.	PO1, PO2	C5	2	1	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)						

COURSE CONTENT

History of nuclear and radio chemistry; definitions (atomic nucleus, isotopes etc.), decay law, half-life, Mean life, nature of nuclear reaction, Mass and stability of the atomic nucleus, chemical effects induced by nuclear reactions, Radioactive equilibrium, nuclear reaction mechanisms, Detection and measurement of radioactivity, Production of radio-isotopes, Environmental aspects of radionuclide, chemical analysis using radiotracers, Activation analysis, Different separation methods, solvent extraction method, ion exchange method, Separation of cesium & strontium, Isotope dilution analysis, Application of radioisotope in different sector.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basic concept of nuclear and radio chemistry.	2											
CO2	**Explain** the chemical effects induced by nuclear reactions.	2	2	2									
CO3	**Explain** the production of radio-isotopes and activation analyses.	3		3									
CO4	**Apply** different separation methods and isotope dilution analysis.	2	2										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	In order to apply fundamental concepts of nuclear reaction and reaction mechanisms, and compare with nuclear and chemical reaction, detection and measurement of radioactivity, the knowledge of mathematics, natural science,

		engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO2-PO1	2	In order to analyze stability of nuclear material, activation analysis of radioactive material, chemical analysis using radiotracers, isotope dilution analysis, and decay chain analysis, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO2-PO2	2	In order to analyze stability of nuclear material, activation analysis of radioactive material, chemical analysis using radiotracers, isotope dilution analysis, and decay chain analysis, 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 stability of nuclear material, activation analysis of radioactive material, chemical analysis using radiotracers, isotope dilution analysis, and decay chain analysis, 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-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	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, radioactive equilibrium, different separation method like solvent extraction method, ion exchange method etc., the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO4-PO2	2	In order to evaluate decay law, half-life, mean life, radioactive equilibrium, different separation method like solvent extraction method, ion exchange method etc. 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 STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

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

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
	Class Participation and Class attendance	5+5= 10%	CO1	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	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
	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 analyze the basic nuclear and chemical properties of nuclear material and radio isotopes.		

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** fundamental concepts of detection and measurement of radioactivity.	PO1, PO4	C3	1	-	4	R, Q, T
CO2	**Analyze** different separation method like solvent extraction method, ion exchange method etc. for various radioisotopes.	PO2, PO4	C4	1	-	4	R, Q, 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)						

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

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** fundamental concepts of detection and measurement of radioactivity.	2			3								
CO2	**Analyze** different separation method like solvent extraction method, ion exchange method etc. for various radioisotopes.		2		3								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	In order to apply fundamental concepts of detection and measurement of radioactivity, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems are to apply.
CO1-PO4	3	In order to apply fundamental concepts of detection and measurement of radioactivity, ability to design and conduct experiments, as well as to analyze and interpretation of data.
CO2-PO2	2	In order to analyze different separation method like solvent extraction method, ion exchange method etc. for various radioisotopes, 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-PO4	3	In order to analyze different separation method like solvent extraction method, ion exchange method etc. for various radioisotopes, ability to design and conduct experiments, as well as to analyze and interpretation of data.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical / Tutorial / Studio	28
Student-Centered 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 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**	**CO**	**Blooms Taxonomy**
Continuous Assessment (40%)	Lab participation and Report	20%	CO 1, CO2	C3, C4
	Labtest-1, Labtest-2	40%	CO1, CO2	C3, C4
	Viva Voce	15%	CO1, CO2	C3, C4
Lab Quiz		25%	CO1, CO2	C3, C4
Total Marks		100%		

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

REFERENCE BOOKS

1. 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

Level-2, Term-II

	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

1. To introduce the neutron transport and diffusion theory.
2. To understand fundamental properties of the NTE, neutron interactions and development of one-group neutron diffusion theory.
3. To discuss the basic definitions and concepts of chain-reacting systems.
4. To understand the reactivity effects of reactor power and transmutation of radionuclide in nuclear reactors.

LEARNING OUTCOMES

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

1. Apply neutron transport and diffusion theory in various reactor core configurations.
2. Analyze the diffusion theories depending on source geometry.
3. Explain the basic concepts and definitions of chain-reacting systems.
4. Evaluate the reactivity effect and Doppler Effect on reactor power.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** different fundamental properties of neutron transport and diffusion equations.	PO1, PO2	C3	-	-	3	T, Q, F
CO2	**Analyze** the diffusion theories depending on source geometry in various reactor core configurations.	PO3	C4	-	-	4	T, ASG, F
CO3	**Explain** the basic concepts and definitions of chain-reacting systems.	PO2, PO3	C2	-	-	4	MT, F
CO4	**Evaluate** the reactivity and Doppler Effects on reactor power.	PO1, PO3	C5	-	-	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)

COURSE CONTENT

	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, The multi neutron diffusion equation. Solution of the neutron diffusion equation for passive media with an external neutron source, 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 critical size of a thermal reactor, power and breeding, fission and fusion reaction, fission characteristics, chain reaction, fast and thermal spectrum calculations, reactor dynamics, reactivity, reactivity effects on reactor power, in-hour equation, delayed neutron, doppler effect, production and transmutation of radionuclide in nuclear reactors.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** different fundamental properties of neutron transport and diffusion equations.	3	3										
CO2	**Analyze** the diffusion theories depending on source geometry in various reactor core configurations.			2									
CO3	**Explain** the basic concepts and definitions of chain-reacting systems.		2	2									
CO4	**Evaluate** the reactivity and Doppler Effects on reactor power.	2		2									

(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.
CO1-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.
CO2-PO3	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 considerations.
CO3-PO2	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.

CO3-PO3	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.
CO4-PO1	2	In 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-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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Four and six-factor formula, neutron transport and diffusion theory	**Class Test 1 Final**
Week-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	**Class Test 2 Final**
Week-5	Introduction to buckling, multiplication constants, critical size	
Week-6	Neutron slowing down, and resonance capture	
Week-7	Applications using two-group theory, methodologies of neutron flux calculations	
Week-8	The chain-reacting systems, thermal nuclear reactor	

Week-9	The calculation of the multiplication factor for a homogenous thermal reactor, heterogeneous thermal reactor	**Mid Term**
Week-10	The critical size of a thermal reactor, power and breeding	
Week-11	Fission and fusion reaction, fission characteristics, chain reaction	**Class Test 3 Final**
Week-12	Fast and thermal spectrum calculations, reactor dynamics	
Week-13	Reactivity, reactivity effects on reactor power, in-hour equation, delay neutron	
Week-14	Doppler effect, production and transmutation of radionuclide in nuclear reactors	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, 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. 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

Level-2, Term-I

	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
	1. To provide an introduction to heat and momentum transfer encountering practical application in industry. 2. To introduce the sources of conventional and renewable energy. 3. To know the function of steam generators and turbines. 4. To familiarize with the different types of refrigeration and air conditioning systems.
	LEARNING OUTCOMES

	Upon completion of the course, the students will be able to 1. Define the principles of heat and momentum transfer to basic engineering systems. 2. Analyze and calculate heat and momentum transfer in complex systems involving several heat transfer mechanisms. 3. Explain the essential parts and functions of steam generators and turbines. 4. Evaluate the thermodynamic relations to various air-conditioning and refrigeration processes.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Describe** the working principles of convective heat transfer mechanisms and its physical phenomenon.	PO1	C1, C2, C5	1	1	1	T, Q, F
CO2	**Differentiate** the modes and methods of convective heat and mass transfer.	PO2	C4	3	2	2	ASG, F
CO3	**Compute** the performance characteristics of different types of heat transfer equipment.	PO4	C3	2	1	1	MT, F
CO4	**Design** different types of heat exchanging equipment based on industrial application.	PO3	C6	2	1	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)
	COURSE CONTENT

	Definition and significance of heat transfer, Basic modes of heat transfer; basic equations and principles of heat transfer, Dimensionless Number; Conduction: Fourier's law of heat conduction; one dimensional steady-state conduction; thermal resistance concept; extended surfaces and fins, two-dimensional and transient conduction. **Numerical Methods in Heat and Mass Transfer**: Finite difference methods; finite element methods; analytical solutions and approximate methods, computer-aided analysis and simulations. **Convection**: Convection mechanisms: forced and natural convection; boundary layer concepts, heat transfer coefficients and correlations, external and internal flow heat transfer. **Radiation Heat Transfer**: Blackbody radiation and Stefan Boltzmann law; radiation properties and behavior of surfaces; radiation exchange between surfaces; radiative heat transfer in participating media. Radiation shields and enclosures. **Heat Exchangers**: Classification and types of heat exchangers; analysis and design, Mass Transfer: Diffusion and Fick's law; mass transfer coefficients; mass transfer in fluids. **Heat and Mass Transfer with Phase Change**: Evaporation and condensation; boiling and condensation heat transfer; Heat and Mass Transfer in Industrial Processes.
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** the principles of heat and momentum transfer to basic engineering systems.	3											
CO2	**Analyze** and **calculate** heat and momentum transfer in complex systems involving several heat transfer mechanisms.		3										
CO3	**Explain** the essential parts and functions of steam generators and turbines.		3										
CO4	**Evaluate** the thermodynamic relations to various air-conditioning and refrigeration processes.	3	3										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The knowledge of mathematics, science, engineering fundamentals is required to define the principles of heat and momentum transfer to basic engineering systems.
CO2-PO2	3	In order to analyze and calculate heat and momentum transfer in complex systems involving several heat transfer mechanisms, 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 and calculate heat and momentum transfer in complex systems involving several heat transfer mechanisms, 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 explain the essential parts and functions of steam generators and turbines, 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-PO1	3	In order to evaluate the thermodynamic relations to various air-conditioning and refrigeration processes, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO4-PO2	3	In order to evaluate the thermodynamic relations to various air-conditioning and refrigeration processes, 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 STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	56
Practical / Tutorial / Studio	-

	Student-Centered Learning	-
	Self-Directed Learning Non-face-to-face learning Revision	 112 28
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 3 1 3
	Total	203

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Definition and significance of heat transfer, Basic modes of heat transfer; basic equations and principles of heat transfer, Dimensionless Number; Conduction	**Class Test 1, Final**
Week-2	Fourier's law of heat conduction; one dimensional steady-state conduction	
Week-3	Thermal resistance concept; extended surfaces and fins, two-dimensional and transient conduction.	
Week-4	Finite difference methods; finite element methods;	**Class Test 2, Final**
Week-5	Analytical solutions and approximate methods, computer-aided analysis and simulations	
Week-6	Convection mechanisms: forced and natural convection; boundary layer concepts	
Week-7	Heat transfer coefficients and correlations, external and internal flow heat transfer.	
Week-8	Blackbody radiation and Stefan Boltzmann law; radiation properties and behavior of surfaces;	**Mid Term, Final**
Week-9	Radiation exchange between surfaces; radiative heat transfer in participating media. Radiation shields and enclosures	
Week-10	Classification and types of heat exchangers; Analysis and design, Mass Transfer	
Week-11	Diffusion and Fick's law; mass transfer coefficients; mass transfer in fluids	**Class Test 3, Final**
Week-12	Evaporation and condensation; boiling and condensation heat transfer;	
Week-13	Heat and Mass Transfer in Industrial Processes.	
Week-14	Review class	

ASSESSMENT STRATEGY

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

Level-2, Term-I

	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		
	NE 243		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	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 NE 243.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply principles of heat and momentum transfer to basic engineering systems. 2. Analyze the systems examining trade-offs in different thermal engineering problems.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** principles of heat and momentum transfer to basic engineering systems.	PO2, PO4	C3	2	2	3	R, Q, T
CO2	**Analyze** the systems examining trade-offs in different thermal engineering problems.	PO4, PO9	C4	3	2	4	R, MT, T, Pr

(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

1. Visual demonstration of the three boiling modes (convective, nucleate and film boiling).
2. Determination of thermal contact conductance.
3. Study of free convection of fin/flat plate/pipe bundle.
4. Study of thermal radiation unit.
5. Study of condensation of water.
6. Determination of calorific value of a gaseous fuel by Boy's Calorimeter.
7. Study of a boiler.
8. Demonstration of the cause of liquid carry over or priming in boilers.
9. Study of a Refrigeration and Air-conditioning Unit.
10. Determination of the pressure-temperature relationship (*p-T* diagram) of a pure substance.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** principles of heat and momentum transfer to basic engineering systems.		3		2								
CO2	**Analyze** the systems examining trade-offs in different thermal engineering problems.				3					3			

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**

CO1-PO2	3	In order to apply principles of heat and momentum transfer to basic engineering systems, 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	2	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 to analyze the systems examining trade-offs in different thermal engineering problems, 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-PO9	3	In order to analyze the systems examining trade-offs in different thermal engineering problems, it is needed to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	28
	Practical / Tutorial / Studio	28
	Student-Centered Learning	-
	Self-Directed Learning	
	Preparation of Lab Reports	28
	Preparation of Lab Test	20
	Preparation of presentation	14
	Preparation of Quiz	-
	Engagement in Group Projects	-
	Formal Assessment	
	Continuous Assessment	1
	Final Quiz	1
	Total	120

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction	
Week-2	Visual demonstration of the three boiling modes (convective, nucleate and film boiling)	
Week-3	Determination of thermal contact conductance	
Week-4	Study of free convection of fin/flat plate/pipe bundle	
Week-5	Study of thermal radiation unit	
Week-6	Study of condensation of water	
Week-7	Mid-term	
Week-8	Determination of calorific value of a gaseous fuel by Boy's Calorimeter	

Week-9	Study of a boiler
Week-10	Demonstration of the cause of liquid carry over or priming in boilers
Week-11	Study of a Refrigeration and Air-conditioning Unit
Week-12	Determination of the pressure-temperature relationship (p-T diagram) of a pure substance
Week-13	Lab practice
Week-14	Final examination

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (60%)	Class Participation+ Attendance	5+5=10%	CO1	C2
	Conduct of Lab Test	20%	CO2	C2-C4
	Report Writing	15%	CO1, CO2	C2-C4
	Mid term	15%	CO2	C2-C4
Final Evaluation (40%)	Exam	30%	CO1	C4
	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

Level-2, Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 251 : Nuclear Materials	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 introduction to different types of nuclear materials and their properties and applications. Besides, this course will introduce some basic concept relevant to crystallographic structure, material strengthening process and phase diagram.
	OBJECTIVES

	1. To understand the different phase and structure of materials by phase diagram. 2. To know the structure of the metals, crystal defects, fracture mechanics and heat treatment process. 3. To understand the characteristics of fission materials-density, melting point, electrical and thermal conductivity, fission cross section of coolants and cladding materials.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply different types of mechanical test on metals. 2. Analyze material phase diagram and iron-iron carbide diagram. 3. Explain the structure of the metals, crystal defects and heat treatment process. 4. Evaluate the characteristics of fission materials, cladding materials, shielding materials and moderating materials.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** phase diagram, and different types of material phases.	PO1	C3	2		1	T, MT, F
CO2	**Analyze** different types of mechanical test.	PO2	C4	1		3,4	ASG, T, F
CO3	**Explain** the diffusion of the metals, crystal defects and heat treatment processes.	PO2	C2	2		3	T, F
CO4	**Evaluate** the characteristics nuclear reactor of materials and PCI failure.	PO1	C5	1		1,4	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

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.

Diffusion of materials, application of metal diffusion, mechanical properties of materials, hardness test, bend test, Charpy impact test, ductile and brittle fracture, ductile to brittle transition, fatigue failure, creep, thermal stress, stress corrosion cracking, radiation damage, radiation swelling, Brinkman displacement spike model, Seeger's refined displacement spike model, radiation defects, Inverse Kikendall Effect, structural materials of NPP, structural material classification, material degradation, irradiation effects, ceramic nuclear fuel, nuclear and mechanical behavior of UO_2, fuel-cladding interaction, PCI failure, metallic nuclear fuel, alloys of uranium, thermal cycling growth, radiation growth, metallic plutonium, plutonium fuel, alloys of plutonium, thorium fuel.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** phase diagram, and different types of material phases.	2											
CO2	**Analyze** different types of mechanical test.		3										
CO3	**Explain** the diffusion of the metals, crystal defects and heat treatment processes.		2										
CO4	**Evaluate** the characteristics nuclear reactor of materials and PCI failure.	2											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	2	Apply heat treatment concept on metals
CO2-PO2	3	Analyze material phase diagram and iron-iron carbide diagram
CO3-PO2	2	Explain radiation damage, radiation defects, radiation damage models
CO4-PO1	2	Evaluate ductile, brittle fracture, stress corrosion cracking, fuel cladding interaction, PCI failure

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	84
	Revision	21

	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Phase diagram-different types of material phases, diffusion	
Week-2	Non-equilibrium cooling, homogenation	
Week-3	Different types of mechanical test, Charpy impact test, tensile test, hardness test	**Class Test 1, Final Exam**
Week-4	Dislocation, precipitation, segregation, cold work	
Week-5	Heat treatment	**Class Test 2, Final Exam**
Week-6	Structure of the metals, crystallography, crystal defects	
Week-7	Iron carbide equilibrium diagram, heat treatment of the metal, alloy steels	
Week-8	Diffusion in solids	**Mid Term, Final Exam**
Week-9	Requirements of reactor materials, fuel materials and plutonium	
Week-10	Uranium, plutonium and thorium and their alloys and compound core materials	
Week-11	Radiation damage and radiation defects	
Week-12	Structural materials of NPP	**Class Test 3, Final Exam**
Week-13	Fatigue, stress corrosion cracking, creep	
Week-14	Radiation swelling, pellet cladding interaction	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
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

Level-2, Term-I

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

	PRE-REQUISITE
	NE 251
	CURRICULUM STRUCTURE
	Outcome Based Education (OBE)
	SYNOPSIS/RATIONALE
	To learn and familiarize the basics of different Nuclear Materials and their application.
	OBJECTIVES
	To verify practically the theories and concepts learned in NE 251.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply experimental procedure to analyze the crystallographic /micro structure of the material. 2. Analyze phase diagram as per temperature and alloy composition. 3. Demonstrate various types of heat treatment process to enhance the strength of the materials. 4. Capable of using special methods to prepare sample specimen.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** experimental procedure to **analyze** the crystallographic/ micro structure of the material.	PO1	C3, C4	1	2	1,2	Q, R, T
CO2	**Analyze** phase diagram as per temperature and alloy composition.	PO2, PO3	C4	3,4	1	3,4	Q, R, T
CO3	**Demonstrate** various types of heat treatment process to enhance the strength of the materials.	PO3, PO4	C3	3,4	2	3	Q, R, T
CO4	**Capable** of using special methods to prepare sample specimen.	PO1	C4	1,6	1	3	Q, R, 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)
	COURSE CONTENT
	1. Introduction to Metallographic and Metallographic Sample Specimen Preparation. 2. Study of Phase Diagram 1 3. Study of Phase Diagram 2 4. Microstudy of steel 5. Heat treatment of steels 1 6. Heat treatment of steels 2 7. Microstudy of Cast Iron 8. Study of morphology and elemental analysis using SEM 9. Study of elemental analysis using XRF 10. Micro fracture detection on the metallic surface using Ultrasonic Flaw Detector

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** experimental procedure to **analyze** the crystallographic /micro structure of the material.	2											
CO2	**Analyze** phase diagram as per temperature and alloy composition.		2	2									
CO3	**Demonstrate** various types of heat treatment process to enhance the strength of the materials.			3	2								
CO4	**Capable** of using special methods to prepare sample specimen.	3											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	Scientific knowledge is required to analyze the microstructure of the material.
CO2-PO2	2	Problem identification and finding its solution is essential to understand the phase diagram.
CO2-PO3	2	It could be done by forming a group.
CO3-PO3	3	Group performance /team work is very important.
CO3-PO4	2	Usually performed on the basis of data analyze and interpretation.
CO4-PO1	3	Scientific knowledge is required to prepare sample specimen.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)

	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 28 28 -
	Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test Preparation of presentation Preparation of Quiz Engagement in Group Projects	 28 20 14 - -
	Formal Assessment Continuous Assessment Final Quiz	 1 1
	Total	120

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to Metallographic and Metallographic Sample Specimen Preparation.	
Week-2	Study of Phase Diagram 1	
Week-3	Study of Phase Diagram 2	
Week-4	Microstudy of steel	
Week-5	Heat treatment of steels 1	
Week-6	Heat treatment of steels 2	
Week-7	Microstudy of Cast Iron	
Week-8	Study of morphology and elemental analysis using SEM	
Week-9	Study of elemental analysis using XRF	
Week-10	Micro fracture detection on the metallic surface using Ultrasonic Flaw Detector	
Week-11	Practice lab 1	
Week-12	Quiz test, Viva	
Week-13	Lab test 1	
Week-14	Lab test 2	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment	Conduct of Lab Tests/Class Performance	25%	CO1-CO4	C1-C6
	Report Writing/ Programming	15%	CO1-CO4	C1-C6
	Mid-Term Evaluation (exam/project/assignment)	20%	CO1-CO4	C1-C6
Final Assessment	Viva Voce	10%	CO1-CO4	C1-C6
	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

Level-2, Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 261 : Numerical Methods in Nuclear Engineering Analysis	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	MATH 101, Math 103 and CSE 121		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	1. This course will emphasize the development of numerical algorithms to provide solutions to common problems formulated in nuclear engineering field. 2. 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.		
	OBJECTIVES		
	1. To know the roots of polynomials and transcendental equations. 2. To able to solve differential equations applying different numerical methods. 3. To able to compare various mathematical operations and tasks, such as interpolation, differentiation, integration 4. To able to evaluate the solving equations by finite difference methods and curve fitting.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Apply fundamentals of numerical analysis in finding roots of various engineering problem related polynomials and transcendental equations. 2. Analyze the differential equations by different numerical methods. 3. Compare various mathematical operations and tasks, such as interpolation, differentiation, and integration. 4. Evaluate solving equations by finite difference methods and curve fitting.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** fundamentals of numerical analysis in finding roots of various engineering problem related polynomials and transcendental equations.	1	C1	1	-	2	T, Q, F
CO2	**Analyze** the differential equations by different numerical methods.	2	C2	2	-	2	T, Q, F

CO3	**Evaluate** various mathematical operations and tasks, such as interpolation, differentiation, and integration.	3	C3	1	-	3	MT, Q, F
CO4	**Apply** finite difference methods in solving differential equations and curve fitting.	3	C4	2	-	3	T, Q, 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

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.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** fundamentals of numerical analysis in finding roots of various engineering problem related polynomials and transcendental equations.	3											
CO2	**Analyze** the differential equations by different numerical methods.		3										
CO3	**Evaluate** various mathematical operations and tasks, such as interpolation, differentiation, and integration.			3									
CO4	**Apply** finite difference methods in solving differential equations and curve fitting.			3									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
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, formulation, research the literature and analyze complex engineering problems analysis of differential equations by different numerical methods are required.

CO3-PO3	3	In 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 computational processes to meet desired needs within realistic constraints, it requires to evaluate solving equations by finite difference methods and curve fitting.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Roots of polynomials and transcendental equations: bisection method, method of false position, iteration method	**Class Test 1, Final Exam**
Week-2	Roots of polynomials and transcendental equations: Newton-Raphson method, Ramanujan's method, secant method, Muller's method	
Week-3	Solution of linear and non-linear algebraic equations (I)	
Week-4	Solution of linear and non-linear algebraic equations (II)	**Class Test 2, Final Exam**
Week-5	Interpolation methods: finite differences method	
Week-6	Interpolation methods: Stirling's formula, Bessel's formula, Everett's formula	
Week-7	Interpolation Methods: Lagrange's Formula, Hermite's Formula	
Week-8	Solution of differential equations: by Taylor's series	**Mid Term, Final Exam**
Week-9	Solution of differential equations: Picard's method, Euler's method, Runge-Kutta method	
Week-10	Solution of differential equations: predictor-corrector methods, cubic spline method, boundary value problems	
Week-11	Numerical differentiation	

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

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2, C4
	Class Participation and Class attendance	5+5= 10%	CO1-CO4	C1-C4
	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

Level-2, Term-II

	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 Methods and its application.
	OBJECTIVES
	To verify practically the theories and concepts learned in NE 261.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Design and solve mathematical problems by numerical technique. 2. Develop the methodology for solving complex equations with the help of numerical methods.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Design** and **solve** mathematical problems by numerical technique.	PO3, PO5	C6	1,2	2	2	MT, T, R, Q
CO2	**Develop** 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-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

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in NE 261. In the second part, students will design simple systems using the principles learned in NE 261.

Exp 01: Solve an equation of f(x) = exp(-x) by Fixed Point Iteration method.

Exp 02: Solve an equation of f(x) = exp(-x) by Newton Raphson method.

Exp 03: Solve an equation of f(x) = exp(-x) by Ramanujan's method.

Exp 04: 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.

Exp 05: Develop a code which will deliver the mean value of the students' heights.

Exp 06: Prepare 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.

Exp 07: Prepare an algorithm and curves for extrapolation and interpolation of different data.

Exp 08: Build a code to find the result of following problem:

1+2^2+3^2+…..........+N^2 = ?

Exp 09: Build a code to find the result of following problem:

1-2+3.............. +N = ?

Exp 10: Build a code to find the result of following problem:

	1+3+5+7+… .... +N = ? Exp 11: Obtain the solutions by using Gauss Elimination method. Exp 12: Obtain the solutions by using Gauss-Jordan method.
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Design** and **solve** mathematical problems by numerical technique.			3		3							
CO2	**Develop** the methodology for solving complex equations with the help of numerical methods.			3	2	3							

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO3	3	Some design problems need to be solved where students will be required to construct and solve mathematical problems by numerical technique.
CO1-PO5	3	Modern simulation tools and numerical tools are required for solving large scale complex mathematical problems by numerical technique.
CO2-PO3	3	Ability to develop the methodology for solving complex nuclear related equations is required the help of different numerical techniques.
CO2-PO4	2	Design, analyze and interpret nuclear data is required the help of numerical methods to solve the complex engineering problems.
CO2-PO5	3	Modern simulation tools and numerical tools are required for develop the methodology to solve complex equation by numerical technique.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	28
	Practical / Tutorial / Studio	28
	Student-Centered Learning	-
	Self-Directed Learning	
	Preparation of Lab Reports	28
	Preparation of Lab Test	20
	Preparation of presentation	14
	Preparation of Quiz	-
	Engagement in Group Projects	-
	Formal Assessment	
	Continuous Assessment	1
	Final Quiz	1
	Total	120

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
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	Prepare 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: $1+2^2+3^2+\ldots\ldots\ldots+N^2=?$	
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	CO	Blooms Taxonomy
	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 Marks		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

Level-2, Term-II

	COURSE INFORMATION		
Course Code Course Title	: GESL 221 : Environment, Sustainability and Law	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	This course is designed to learn and familiarize the basics of radiation energy phenomenon and its impact on environment.		
	OBJECTIVES		
	1. To know the environmental impact of Nuclear Power Plants. 2. To understand the features of radiation effect on biodiversity. 3. To understand the regulatory aspects for the environment monitoring and public safety. 4. To understand the IAEA guidelines for environment safety.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Define energy, energy conversion system and management. 2. Explain IAEA Safety Standards and guides for environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning. 3. Analyze radioactivity monitoring equipment, analytical methods and their techniques, radiation level and public awareness systems. 4. Evaluate environmental monitoring program of the regulatory body and the operators, National Monitoring System of the radioactivity.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** energy, energy conversion system and management.	PO1	C1	-	-	1	T, F, ASG
CO2	**Explain** IAEA Safety Standards and guides for environmental radiological	PO1	C2	-	-	1	T, F, ASG

	monitoring and surveillance requirements during NPP construction, and operation and decommissioning.						
CO3	**Analyze** radioactivity monitoring equipment, analytical methods and their techniques, radiation level and public awareness systems.	PO6	C4	-	-	1	MT, F
CO4	**Evaluate** environmental monitoring program of the regulatory body and the operators.	PO7	C5	-	-	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)

COURSE CONTENT

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.
IAEA Safety Standards and guides for environmental monitoring of NPPs, environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning.
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 sustainability; Geomorphology, geology and seismic studies for NPP safety.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** energy, energy conversion system and management.	3											
CO2	**Explain** IAEA Safety Standards and guides for environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning.	3											
CO3	**Analyze** radioactivity monitoring equipment, analytical methods and their techniques, radiation level and public awareness systems.						2						
CO4	**Evaluate** environmental monitoring program of the regulatory body and the operators.							3					

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to define energy, energy conversion system and management, basis knowledge of science is required.
CO2-PO1	3	In order to apply IAEA Safety Standards and guides for environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO3-PO6	2	In order to analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer, 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-PO7	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 STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 28 - -
	Self-Directed Learning Non-face-to-face learning Revision	 56 14
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	104

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Sources of energy, energy consumption patterns: Life-cycle cost calculations; Energy demand forecasting	**Class Test 1, Final**
Week-2	Energy conversion methods.; energy efficiency; energy management and conservation; impacts of energy utilization on environment	
Week-3	IAEA Safety Standards and guides for environmental monitoring of NPPs	
Week-4	Environmental radiological monitoring and surveillance requirements during NPP construction, and operation and decommissioning	**Class Test 2, 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, Final**
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	
Week-11	Thermal ecological studies	**Class Test 3, Final**
Week-12	Biodiversity conservation studies for environment safety and sustainability	
Week-13	Geomorphology, geology studies for environment safety and sustainability	
Week-14	Seismic studies for NPP safety	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
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
	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

1. 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 Measurement	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 impart knowledge on the operation of different radiation measurement technique and develop skill on statistical analysis of the radioactive samples.
	OBJECTIVES
	1. To know the nuclear instrumentation and measurement. 2. To understand the operation of different radiation measurement technique. 3. To understand the statistical analysis of the radioactive samples. 4. To understand the radiation survey techniques.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply fundamentals of radiation detection and measurement theory in solving various engineering problem related to process of energy transfer. 2. Analyze the methods of radiation detection. 3. Evaluate the process of radiation detection and measurement. 4. Formulate the methodology for the design and development of detectors for radiation detection and measurement.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** fundamentals of radiation detection principle in solving various engineering problem related to radiation phenomena.	PO1	C3	-	-	3	T, F
CO2	**Analyze** the methods of radiation detection.	PO2	C4	-	-	4	MT, F
CO3	**Evaluate** the process of radiation detection and counting statistics.	PO3	C5	-	-	5	T , F, ASG
CO4	**Formulate** the methodology for the calibration and counting efficiency of the radiation detectors.	PO2	C6	1	-	6	F, 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)

COURSE CONTENT

	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. **Detection of nuclear radiation:** (a) detection of charged particles, nuclear interaction with matter, bubble chamber, photographic emulsion, scintillation detectors, Cerenkov detector, P.M. Tubes, semiconductor detector, thermo-luminescent dosimeter; (b) neutral particle detection, neutron detection, detector based on boron reaction, time of flight technique, proton recoil telescope, neutron detection by activation foils; Gamma-ray detection methods and spectrometers, Germanium detectors (HPGe), and Compton scattering detectors. **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.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** fundamentals of radiation detection principle in solving various engineering problem related to radiation phenomena.	3											
CO2	**Analyze** the methods of radiation detection.		3										
CO3	**Evaluate** the process of radiation detection and counting statistics.			3									
CO4	**Formulate** the methodology for the calibration and counting efficiency of the radiation detectors.		3										

(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.
CO2-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.

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, cultural, societal, and environmental considerations.

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 LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	**Topics**	**Remarks**
Week-1	Fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources;	**Class Test 1, Final Exam**
Week-2	Characteristics of data, statistical models, applications of statistical models, propagation of errors	
Week-3	Optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting	
Week-4	Simplified detector model, modes of detector operation, pulse height spectra	**Class Test 2, Final Exam**
Week-5	Sensitivity, energy resolution, detection efficiency, dead time	
Week-6	Radiation dose measurements of ionization chambers.	
Week-7	Revision	
Week-8	Detection of charged particles, nuclear interaction with matter, bubble chamber, photographic emulsion, scintillation detectors, Cerenkov detector, P.M. Tubes,	**Mid**

	semiconductor detector, thermo-luminescent dosimeter	**Term, Final Exam**
Week-9	Neutral particle detection, neutron detection, detector based on boron reaction, time of flight technique, proton recoil telescope, neutron detection by activation foils	
Week-10	Gamma-ray detection methods and spectrometers, Germanium detectors (HPGe), and Compton scattering detectors	
Week-11	Standardization of radioactive sources, calibration of detectors, absolute counting, source geometry	

Week-12	Source absorption, air and window effects, source dilution	**Class Test 3, Final Exam**
Week-13	Measurement of very short and very long half-lives	
Week-14	Revision	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C3, C5, C6
	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

Level-3, Term-I

	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 radiation.
	OBJECTIVES

	1. To know the Nuclear Instrumentation and Measurement. 2. To understand the operation of different radiation measurement technique. 3. To understand the statistical analysis of the radioactive samples. 4. To understand the radiation survey techniques.
	LEARNING OUTCOMES
	1. Apply the different measurement technique to detect radioactivity and follow radiation safety during experimentation. 2. Design and solve real life problems adapting to the specified requirements using both simulating tools and hardware.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** the different measurement technique to detect radioactivity and **follow** radiation safety during experimentation.	PO1, PO4	C3	-	2	1-3	R, Q, T,
CO2	**Design** and **solve** real life problems adapting to the specified requirements using both simulating tools and hardware.	PO5	C6	1	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)
	COURSE CONTENT
	1. Background radiation measurements. 2. Search for lost point radioactive sources by using radiation survey meter or mobile gamma spectrometry. 3. Determining the Linear Absorption coefficient of Al & Pb using Beer's Law. 4. Gamma-ray spectrometry using NaI(Tl) detector. 5. Experimental determination of FWHM and FWTM of NaI detector for different energies. 6. Determination of the efficiency of NaI(Tl) scintillation detector for different energies of gamma rays.
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** the different measurement technique to detect radioactivity and **follow** radiation safety during experimentation.	3			3								
CO2	**Design** and **solve** real life problems **adapting** to the specified requirements using both simulating tools and hardware.					3							

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical / Tutorial / Studio	28
Student-Centered Learning	-
Self-Directed Learning	
Preparation of Lab Reports	14
Preparation of Lab Test	10
Preparation of presentation	9
Preparation of Quiz	-
Engagement in Group Projects	-
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	Background radiation measurements	
Week-2	Search for lost point radioactive sources by using radiation survey meter or mobile gamma spectrometry	
Week-3	Determining the Linear Absorption coefficient of Al & Pb using Beer's Law	
Week-4	Gamma-ray spectrometry using NaI(Tl) detector	
Week-5	Experimental determination of FWHM and FWTM of NaI detector for different energies	
Week-6	Determination of the efficiency of NaI(Tl) scintillation detector for different energies of gamma rays	
Week-7	Quiz test, Lab Test, Viva	

ASSESSMENT STRATEGY

Components		Grading	CO	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

Level-3, Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 305 : Fluid Mechanics and Machinery	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 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
	1. To understand the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces. 2. 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. 3. To identify various types of pumps and turbines and their functions. 4. To evaluate various types of pumps and turbines using dimensional and vector analysis.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces. 2. Analyze the momentum and energy equation in fluid body and engineering fluid mechanics systems using the dimensional analysis and various losses in piping networks. 3. Compare the various types of pumps and turbines and their functions. 4. Evaluate the various types of pumps and turbines using dimensional and vector analysis.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** 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	**Analyze** 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	**Compare** the various types of pumps and turbines and their functions.	PO2	C5	2	1	3	MT, F
CO4	**Evaluate** the various types of pumps and turbines using dimensional and vector analysis.	PO3	C6	3	1	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)
	COURSE CONTENT

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; Conservation of mass, Euler's equation, Bernoulli's equation, Conservation of linear momentum – Cauchy's equation, 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 pumps; Euler pump/turbine; impulse and reaction turbines; centrifugal and axial flow pumps, jet pump; 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)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** the fundamentals of fluid mechanics theory in solving various engineering problem related to pressure and forces.	3											
CO2	**Analyze** 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	**Compare** the various types of pumps and turbines and their functions.		3										
CO4	**Evaluate** the various types of pumps and turbines using dimensional and vector analysis.			3									

(3 – High, 2- Medium, 1-low)

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 using dimensional and vector analysis, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Fundamental concept of fluid as a continuum; Pressure variation in static incompressible and compressible fluids; Manometers	**Class Test 1, Final Exam**
Week-2	Fluid statics: basic hydrostatic equation; Forces on plane and curved surfaces; Buoyant force; Stability of floating and submerged bodies	
Week-3	Pressure distribution of a fluid in a rotating system; Relation between system approach and control volume approach	
Week-4	Continuity, momentum and energy equations; Special forms of energy and momentum equations and their applications; Pressure, velocity and flow measurement devices	**Class Test 2, Final Exam**
Week-5	Dimensional analysis and similitude	
Week-6	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	
Week-7	Real fluid flow; Frictional losses in pipes and fittings	
Week-8	Types of fluid machinery; Rotodynamic and positive displacement machines	**Mid Term, Final Exam**
Week-9	Velocity diagrams and Euler pump/turbine equation; Impulse and reaction turbines	
Week-10	Centrifugal and axial flow pumps; Deep well turbine pumps	
Week-11	Dimensional analysis applied to fluid machinery: specific speed, unit power, unit speed, unit discharge	**Class Test 3, Final Exam**
Week-12	Performance and characteristics of turbines and pumps; Design of pumps, jet pump	

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 selection of fluid machine	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C6
	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

Level-3, Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 306 : 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.		

OBJECTIVES

To verify practically the theories and concepts learned in NE 351.

LEARNING OUTCOMES

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

1. Examine the fluid characteristics.
2. Evaluate fluid machineries characteristics.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Examine** the fluid characteristics.	PO3, PO4	C4	2	2	4	R, Q, T
CO2	**Evaluate** fluid machineries characteristics.	PO3, PO9	C6	3	3	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)

COURSE CONTENT

1. Verification of Bernoulli's equation.
2. Study of flow through a Venturimeter.
3. Study of fluid friction in a pipe.
4. Introduction to Centrifugal Pump characteristics.
5. Study of Propeller Turbine characteristics.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Examine** the fluid characteristics.			3	3								
CO2	**Evaluate** fluid machineries characteristics.			3						2			

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO3	3	Upon formulation, mathematical analysis and reasoning, valid conclusions are made to meet selection and desired performance needs of new heterojunction devices within realistic constraints for serving practical purposes.
CO1-PO4	3	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, mathematical analysis and reasoning, valid conclusions are made to meet selection and desired performance needs of new heterojunction devices within realistic constraints for serving practical purposes.
CO2-PO9	2	The design problems involve discussions and brainstorming as an individual and as a whole in a group. Thus, the ability to work in a team is developed.

TEACHING LEARNING STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	14
	Practical / Tutorial / Studio	28
	Student-Centered 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 Discussion, Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

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	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (60%)	Class Participation + Attendance	15%	CO1	C4
	Conduct of Lab Test	20%	CO1, CO2	C4, C6
	Report Writing	15%	CO1, CO2	C4, C6
	Mid term	15%	CO2	C6
Final Evaluation (40%)	Exam	30%	CO1, CO2	C4, C6
	Viva Voce/ Presentation	10%	CO1, CO2	C4, 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. *Fluid Mechanics with Engineering Applications* – Robert L. Daugherty, Joseph B. Franzini, E. John Finnemore, Mc Graw-Hill companies, 8th edition, 1985.

REFERENCE SITE

Level-3, Term-I

	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

1. To understand reactor kinetics and transfer function in nuclear engineering.
2. To understand the propagation of a neutron beam in a passive medium.
3. To know the analysis of criticality of heterogeneous and homogeneous reactors and reactivity worth of partially inserted control rod.
4. To understand the perturbation theory and its application.
5. To calculate multi neutron diffusion equation in passive media with an external source.

LEARNING OUTCOMES

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

1. Apply reactor kinetics and transfer function in nuclear reactor engineering.
2. Analyze the criticality of heterogeneous and homogeneous reactors and also analyze reactivity worth of partially inserted control rod.
3. Explain scalar neutron flux and neutron current, perturbation theory and its application.
4. Evaluate multi neutron diffusion equation in passive media with an external source, Fermi age calculation, and neutron migration length.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** reactor kinetics and transfer function in nuclear reactor engineering.	PO1, PO2	C3	-	-	3	T, Q, F

CO2	**Analyze** the criticality of heterogeneous and homogeneous reactors and also **analyze** reactivity worth of partially inserted control rod.	PO3	C4	-	-	4	ASG, F
CO3	**Explain** scalar neutron flux and neutron current, perturbation theory and its application.	PO3	C5	-	-	5	MT, F
CO4	**Understand** multi neutron diffusion equation in passive media with an external source, and Fermi age theory.	PO3	C5	1	-	6	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

Reactor kinetics and transfer function, Propagation of a neutron beam in a passive medium. Scalar neutron flux and neutron current. Reactor criticality calculations, the calculation of the multiplication factor for a homogenous thermal reactor, heterogeneous thermal reactor, 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 theory, and neutron migration length, Neutron poisons in a reactor, production and equilibrium of Xe, Sm.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** reactor kinetics and transfer function in nuclear reactor engineering.	3	3										
CO2	**Analyze** the criticality of heterogeneous and homogeneous reactors and also **analyze** reactivity worth of partially inserted control rod.			2									
CO3	**Explain** scalar neutron flux and neutron current, perturbation theory and its application.			3									
CO4	**Understand** multi neutron diffusion equation in passive media with an external source, and Fermi age theory.			3									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	3	In order to apply reactor kinetics and transfer function in nuclear reactor engineering, 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 apply reactor kinetics and transfer function in nuclear reactor engineering, 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 the criticality of heterogeneous and homogeneous reactors and also analyze reactivity worth of partially inserted control rod, 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	3	In order to explain scalar neutron flux and neutron current, perturbation theory and its application, 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-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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture	 42
	Practical / Tutorial / Studio Student-Centered Learning	- -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Reactor kinetics and transfer function	**Class Test 1, Final Exam**
Week-2	Propagation of a neutron beam in a passive medium	
Week-3	Scalar neutron flux and neutron current	
Week-4	The multi neutron diffusion equation	**Class Test 2, Final Exam**
Week-5	Solution of the neutron diffusion equation for passive media with an external neutron source	
Week-6	Reactor criticality calculations	

Week-7	Criticality analysis of heterogeneous and homogeneous reactors	
Week-8	Reactivity worth of partially inserted control rod	**Mid Term, Final Exam**
Week-9	Nodal Analysis	
Week-10	Sn method	
Week-11	Dn method	**Class Test 3, Final Exam**
Week-12	Perturbation Theory and its applications	
Week-13	Elastic scattering kinematics	
Week-14	Fermi age calculation, and neutron migration length	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
	Class Participation and Class attendance	5+5= 10%	CO1, CO2	C3, C4
	Mid term	10%	CO3	C5
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

<u>Level-3, Term-I</u>

	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 introduction to nuclear security and safeguard acts on nuclear sector. It will introduce the important concepts such as 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 and analyze Design Basis Threat (DBT) on boarder, airport, sea port. Apart from these, this course will also introduce the important topics including inspection guidance, assessment methodology for nuclear security cultures, insider threats analysis, cyber security, nuclear security event response and neutralization.
	OBJECTIVES
	1. To understand the fundamentals of physical protection regime and layers, graded approach, defence in depth, Physical Protection System (PPS) design architecture for protection of nuclear material and radioactive sources during use, storage, and transport. 2. To study on national legislative and regulatory frameworks and international nuclear security instruments. 3. To know risk, threat characteristics, and threat assessments. 4. To know NPT, IAEA safeguards systems, evolving safeguards implementation, safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation. 5. To understand the nuclear security and safeguard interfacing. 6. To acquire knowledge on safeguards information system, safeguards verification systems, and SSAC.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply nuclear security and safeguard acts on nuclear sector. 2. Explain safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation. 3. Analyze physical protection regime, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities . 4. Evaluate safeguards information system, safeguards verification systems, enrichment and reprocessing facilities, safeguards R&D for advanced nuclear fuel cycles.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** nuclear security and safeguard acts on nuclear sector.	PO1	C3	-	-	3	T, Q, F
CO2	**Explain** safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation.	PO2	C5	-	-	4	ASG, F

CO3	**Analyze** physical protection regime, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities.	PO2	C4	-	-	5	MT, F
CO4	**Evaluate** safeguards information system, safeguards verification systems, enrichment and reprocessing facilities, safeguards R&D for advanced nuclear fuel cycles.	PO3	C5	1	-	6	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						

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 Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** nuclear security and safeguard acts on nuclear sector.	3											
CO2	**Explain** safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation.		3										
CO3	**Analyze** physical protection regime, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities.		3										
CO4	**Evaluate** safeguards information system, safeguards verification systems, enrichment and reprocessing facilities, safeguards R&D for advanced nuclear fuel cycles.			3									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	3	In order to apply nuclear security and safeguard acts on nuclear sector, 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 explain safeguards agreements, additional protocol agreements, national regulatory framework for safeguards policy and regulation, 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 analyze physical protection regime, Physical Protection System (PPS) designs for protection of nuclear material, radiation and associated facilities, 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	2	In order to evaluate safeguards information system, safeguards verification systems, enrichment and reprocessing facilities, safeguards R&D for advanced nuclear fuel cycles, 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 Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Definition of nuclear security; threat, theft, sabotage, nuclear attacks, historical developments, international protocols	**Class Test 1, Final Exam**
Week-2	UNSCR-1373, 1540, IAEA nuclear security document series and hierarchy, member state's obligations towards nuclear security	
Week-3	Legal and non-legal binding instruments for member states, legislative and regulatory framework for nuclear security, physical protection regime and layers	
Week-4	Graded approach, category of nuclear material, Physical Protection System (PPS) designs for protection of nuclear material	**Class Test 2, Final Exam**
Week-5	Detection architecture (boarder, airport, sea port), regulation for nuclear material and radioactive sources in storage and transport	
Week-6	Export and import control, assessment methodology for nuclear security cultures	
Week-7	Radiation and associated facilities, Design Basis Threat (DBT) analysis	
Week-8	Safeguards information system, safeguards verification systems	**Mid Term, Final Exam**
Week-9	Nuclear security event response and neutralization, NPT, IAEA safeguards systems	
Week-10	Safeguards challenges for fuel fabrication	

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

ASSESSMENT STRATEGY

Components		**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C5
	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

Level-3, Term-I

	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)		

<table>
<tr><td></td><td colspan="8">SYNOPSIS/RATIONALE</td></tr>
<tr><td></td><td colspan="8">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.</td></tr>
<tr><td></td><td colspan="8">OBJECTIVES</td></tr>
<tr><td></td><td colspan="8">1. To enable the students to design and analyze the Physical Physical Protection System (PPS) to secure nuclear materials.
2. To make students acquainted with IAEA safeguards system and its application.
3. To be familiar with different procedure in practical to ensure safeguard act.
4. To impart into students the safeguards with verification systems, enrichment and reprocessing facilities.</td></tr>
<tr><td></td><td colspan="8">LEARNING OUTCOMES</td></tr>
<tr><td></td><td colspan="8">Upon completion of the course, the students will be able to
1. Apply safeguard knowledge to prevent nuclear proliferation.
2. Analyze Physical Protection System (PPS) and adapt to the specified requirements using both simulating tools and hardware.
3. Design simple Physical Protection System (PPS) to secure nuclear materials.</td></tr>
<tr><td></td><td colspan="8">COURSE OUTCOMES & GENERIC SKILLS</td></tr>
<tr><td>No.</td><td>Course Learning Outcome</td><td>Corresponding POs</td><td>Bloom’s Taxonomy</td><td>CP</td><td>CA</td><td>KP</td><td>Assessment Methods</td></tr>
<tr><td>CO1</td><td>Apply safeguard knowledge to prevent nuclear proliferation.</td><td>PO1</td><td>C3</td><td>1</td><td>2</td><td>3</td><td>R, Q, T</td></tr>
<tr><td>CO2</td><td>Analyze Physical Protection System (PPS) and adapt to the specified requirements using both simulating tools and hardware.</td><td>PO2</td><td>C4</td><td>2</td><td>1</td><td>4</td><td>MT, R, Q, T</td></tr>
<tr><td>CO3</td><td>Design a simple Physical Protection System (PPS) to secure nuclear materials.</td><td>PO4</td><td>C6</td><td>1</td><td>1</td><td>7</td><td>R, Q, T, PR</td></tr>
<tr><td></td><td colspan="8">(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)</td></tr>
<tr><td></td><td colspan="8">COURSE CONTENT</td></tr>
<tr><td></td><td colspan="8">1. Analysis of Probabilistic Risk Assessment (PSA) inside the Pressurized Water Reactor (PWR).
2. Application of malicious software in order to ensure cyber security of the NPP.
3. Practice of emergency preparedness and activities for NPP workers and employees on transient situation.
4. Analysis of emergency mode operation in case of any transient situation inside the reactor.
5. Analysis of Physical Protection System (PPS) to prevent any kind of sabotage and removal of nuclear materials.
6. Design a Physical Protection System (PPS) to prevent any kind of sabotage and removal of nuclear materials.</td></tr>
</table>

	SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** safeguard knowledge to prevent nuclear proliferation.	3											
CO2	**Analyze** Physical Protection System (PPS) and **adapt** to the specified requirements using both simulating tools and hardware.		3										
CO3	**Design a simple** Physical Physical Protection System (PPS) to secure nuclear materials.				2								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	Knowledge of both scientific and safeguard fundamentals are required to design PPS.
CO2-PO2	3	Security will be ensured by finding relevant problems and its corresponding solution.
CO3-PO4	2	Designing a PPS by following proper IAEA guidance.

TEACHING LEARNING STRATEGY

	Teaching and Learning Activities	Engagement (hours)
	Face-to-Face Learning	
	Lecture	14
	Practical / Tutorial / Studio	28
	Student-Centered Learning	-
	Self-Directed Learning	
	Preparation of Lab Reports	14
	Preparation of Lab Test	10
	Preparation of presentation	
	Preparation of Quiz	9
	Engagement in Group Projects	
	Formal Assessment	
	Continuous Assessment	1
	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	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	

ASSESSMENT STRATEGY

Components	Grading	CO	Blooms Taxonomy
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

Level-3, Term-II

	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
	1. To provide comprehensive learning platform to students where they can enhance their employ ability skills and become job ready along with real corporate exposure. 2. To provide learners hands on practice within a real job situation.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Interview the people involved in design, construction of NPP. 2. Identify required skills for reactor operation and maintenance. 3. Utilize management tools to handle different categories reactor control systems. 4. Plan the crisis management and resolve the conflicts amongst subordinates. 5. Understand management and operation and maintenance of radiological equipment in medical sector. 6. Take part in decision making process.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Interview** the people involved in **design**, **construction** of NPP.	PO1	C3	1		4-6	Rp, Pr, WS
CO2	**Identify** required skills for reactor operation and maintenance.	PO1	C3	1		6	Rp, Pr, WS
CO3	**Utilize** management tools to handle different categories reactor control systems.	PO5	C3	7		5-6	Rp, Pr, WS
CO4	**Plan** the crisis management and resolve the conflicts amongst subordinates.	PO9	C6	7		5-6	Rp, Pr, WS
CO5	**Understand** 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 – Complex Activities, KP – Knowledge Profile, R – Regularity in Work and Attendance, KS – Knowledge Skill, WS – Working Skill and Work Performance , Pr – Presentation, T – Test; PR – Project ; Q – Quiz; ASG – Assignment; Rp - Report; F – Final Exam)
	COURSE CONTENT
	Content is prepared by the specified industries. Student has to apply theoretical and technical knowledge to perform or execute the given task by the specified industries.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Interview** the people involved in **design**, **construction** of NPP.	3											
CO2	**Identify** required skills for reactor operation and maintenance.	3											
CO3	**Utilize** management tools to handle different categories reactor control systems.					3							
CO4	**Plan** the crisis management and resolve the conflicts amongst subordinates.									3			
CO5	**Understand** management and operation and maintenance of radiological equipment in medical sector.			3									
CO 6	**Take part** in decision making process.												2

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to interview the people involved in design, construction of NPP, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO2-PO1	3	In order to identify required skills for reactor operation and maintenance, , the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO3-PO5	3	In order to utilize management tools to handle different categories reactor control systems, 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.
CO4-PO9	3	In order to plan the crisis management and resolve the conflicts amongst subordinates, it is needed to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
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.
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 LEARNING STRATEGY

Teaching and Learning Activities	Engagement (weeks)
Face-to-Face Learning	As per industries
Self-Directed Learning	As per industries
Formal Assessment	As per industries
Total	**5**

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 (%)	CO	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

Level-3, Term-II

	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 introduction to nuclear reactor operation and safety. It will introduce the important concepts such as research and power reactor operation, different cooling systems of research and power reactor, piping and instrumentation diagrams of nuclear reactor, operation limits and conditions, safety systems of research and power reactor, emergency response and safety culture concept. Apart from these, this course will also introduce safety standards for nuclear facilities available in the IAEA and other countries, fundamental safety principles and safety criteria. From this course students will also learn fundamentals of deterministic and probabilistic safety analysis for nuclear installations.		

	OBJECTIVES
	1. To understand the general concepts and issues behind nuclear reactor operation and safety. 2. To able to explain and analyze the elements of Deterministic Safety Analysis (DSA) and Probabilistic Safety Analysis (PSA). 3. To able to explain the principles of reactor operation, reactor start-up sequence & operation at power; pre-nuclear commissioning. 4. To able to hypothesize and classify the operation transients and sever accidents, accident phenomena, general problems of reactor operation.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Define the nuclear reactor safety features, safety principles, safety systems and safety culture concept. 2. Explain and analyze the elements of deterministic and probabilistic safety analysis. 3. Explain the principles of reactor operation, reactor start-up sequence & operation at power, pre-nuclear commissioning. 4. Analyze the operation transients & severe accidents, accident phenomena, general problems of reactor operation
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** the nuclear reactor safety features, safety principles, safety systems and Safety culture concept.	PO1	C1	-	-	6	T, Q, F
CO2	**Explain** and **analyze** the elements of deterministic and probabilistic safety analysis.	PO3	C2, C4	-	-	2,3	ASG, F
CO3	**Explain** the principles of reactor operation, reactor start-up sequence and operation at power, pre-nuclear commissioning.	PO1	C2	-	-	6	MT, F
CO4	**Analyze** the operation transients and severe accidents, accident phenomena, general problems of reactor operation.	PO2	C4	1	-	4	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
	Safety characterization and safety features of nuclear power plants, fundamental safety functions, reactor safety principles and criteria, Design-Basis and Beyond-Design-Basis events, safety systems, containment performance, safety issues and safety issue resolution, regulation and safety culture; operating experience of Research Reactor and Power Reactor (PWR), general problems of reactor operation; principles of control and operation; methods of control; range of control; functions of operators; layout of control desks; warnings and emergencies; reactor start-up sequence; pre-nuclear commissioning; mechanical and electrical tests; coolant flow tests; operation at power; reactivity balance at power operation.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** the nuclear reactor safety features, safety principles, safety systems and safety culture concept.	3											
CO2	**Explain** and **analyze** the elements of deterministic and probabilistic safety analysis.			3									
CO3	**Explain** the principles of reactor operation, reactor start-up sequence and operation at power, pre-nuclear commissioning.	3											
CO4	**Analyze** the operation transients and severe accidents, accident phenomena, general problems of reactor operation.		2										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	3	In order to apply the knowledge of engineering fundamentals and an engineering specialization to the solution of complex nuclear science and engineering problems, definition of the nuclear reactor safety features, safety principles, safety systems and safety culture concept are required.
CO2-PO3	3	In order to design nuclear safety systems, and analysis, components, or processes to meet desired needs within realistic constraints, explanation and analysis of the elements of deterministic and probabilistic safety analysis are required.
CO3-PO1	3	In order to apply the knowledge of engineering fundamentals and an engineering specialization to the solution of complex nuclear science and engineering problems, explanation the principles of reactor operation, reactor start-up sequence and operation at power, pre-nuclear commissioning are required.
CO4-PO2	3	In order to undertake problem identification, formulation, research the literature and analyze complex engineering problems, analyze of the operation transients and severe accidents, accident phenomena, general problems of reactor operation are required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered 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	Safety characterization and safety features of nuclear power plants	**Class Test 1, Final Exam**
Week-2	Reactor safety principles and criteria, design-basis and beyond-design-basis events	
Week-3	Safety systems, containment performance, safety issues and safety issue resolution	
Week-4	Probabilistic Safety Analysis (basic elements), regulation and safety culture	**Class Test 2, Final Exam**
Week-5	Deterministic Safety Analysis (basic elements)	
Week-6	Operating experience of Research Reactor and Power Reactor (PWR), general problems of reactor operation	
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 Term, Final Exam**
Week-9	Reactor start-up sequence; pre-nuclear commissioning	
Week-10	Mechanical and electrical tests; coolant flow tests	
Week-11	Operation at power; reactivity balance at power operation	**Class Test 3, Final Exam**
Week-12	Accident management, emergency operation procedure	
Week-13	Analysis of operation transients, accidents and severe accidents	
Week-14	Accident phenomena, including severe accidents	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
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 and Control Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	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		
	1. To introduce the students with the illustration of various control systems using Block Diagram/ Signal Flow Graph (SFG) and reduction of complicated system to a simplified one. 2. To impart the basic knowledge of electrical, mechanical and electro-mechanical system including with their inter-conversion and system transfer function. 3. To use Routh's stability criteria, root locus technique, Bode plot and Nyquist stability criteria to analyze the system stability. 4. To impart in-depth theoretical knowledge of control system engineering to design the practical controlling algorithm.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Define Automation, Kinematics, Manipulators and Explain automation strategy 2. Translate the pneumatic, hydraulic, and even heat transfer systems to its equivalent electrical circuit model and evaluate the output characteristics with the specified input. 3. Interpret the basic concepts of stability for various control systems from both the classical and the state-space viewpoints. 4. Design control systems using different automation tools		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** Automation, Kinematics, Manipulators and Explain automation strategy	PO1	C1	1	-	3	T, Q, F
CO2	**Translate** the pneumatic, hydraulic, and even heat transfer systems to its equivalent electrical circuit model and	PO1	C2, C5	1	-	1, 3	ASG, F

	evaluate the output characteristics with the specified input.						
CO3	**Interpret** the basic concepts of stability for various control systems from both the classical and the state-space viewpoints.	PO1	C2	2	-	3	MT, F
CO4	**Design** control systems using different automation tools	PO3	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 Programmable Logic Controller (PLC), microcontroller, relay etc.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** Automation, Kinematics, Manipulators and automation strategy.	3											
CO2	**Evaluate** the pneumatic, hydraulic, and even heat transfer systems to its equivalent electrical circuit model and the output characteristics with the specified input.	3											
CO3	**Interpret** the basic concepts of stability for various control systems from both the classical and the state-space viewpoints.	3											

CO4	**Design** control systems using different automation tools.			2									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The knowledge of mathematics, science and electrical engineering sciences has to be applied to define and classify different types of control systems as well as minimize a complicated system into a more simplified form with single transfer function.
CO2-PO1	3	In order to translate different systems to its equivalent electrical circuit model and evaluate the output characteristics, the knowledge of mathematics, science and electrical engineering science is needed.
CO3-PO1	3	To interpret the basic concepts of stability for various control systems from both the classical and the state-space viewpoints the knowledge of mathematics, science and electrical science is required.
CO4-PO3	3	To design a practical feedback control system, it is required to design components or processes that meet specified needs with appropriate consideration for public health and safety with environmental considerations.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Automation strategy, role of automation in industries, benefits of automation	**Class Test 1, Final Exam**
Week-2	Introduction to automation tools programmable logic control, microcontroller, relay etc.	
Week-3	Elements of pneumatic and electrical control systems; valves and actuators; stepper motors; case studies of industrial automation systems	
Week-4	Basic concepts: System, control system, input, output, open-loop and closed loop control systems. elements of a general control system, examples of control system	**Class Test**

Week-5	Transfer functions and systems response: Review of Laplace transform, impulse, step and Ramp functions	**2, Final Exam**
Week-6	Concept of transfer functions of common components, block diagram algebra, signal flow graphs, impulse, step, and ramp response of first and second order systems	
Week-7	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.	
Week-8	Manipulators: Classification of robot; example of robot application, identification of manipulator components and terminology; joints classification.	**Mid Term, Final Exam**
Week-9	Kinematics: Kinematic description of multi-degree of freedom manipulators, joint coordinates.	
Week-10	Task coordinates, transformation coordinate system, kinematic model, dynamic equation of six degree of freedom robot arm	
Week-11	Introduction to Jacobians and dynamic performance. Automation strategy	**Class Test 3, Final Exam**
Week-12	Role of automation in industries, benefits of automation, introduction to automation tools Programmable Logic Controller (PLC),	
Week-13	Microcontroller, relay etc	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	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
	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

Level-3, Term-II

	COURSE INFORMATION

Course Code Course Title	: NE 333 : Reactor Instrumentation and Control	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 develop the capability on basic principles of detection and measurements of reactor instrumentation system which will enable students to understand the behaviour of instrumentation on normal condition as well as to analyze instrumentation response during accidental condition in nuclear power plants.
	OBJECTIVES
	1. To understand the reactor systems, sensor performance and reliability test. 2. To understand the details of instrumentation response on nuclear accidents. 3. To acquire the knowledge on the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics. 4. To know the process of data acquisition, data analysis and basic principles of measurements.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Evaluate sensor performance and reliability test of reactor systems. 2. Analyze the instrumentation response on nuclear accidents. 3. Formulate the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics. 4. Apply the data acquisition process and measurements technique to calculate the temperature, flow, pressure and heat flux.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** sensor performance and reliability test of reactor systems.	PO1	C5	-	-	3	T, Q, F
CO2	**Analyze** the instrumentation response on nuclear accidents.	PO1, PO2	C4	-	-	4	ASG, F
CO3	**Explain** the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics.	PO2, PO3	C6	-	-	5	MT, F
CO4	**Apply** 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 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

Overview of reactor I&C system, NPP I&C system architecture, classification of I&C systems, 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 Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** sensor performance and reliability test of reactor systems.	3											
CO2	**Analyze** the instrumentation response on nuclear accidents.	3	3										
CO3	**Explain** the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics.		3	3									
CO4	**Apply** the data acquisition process and measurements technique to calculate the temperature, flow, pressure and heat flux.	3	3										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to evaluate sensor performance and reliability test of reactor systems, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is be applied.
CO2-PO1	3	In order to analyze the instrumentation response on nuclear 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 analyze the instrumentation response on nuclear accidents, 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 formulate the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics, 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-PO3	3	In order to formulate the instrumentation systems of nuclear power plants including microprocessor, micro controller and nuclear electronics, 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	3	In order to apply the data acquisition process and measurements technique to calculate the temperature, flow, pressure and heat flux, 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	3	In order to apply the data acquisition process and measurements technique to calculate the temperature, flow, pressure and heat flux, 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 STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Overview of reactor I&C system, NPP I&C system architecture, classification of I&C systems	**Class Test 1, Final Exam**
Week-2	Basic principles of measurements	
Week-3	Characteristics and behaviour of typical measuring systems; transfer function measurement systems	
Week-4	Basic I&C loop and major loop elements including transmitters	**Class Test 2, Final Exam**
Week-5	Signal conditioner, controllers	
Week-6	Actuators and final control elements	
Week-7	Temperature, flow, pressure, liquid level sensors	
Week-8	Neutron flux, ex-core and in-core nuclear instrumentations	**Mid Term, Final Exam**
Week-9	Sensor performance and reliability test,; protection systems; calibration	
Week-10	control rod drives and rod position indication system, power supplies; NPP I&C system architecture	
Week-11	Classification of I&C systems; Microprocessor, micro controller and nuclear electronics	**Class Test 3, Final Exam**
Week-12	Measurements of temperature	

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

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
	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

1. 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.
2. Ahmed, S. N. *Physics and Engineering of Radiation Detection*, 2nd Edition. APA, USA:Academic Press, 2007.
3. 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

Level-3, Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 334 : Reactor Instrumentation and Control Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
	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
	1. To enable the students to analyze and demonstrate the process instrumentation. 2. To make students acquainted with voltage, current and power measurement by ammeter and voltmeter. 3. To verify the measured value with calculated results. 4. To design a simple temperature and pressure measurement system for reactor.
	LEARNING OUTCOMES
	1. Analyze and demonstrate the process instrumentation. 2. Measuring voltage, current and power measurement device such as ammeter and voltmeter. 3. Analyzing measured value with calculated results. 4. Design a simple temperature and pressure measurement system for reactor.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Analyze** and **demonstrate** the process instrumentation.	PO1, PO4	C2, C4	1	2	1,2	Q, R, T
CO2	**Measure** voltage, current and power measurement device such as ammeter and voltmeter.	PO2, PO5	C5	2	1	6	Q, R, T
CO3	**Analyzing** measured value with calculated results.	PO1, PO4	C4	2	3	2	Q, R, MT
CO4	**Design** a simple temperature and pressure measurement system for reactor.	PO4	C6	1	1	5	Q, R, Pr

	(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
	1. Errors in measurement and basic statistical sampling. 2. Measurement of medium resistance using wheatstone bridge. 3. Range Extension of Ammeter and Voltmeter. 4. Measurement of Power by a) 3 Voltmeter Method b) 3 Ammeter Method 5. Study of PLC Based Control system
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Analyze** and **demonstrate** the process instrumentation.	2			3								
CO2	**Measuring** voltage, current and power measurement device such as ammeter and voltmeter.		2			2							
CO3	**Analyzing** measured value with calculated results.	2			2								
CO4	**Design** a simple temperature and pressure measurement system for reactor.				3								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	Knowledge of both scientific and reactor fundamental knowledge is required to **analyze** and **demonstrate** the process instrumentation.
CO1-PO4	3	Design basis knowledge and data interpretation is very important to **analyze** and **demonstrate** the process instrumentation.
CO2-PO2	2	Proper measurement must be ensured by to find the solution of the problem.
CO3-PO1	2	Knowledge of both scientific and reactor fundamental knowledge is required to **analyze** measured value with calculated results.
CO3-PO4	2	Design basis knowledge and data interpretation is very important to **analyze** measured value with calculated results.
CO4-PO4	3	Design basis knowledge and data interpretation is very important to design a simple temperature and pressure measurement system for reactor.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	14
Practical / Tutorial / Studio	28
Student-Centered Learning	-
Self-Directed Learning	
Preparation of Lab Reports	14
Preparation of Lab Test	10
Preparation of presentation Preparation of Quiz Engagement in Group Projects	9
Formal Assessment	
Continuous Assessment	1
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	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	

ASSESSMENT STRATEGY

Components	Grading	CO	Blooms Taxonomy
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

Level-3, Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 355 : 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 introduction to heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer. It will introduce the important concepts such as energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer, multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer. Apart from these, this course will also introduce the important topics including core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences.
	OBJECTIVES

	1. 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. 2. To know energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer. 3. To apply multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer. 4. To evaluate core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Apply fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer. 2. Analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer. 3. Explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer. 4. Evaluate core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** 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	**Analyze** 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	**Explain** multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.	PO1, PO2, PO3	C2	1	-	4	MT, F
CO4	**Evaluate** core thermal design, nuclear and thermal hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.	PO1, PO2, PO3	C5	2	1	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)
	COURSE CONTENT

	Concept of thermal-hydraulics, objectives of nuclear reactor thermal hydraulics, 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 thermal hydraulics concerned with safe and effective heat removal from the reactor core for power production. Analysis of operational and accident transient sequences, nuclear and thermal hydraulic transient, and engineering aspects of nuclear reactor safety.
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** fundamental of heat transfer mechanisms and fluid mechanics in fluids and analogies in solving various engineering problem related to process of energy transfer.	3	3										
CO2	**Analyze** energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements and transfer.	2	2	2									
CO3	**Explain** multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer	2	2	2									
CO4	**Evaluate** core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety.	2	2	2									

(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 heat transfer mechanisms and fluid mechanics in fluids and analogies 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.
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	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 distribution, reactor heat generation, temperature distributions in fuel elements and 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-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 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.
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-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety, 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	2	In order to evaluate core thermal design, nuclear and thermal-hydraulic operational and accident transient sequences, and engineering aspects of nuclear reactor safety, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21

	Formal Assessment Continuous Assessment	2
	Mid-Term Final Examination	1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Concept of thermal-hydraulics, objectives of nuclear reactor thermal hydraulics	**Class Test 1, Final Exam**
Week-2	Fundamentals of heat transfer mechanisms and fluid mechanics in fluids and analogies	
Week-3	Energy and core flow distribution, Reactor heat generation and transfer	
Week-4	Radial and axial temperature distributions in fuel elements,	**Class Test 2, Final Exam**
Week-5	Applications of single-phase, two-phase flow and convective boiling to reactor coolant channel analysis	
Week-6	Core thermal design and safety analysis, Two-phase flow patterns	
Week-7	Critical heat flux, DNBR, AOOs,	
Week-8	Void coefficient, Radiative heat transfer	**Mid Term, Final Exam**
Week-9	Thermal-hydraulic safety limits and conditions	
Week-10	Current research topics of the nuclear thermal hydraulics concerned with safe and effective heat removal from the reactor core for power production.	
Week-11	Analysis of operational and accident transient sequences	**Class Test 3, Final Exam**
Week-12	Nuclear and thermal hydraulic transient	
Week-13	Engineering aspects of nuclear reactor safety	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
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

Level-3, Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 356 : Nuclear Reactor Thermal Hydraulics Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
	PRE-REQUISITE		
	NE 355		
	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 concepts learned in NE 355.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements. 2. Explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Analyze** 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** multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.	PO2, PO4	C5	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)

COURSE CONTENT

Study of heat exchanger.
Demonstration of the law of partial pressures.
Investigation of the effect of pressure on critical thermal flow.
Determination of thermal conductivity of a metal by steady state method.
Study of force convection heat transfer in a circular tube.
Study of forced convection of fin/flat plate/pipe bundle.
Study of heat transfer by radiation and convention.
Determination of heat flow and surface heat transfer coefficient at constant pressure.
Demonstration of film-wise condensation and measurement of overall heat transfer coefficient.
Investigation of the air effect in a condenser.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Analyze** energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements.		3	3									
CO2	**Explain** multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer.		3		3								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO2	3	In order to analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements, 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-PO3	3	In order to analyze energy conversion and core flow distribution, reactor heat generation, temperature distributions in fuel elements, 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.
CO2-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.

CO2-PO4	3	In order to explain multi-phase flow, convective boiling to reactor coolant channel process and radiative heat transfer, 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	
	Lecture	28
	Practical / Tutorial / Studio	28
	Student-Centered Learning	-
	Self-Directed Learning	
	Preparation of Lab Reports	28
	Preparation of Lab Test	20
	Preparation of presentation	14
	Preparation of Quiz	-
	Engagement in Group Projects	-
	Formal Assessment	-
	Continuous Assessment	1
	Final Quiz	1
	Total	120

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction	**Mid-term**
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	
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	**Final Exam**
Week-9	Study of heat transfer by radiation and convention	
Week-10	Determination of heat flow and surface heat transfer coefficient at constant pressure	
Week-11	Demonstration of film-wise condensation and measurement of overall heat transfer coefficient	
Week-12	Investigation of the air effect in a condenser	
Week-13	Lab practice	
Week-14	Final examination	

ASSESSMENT STRATEGY

Components		Grading	CO	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 Evaluation (40%)	Exam	30%	CO1, CO2	C4, C5
	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

Level-3, Term-II

	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 concerned with the mechanical properties of materials as they relate to the strength and stability of structures and mechanical components, and the skills and knowledge required to develop analytical techniques used to solve a wide range of linear stress/strain problems.
	OBJECTIVES
	1. To know the basic concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components. 2. To learn the characteristics and calculate the magnitude of combined stresses in individual members and complete structures. 3. To calculate the deflection at any point on a beam subjected to a combination of loads. 4. To illustrate science/engineering data graphically and interpret the role of such displays in data analysis.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Define the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components. 2. Explain the characteristics and calculate the magnitude of combined stresses in individual members and complete structures. 3. Analyze various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress and calculate the deflection at any point on a beam subjected to a combination of loads. 4. Construct graphical displays of science/ engineering data and interpret the role of such displays in data analysis.

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components.	PO1	C1	1	1	1	T, Q, F
CO2	**Explain** the characteristics and **calculate** the magnitude of combined stresses in individual members and complete structures.	PO2	C2, C5	2	1	2	ASG, F
CO3	**Analyze** various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress and **calculate** the deflection at any point on a beam subjected to a combination of loads.	PO3	C4, C5	2	1	3	MT, F
CO4	**Construct** graphical displays of science/ engineering data and **interpret** the role of such displays in data analysis.	PO3	C2, C6	2	2	4	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

Stress analysis: statically indeterminate axially loaded member, axially loaded member, thermal and centrifugal stresses; Stresses in thin and thick walled cylinders and spheres.
Beams: Shear force and bending moment diagrams; Various types of stresses in beams; Flexure formula; Deflection of beams: integration and area moment methods;
Torsion formula; Angle of twist; Modulus of rupture; Helical springs; Combined stresses: principal stress, Mohr's Circle; Columns: Euler's formula, intermediate column formulas, the Secant formula; Flexure formula of curved beams.
Introduction to experimental stress analysis techniques; Strain energy; Failure theories.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components.	3											
CO2	**Explain** the characteristics and **calculate** the magnitude of combined stresses in individual members and complete structures.		3										
CO3	**Analyze** various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress and **calculate** the deflection at any point on a beam subjected to a combination of loads.			2									
CO4	**Construct** graphical displays of science/ engineering data and **interpret** the role of such displays in data analysis.			3									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to define the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to be applied.
CO2-PO1	3	In order to explain the characteristics and calculate the magnitude of combined stresses in individual members and complete structures, 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	2	In order to analyze various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress and calculate the deflection at any point on a beam subjected to a combination of loads, 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-PO3	3	In order to construct graphical displays of science/ engineering data and interpret the role of such displays in data analysis, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Stress analysis: statically indeterminate axially loaded member, axially loaded member, thermal and centrifugal stresses (I)	
Week-2	Stress analysis: statically indeterminate axially loaded member, axially loaded member, thermal and centrifugal stresses (II)	**Class Test 1, Final Exam**
Week-3	Stress analysis: statically indeterminate axially loaded member, axially loaded member, thermal and centrifugal stresses (III)	
Week-4	Stresses in thin and thick walled cylinders and spheres	**Class Test 2, Final Exam**
Week-5	Beams: Shear force and bending moment diagrams; various types of stresses in beams	
Week-6	Flexure formula; Deflection of beams: integration and area moment methods (I)	
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 Term, Final Exam**
Week-9	Torsion formula; Angle of twist; Modulus of rupture; Helical springs; Combined stresses: principal stress (II)	
Week-10	Mohr’s Circle (I)	
Week-11	Mohr’s Circle (II)	**Class Test**
Week-12	Euler’s formula, intermediate column formulas, the Secant formula; Flexure formula of curved beams (I)	

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	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C1, C2, C5, C6
	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

Level-3, Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 354 : Mechanics of Materials Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
	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		
	1. To learn a basic knowledge of the statistical aspects of mechanics of materials. 2. To understand the formal theory of solid mechanics: the equilibrium, kinematic, and constitutive equations. 3. To introduce the atomistic mechanisms underlying the mechanical behavior of materials. 4. To evaluate the process-structure-property-performance relationships in materials engineering.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Demonstrate the fundamentals of stresses and strains. 2. Construct graphical displays to interpret the engineering data as well as analyze various structural members subjected to combined stresses by Mohr's circle and calculate the deflection at any point on a beam.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Demonstrate** the fundamentals of stresses and strains.	PO1	C2	1	2	1	R, Q, T
CO2	**Construct** graphical displays to interpret the engineering data as well as **analyze** various structural members subjected to combined stresses by Mohr's circle and **calculate** the deflection at any point on a beam.	PO2, PO4	C4, C6	3	3	4	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)

COURSE CONTENT

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

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Demonstrate** the fundamentals of stresses and strains.	3											
CO2	**Construct** graphical displays to interpret the engineering data as well as **analyze** various structural members subjected to combined stresses by Mohr's circle and **calculate** the deflection at any point on a beam.		3		3								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The knowledge of mathematics, science and engineering drawing fundamentals is required to demonstrate the fundamentals of stresses and strains.
CO2-PO2	3	Identification, formulation, research literature and analysis of complex engineering problems are required to construct graphical displays to interpret the engineering data as well as analyze various structural members subjected to combined stresses by Mohr's circle and calculate the deflection at any point on a beam.
CO2-PO4	3	In order to construct graphical displays to interpret the engineering data as well as analyze various structural members subjected to combined stresses by Mohr's circle and calculate the deflection at any point on a beam, it is required to conduct investigations of complex problems using engineering drawing knowledge and 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	
Lecture	14
Practical / Tutorial / Studio	28
Student-Centered Learning	-
Self-Directed Learning	
Preparation of Lab Reports	14
Preparation of Lab Test	10
Preparation of presentation	9

	Formal Assessment Continuous Assessment Final Quiz	 14 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	Experimental stress analysis techniques and failure theories	
Week-7	Final Exam	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (60%)	Class Participation/ Attendance	5+5= 10%	CO1	C2
	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 (40%)	Exam	30%	CO1, CO2	C2, C4, C6
	Viva Voce/ Presentation	10%	CO1, CO2	C2, C4, C6
Total 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

Level-3, Term-II

	COURSE INFORMATION		
Course Code Course Title	: GEEM 351 : Engineering Ethics and Moral Philosophy	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
	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		
	1. To inculcate the sense of social responsibility. 2. To develop a firm ethical base. 3. To make the students realize the significance of ethics in nuclear professional environment.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Understand the theoretical aspects of ethics and moral philosophy in professional fields. 2. Identify practical and legal problems commonly encountered by engineers in their professional field/industry. 3. Develop foundation knowledge of ethics to be applied in professional fields. 4. Critically assess the codes of professional conduct and their implications in nuclear engineering life.		

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the theoretical aspects of ethics and moral philosophy in professional fields.	PO1	C2	-	-	1	T, Q, F
CO2	**Identify** practical and legal problems commonly encountered by engineers in their professional field/industry.	PO2, PO6	C3	-	-	1	ASG, F
CO3	**Develop** foundation knowledge of ethics to be applied in professional fields.	PO8	C6	-	-	1	MT, F

CO4	**Critically assess** the codes of professional conduct and their implications in nuclear engineering life.	PO12	C5	-	-	1	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

Introduction to ethics, history, evolution, need and importance of ethics in nuclear engineering technology, ethical terminology; Introduction to the Engineering Ethics: purpose, objectives, scope, methods etc. Introduction to Philosophy of Engineering; Professional Engineering Codes, Codes of Ethics (IEB); Code of Ethics (BAERA & IAEA); Whistle Blowing; Ethical problem solving techniques; Case study methodology, different case studies; The Rights and Responsibilities of Engineers; Ethical Issues in Engineering Practice; Ethics Issues in Nuclear Energy Technology; Safety, Risk and Liability; Trust and reliability.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the theoretical aspects of ethics and moral philosophy in professional fields.	1											
CO2	**Identify** practical and legal problems commonly encountered by engineers in their professional field/industry.		2				3						
CO3	**Develop** foundation knowledge of ethics to be applied in professional fields.								3				
CO4	**Critically assess** the codes of professional conduct and their implications in nuclear engineering life.												1

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to understand the theoretical aspects of ethics and moral philosophy in professional fields, 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	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 sciences are required.
CO2-PO6	3	In order to be able to identify practical and legal problems commonly encountered by engineers in their professional field/industry 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-PO8	3	In order to develop foundation knowledge of ethics to be applied in professional fields, application of ethical principles and commit to professional ethics and responsibilities and norms of engineering practice is required.
CO4-PO12	1	In order to engage in lifelong learning through acquiring knowledge on legal and ethical aspects of professions of Nuclear Engineering, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 28 - -
	Self-Directed Learning Non-face-to-face learning Revision	 56 14
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	104

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to ethics, history, evolution, need and importance of ethics in nuclear engineering technology, ethical terminology	**Class Test 1, Final Exam**
Week-2	Introduction to the Engineering Ethics: purpose, objectives, scope, methods etc.	
Week-3	Introduction to Philosophy of Engineering	
Week-4	Professional Engineering Codes, Codes of Ethics (IEB)	**Class Test 2, Final Exam**
Week-5	Code of Ethics (IAEA)	
Week-6	Code of Ethics (BAERA)	
Week-7	Ethical Problem Solving Techniques	
Week-8	Whistle Blowing.	**Mid Term, Final Exam**
Week-9	Case study methodology, different case studies	
Week-10	The Rights and Responsibilities of Engineers	
Week-11	Ethical Issues in Engineering Practice	**Class Test 3, Final Exam**
Week-12	Ethics Issues in Nuclear Energy Technology	
Week-13	Safety, Risk and Liability	
Week-14	Trust and reliability	

ASSESSMENT STRATEGY				
Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (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	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			
Course Code Course Title	: GERM 352 : Fundamentals of Research Methodology	Lecture Contact Hours Credit Hours	: 4.00 : 2.00

PRE-REQUISITE

Nil

CURRICULUM STRUCTURE

Outcome Based Education (OBE)

SYNOPSIS/RATIONALE

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	CP	CA	KP	Assessment Methods
CO1	**Understand** the research fundamentals and **formulate** problem statement and research questions/objectives.	PO2	C2, C6	-			ASG, Q
CO2	**Formulate** and **compose** a research proposal considering research activities/design, background studies, and following standard guidelines.	PO3, PO12	C6	-			R, Pr, ASG, Q
CO3	**Develop** writing and presentation skill, and **demonstrate** 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) 1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the research fundamentals and **formulate** problem statement and research questions/objectives.		3										
CO2	**Formulate** and **compose** a Research proposal considering research activities, background studies, and following standard guidelines.			1									2
CO3	**Develop** writing and presentation skill, and **demonstrate** ethical considerations in conducting research.								1		3		

(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-Centered 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	**Continuous Assessment** (presentation/ quiz/other assignment)
2	Practice session on Foundations of Research	
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.	
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 before, here students will submit report and give PPT
6	Practice session on Research Design	
7	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	
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 Assessment** (presentation/ quiz/other assignment)
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	
13	Review Session (Theory) – I/ Final Presentation	**Assignment 2** Assignment has to provide before, here students will submit report and give PPT
14	Review Session (Practice) – II/ Final Presentation	

ASSESSMENT STRATEGY

Assessment Criteria		CO	Blooms Taxonomy
Components	**Grading**		
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 Credit 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, analyzes 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		
	1. To learn more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work. 2. To study, analyze and provide solutions for the problems related to Nuclear Engineering. 3. To contribute to research and development work. 4. To use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues. 5. To plan and use adequate methods to conduct qualified tasks in given frameworks and to evaluate this work. 6. To create, analyze and critically evaluate different technical/architectural solutions. 7. To critically and systematically integrate knowledge. 8. To learn about the research methodology as well as technical document writing.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will achieve the 1. Ability 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. 2. Ability to analyze scenario and compose the problem statements and the research objectives of the project along with time-cost estimation and ethical values. 3. Ability to formulate research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem. 4. Ability to communicate through clear research writing conform to standard thesis format and performs verbal presentation along with visibility of the proposed system.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	C**onduct** literature review to justify the importance of research and to support development of coherent methodology using standard references including journals, policies, field data, etc.	PO4, PO5	C1-C4, A2	1	1	1	PR, R
CO2	**Analyze** scenario and compose the problem statements and the research objectives of the project along with time-cost estimation and ethical values.	PO2, PO6, PO8	C1, C3-C5, A3, A4, P1	3	2	1, 3,4	Pr, R
CO3	**Formulate** research methodology incorporating clear fundamentals, theories and benchmarked against standard practices governing the research project which incorporate real life problem.	PO1, PO3, PO7, PO9, PO12	C3-C6, A4, P5	2	3	1, 2, 5	Pr, R
CO4	**Communicate** through clear research writing, conform to standard thesis format and verbal presentation along with visibility of the proposed system.	PO7, PO10	C4, C6, A5, 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)

COURSE CONTENT

Students may choose to write alone or in groups of up to 3 students.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	C**onduct** literature review to justify the importance of research and to support development of coherent methodology using standard references including journals, policies, field data, etc.				3	2							
CO2	**Analyze** 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	**Formulate** 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 system.							3			3		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR 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 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	3	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

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 84 - -
	Self-Directed Learning Non-face-to-face learning Revision	 42 -
	Formal Assessment Continuous Assessment Research project Report Mid-Term Final Presentation	 84 42 1
	Total	253

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Activities	Log Book	Remarks
Week-1	Discussion with students, Topics selection (I)	-	
Week-2	Discussion with students, Topics selection (II)	-	
Week-3	Analysis selected topics	Introduction section (Chapter 1)	
Week-4	Review of Literature (I)	Writing literature review (Chapter 2)	
Week-5	Review of Literature (II)	Writing literature review (Chapter 2)	
Week-6	Work on methodology section	Startingof methodology section (Chapter 3)	
Week-7	Presentation on proposed research work	Sample report	

Week-8	Work on Proposal and Presentation covering Introduction, Literature Review, Methodology	Related update	
Week-9	Related data collection, data analysis (I)	Include analyzed result, result and discussion	
Week-10	Related data collection, data analysis (II)	Include analyzed result, result and discussion	
Week-11	Related data collection, data analysis (III)	Include analyzed 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	-	

ASSESSMENT STRATEGY

Evaluator	Component	Grading (%)	Total (%)	CO	Bloom Taxonomy
Supervisor	Problem statement and Research objective report	20	60	CO1	C1-C4, A2
	Literature review report	30		CO2	C1, C3-C5, A3, A4, P1
	Methodology report	10		CO3	C3-C6, A4, P5
Internal Examiner	Proposal report	20	35	CO1	C1-C4, A2
				CO4	C4, C6, A5, P7
	Proposal presentation	15		CO2	C1, C3-C5, A3, A4, P1
				CO3	C3-C6, A4, P5
Coordinator	Log book	5	5	CO4	C4, C6, A5, P7
Total Marks		**100**	**100**		

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

REFERENCE BOOKS

N/A

REFERENCE SITE

Level-4, Term-I

	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 a general introduction to the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management.
	OBJECTIVES
	1. To understand the process of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques. 2. To acquiring the skill of fuel designing, fuel performance analysis, burn-up analysis and spent fuel reprocessing methods. 3. To understand the classification of radioactive waste and its conditioning and develop safety cases and assessments for repositories. 4. To acquire the knowledge of different waste treatment procedures and demonstrate both environmental and radiological safety in case of radioactive waste disposals.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Understand the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management. 2. Explain the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques. 3. Analyze the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories. 4. Evaluate the fuel design and performance analysis and demonstrate both environmental and radiological safety in case of radioactive waste disposals to save environment
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** 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	**Explain** the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.	PO2	C4	-	-	3	ASG, F
CO3	**Analyze** the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories.	PO3	C4	-	-	3	MT, F
CO4	**Evaluate** 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- 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

An overview of the fuel cycle, different fuels and fuel utilization, mining of uranium, Heap leaching, In Situ leaching, milling of uranium, solvent extraction of uranium, purification and conversion to UF6, Uranium enrichment: gaseous diffusion, uranium enrichment: centrifuge enrichment, laser isotope separation process, Separative Work Unit SW, Analysis of SWU, Fuel Rod and Assembly Design properties of irradiated fuel, Spent fuel management, nuclear fuel reprocessing, fusion fuel cycle, fuel cycle economy.

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, purex process, conversion of radioactive wastes, decontamination of radioactive element, treatment process of gaseous, aqueous and solid wastes, 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, Composite waste forms, glass-ceramic composites, engineered encapsulation, transportation and storage systems of nuclear waste, Different disposal techniques, shallow disposal, deep disposal, dry cask storage, Spent fuel pool, policy, governance, social and political issues, environmental impact assessment.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** 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	**Explain** the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.		3										
CO3	**Analyze** the classifications of radioactive waste and its conditioning and **develop** safety cases and assessments for repositories.			3									
CO4	**Evaluate** the fuel design and performance analysis and demonstrate both environmental and radiological safety in case of radioactive waste disposals to save environment							2					

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	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, 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 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, milling, conversions, enrichment and fuel fabrication techniques, 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-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 or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
CO4-PO7	2	In order to evaluate the fuel design and performance analysis and demonstrate both environmental and radiological safety in case of radioactive waste disposals, 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	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	An overview of the fuel cycle, different fuels and fuel utilization, mining of uranium, Heap leaching	

Week-2	In Situ leaching, milling of uranium, solvent extraction of uranium, purification and conversion to UF6	**Class Test 1, Final Exam**
Week-3	Uranium enrichment: gaseous diffusion, uranium enrichment: centrifuge enrichment, laser isotope separation process, Separative Work Unit (SWU)	
Week-4	Analysis of SWU, Fuel Rod And Assembly Design-1, Fuel Rod And Assembly Design-2	**Class Test 2, Final Exam**
Week-5	In core fuel management, Fuel Management And Fuel Reload Pattern -1, Fuel Management And Fuel Reload Pattern -2	
Week-6	Fuel Burn-up Calculation -1, Fuel Burn-up Calculation-2, properties of irradiated fuel	
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 Term, Final Exam**
Week-9	Wastes from the 'front end' and 'back end' of the fuel cycle, decommissioning waste, transuranic waste, different separation techniques of nuclear wastes	
Week-10	The purex process, conversion of radioactive wastes, decontamination of radioactive element, treatment process of gaseous, aqueous and solid wastes	
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 3, Final Exam**
Week-12	Composite waste forms, glass-ceramic composites, engineered encapsulation, transportation and storage systems of nuclear waste	
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	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C5
	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

Level-4 Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 410 : Nuclear Fuel Cycle and Radioactive Waste Management Sessional	Lecture Contact Hours Credit Hours	: 2.0 : 1.0
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	This course is designed to provide a general introduction to the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management.		
	OBJECTIVES		
	1. To understand the process of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques. 2. To acquiring the skill of fuel designing, fuel performance analysis, burn-up analysis and spent fuel reprocessing methods. 3. To understand the classification of radioactive waste and its conditioning and develop safety cases and assessments for repositories. 4. To acquire the knowledge of different waste treatment procedures and demonstrate both environmental and radiological safety in case of radioactive waste disposals.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Understand the various opportunities in the emerging field of nuclear fuel system and the classification of radioactive waste and its conditioning and disposal management. 2. Explain the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques. 3. Analyze the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories. 4. Evaluate the fuel design and performance analysis and demonstrate both environmental and 5. radiological safety in case of radioactive waste disposals to save environment		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** 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	**Explain** the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques.	PO2	C4	-	-	3	ASG, F
CO3	**Analyze** the classifications of radioactive waste and its conditioning and develop safety cases and assessments for repositories.	PO3	C4	-	-	3	MT, F
CO4	**Evaluate** 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- 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, OE-Online Exam)

COURSE CONTENT

1. Sessional based on theory course.
2. Thermal analysis of transportation cask.
3. Cask design and safety analysis by software code.
4. Modelling and simulation of waste management scenario.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** knowledge of nuclear fuel cycle to find roadmap to solve problems.	3											
CO2	**Apply** knowledge of different radioactive waste management procedures to solve radioactive waste management issue.		3										
CO3	**Apply** practical knowledge to understand the radiological safety in case of radioactive waste transport and disposals to save environment.						3						

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to apply knowledge of nuclear fuel cycle, the fundamentals of Uranium mining, milling, conversions, enrichment and fuel fabrication techniques, 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 apply knowledge of different radioactive waste management procedures, 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.
CO3-PO6	3	In order to apply practical knowledge to understand the radiological safety in case of radioactive waste disposals, evaluation of the fuel design and performance analysis and demonstrate both environmental and radiological safety in case of radioactive waste disposals, it is required to conduct investigations of complex problems using research-based knowledge.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)

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

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Sessional based on theory course.	
Week-2	Sessional based on theory course.	**Evaluation 1**
Week-3	Sessional based on theory course.	
Week-4	Thermal analysis of transportation cask.	**Evaluation 2**
Week-5	Cask design and safety analysis by software code.	
Week-6	Modelling and simulation of waste management scenario	**Evaluation 3**
Week-7	Final exam	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Lab performance and Report	10%		
	Online-1	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. 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

Level-4, Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 415 : Radiation Interactions, Shielding and Protection	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
	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 well as special techniques and simulation methods for shielding analysis.		
	OBJECTIVES		
	1. To understand the fundamentals of radiation shielding in radiation fields and sources review of particle interactions. 2. To know the Monte Carlo simulation for shielding analysis and basic methods for radiation dose calculations. 3. To identify various techniques for photons and neutrons. 4. To evaluate transport solutions: straight-ahead approximation, discrete ordinates, method of moments; albedos and duct penetration methods.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Apply fundamentals of radiation shielding in radiation fields and sources review of particle interactions. 2. Analyze the common radiation sources encountered in shield design and Monte Carlo simulation for shielding analysis. 3. Explain build-up factors, extending point kernel techniques to include build-up point kernel codes, medical facility shielding for photons and different techniques for neutron. 4. Evaluate transport solutions: straight-ahead approximation, discrete ordinates, method of moments; albedos and duct penetration methods; skyshine and air scatter.		

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** fundamentals of radiation shielding in radiation fields and sources review of particle interactions.	PO1	C3	-	-	-	T, F

CO2	**Analyze** the common radiation sources encountered in shield design and Monte Carlo simulation for shielding analysis.	PO3	C4	-	-	1	Q, ASG, F
CO3	**Explain** build-up factors, extending point kernel techniques to include build-up point kernel codes, medical facility shielding for photons and different techniques for neutron.	PO2	C5	-	-	2	MT, F
CO4	**Evaluate** transport solutions: straight-ahead approximation, discrete ordinates, method of moments; albedos and duct penetration methods; skyshine and air scatter.	PO2	C5	-	-	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)

COURSE CONTENT

Fundamental concepts: definition of a shield, characterizations of radiation fields and sources review of particle interactions, common radiation sources encountered in shield design, Monte Carlo simulation for shielding analysis, basic methods for radiation dose calculations, special techniques for photons: buildup factors, extending point kernel techniques to include buildup point kernel codes, special techniques for neutrons transport solutions: straight-ahead approximation, method of moments, discrete ordinates, albedos and duct penetration methods; skyshine and air scatter, medical facility shielding, Shielding Design Considerations for Space Applications, Emerging Technologies in Radiation Shielding and Protection, Reactor shielding design calculations.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** fundamentals of radiation shielding in radiation fields and sources review of particle interactions.	2											
CO2	**Analyze** the common radiation sources encountered in shield design and Monte Carlo simulation for shielding analysis.		3										
CO3	**Explain** buildup factors, extending point kernel techniques to include buildup point kernel codes, medical facility shielding for photons and different techniques for neutron.		3										
CO4	**Evaluate** transport solutions: straight-ahead approximation, discrete ordinates, method of moments; albedos and duct penetration methods; skyshine and air scatter.		2										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING		
Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	2	In order to apply fundamentals of radiation shielding in radiation fields and sources review of particle interactions, 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 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 engineering 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	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 mathematics, natural sciences and engineering sciences are required.

TEACHING LEARNING STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	**Topics**	**Remarks**
Week-1	Fundamental concepts: definition of a shield	**Class Test 1, Final Exam**
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	

Week-4	Monte Carlo simulation for shielding analysis (I)	**Class Test 2, Final Exam**
Week-5	Monte Carlo simulation for shielding analysis (II)	
Week-6	Monte Carlo simulation for shielding analysis (III)	
Week-7	Basic methods for radiation dose calculations (I)	
Week-8	Basic methods for radiation dose calculations (II)	**Mid Term, Final Exam**
Week-9	Special techniques for photons: buildup factors, extending point kernel techniques to include buildup point kernel codes, medical facility shielding (I)	
Week-10	Special techniques for photons: buildup factors, extending point kernel techniques to include buildup point kernel codes, medical facility shielding (II)	
Week-11	Special techniques for neutrons, transport solutions: straight-ahead approximation, discrete ordinates, method of moments (I)	**Class Test 3, Final Exam**
Week-12	Special 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)	
Week-14	Albedos and duct penetration methods; skyshine and air scatter (II) and review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
	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

Level-4, Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 417 : Nuclear Accidents Analysis and Nuclear Radiological Emergency	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 nuclear accidents and radiological emergencies cause by these accidents.		
	OBJECTIVES		
	1. To understand the fundamentals of safety functions in major nuclear and radiological accidents investigation. 2. To know various methods of accidental analysis. 3. To identify various types of operating procedures and plant simulators. 4. To evaluate the qualification and training of users. 5. To understand nuclear or radiological emergency response plan of Bangladesh		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Explain major nuclear and radiological accidents. 2. Understand nuclear or radiological emergency response plan. 3. Analyze various methods of accidental analysis for the better impact to the society in accidental conditions 4. Evaluate various types of operating procedures and plant simulators.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** major nuclear and radiological accidents.	PO1	C2	-	-	3	T, Q, F
CO2	**Understand** nuclear or radiological emergency response plan.	PO2	C4	-	-	4	T, ASG, F
CO3	**Analyze** 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.	PO3	C6	1	-	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

	Principles of Nuclear Power Plant Safety, Dispersion of Effluents from Nuclear Facilities, Radiation Doses from Nuclear Facilities, Radiation Doses from Nuclear Plants, Reactor Siting, Reactor Accidents, Accident Risk Analysis, Environmental Radiation Doses, Major nuclear and radiological accidents investigation, categorization of initiating events, conservative analyses, best estimate analyses, accident modelling, licensing analysis, validation of emergency, probabilistic safety analysis, deterministic 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, accident management, emergency operation procedure, analysis of operation transients, accidents and severe accidents, accident phenomena, including severe accidents, accident mitigation, format and structure of accident analysis results, review of accident analysis results. Overview of National Nuclear or Radiological Emergency Response Plan (NNREP): 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 NNREP plan.
	SKILL MAPPING (CO-PO MAPPING)
	(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	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Principles of Nuclear Power Plant Safety, Dispersion of Effluents from Nuclear Facilities	**Class Test 1, Final Exam**
Week-2	Radiation Doses from Nuclear Facilities, Radiation Doses from Nuclear Plants	
Week-3	Reactor Siting, Reactor Accidents, Accident Risk Analysis, Environmental Radiation Doses	
Week-4	Major nuclear and radiological accidents investigation, categorization of initiating events, conservative analyses	**Class Test 2, Final Exam**
Week-5	Best estimate analyses, accident modelling, licensing analysis, validation of emergency	
Week-6	Probabilistic safety analysis, deterministic safety analysis, support for accident management and emergency planning	
Week-7	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	
Week-8	Accident management, emergency operation procedure, analysis of operation transients, accidents and severe accidents, accident phenomena, including severe accidents	**Mid Term, Final Exam**
Week-9	Accident mitigation, format and structure of accident analysis results, review of accident analysis results	
Week-10	Overview of National Nuclear or Radiological Emergency Response Plan (NNREP): Purpose, scope, types of emergencies, organization of the government response,	
Week-11	Radiological monitoring and assessment, medical assessment and response to radiological consequences	**Class Test**
Week-12	Stages of the government response, international co-ordination-requests for assistance in nuclear or radiological emergency,	

Week-13	Maintaining and updating the NNREP plan,	**3, Final Exam**
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C6
	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 : 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 in-core fuel management system and analyze the reactor core with fuel burnup.		
	OBJECTIVES		

	1. To understand the fundamentals of in core fuel management. 2. To know the fundamentals of reactor reload calculations. 3. To identify various types of models for in-core fuel managements. 4. To evaluate nuclear fuel cycle economics, core life time calculation. 5. To know about fuel reshuffling and arrangement.
	LEARNING OUTCOMES

	Upon completion of the course, the students will be able to 1. Understand the operation and control of nuclear power reactor. 2. Explain nuclear reactor start-up, operational modes, transients and shutdown. 3. Compare various types of models for in-core fuel managements. 4. Evaluate nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the operation and control of nuclear power reactor.	PO1, PO2	C2	-	-	3	T, Q, F
CO2	**Explain** nuclear reactor start-up, operational modes, transients and shutdown.	PO3	C5	-	-	4	ASG, F
CO3	**Analyze** various types of reactor models for in-core fuel managements.	PO2	C5	-	-	5	MT, F
CO4	**Evaluate** nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.	PO3	C5	1	-	6	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
	Introduction to fuel management, variables of core management, reactor core analysis, core simulation and nodal methods, core burnup and fuel, depletion modelling, fundamentals of reactor reload calculations, models for in-core fuel managements, PWR in-core fuel management, BWR in-core fuel management, VVER in-core fuel management, Gen IV in-core fuel management, optimization of core reload designs and burnable poison placement, nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.
	SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the operation and control of nuclear power reactor.	2	3										
CO2	**Explain** nuclear reactor start-up, operational modes, transients and shutdown.			3									
CO3	**Analyze** various types of reactor models for in-core fuel managements.		3										
CO4	**Evaluate** nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.			3									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	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 various types of models for in-core fuel managements, 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.
CO4-PO3	3	In order to evaluate nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement, ability to design a system or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	84
	Revision	21
	Formal Assessment	
	Continuous Assessment	2

	Mid-Term Final Examination	1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to fuel management, variables of core management	**Class Test 1, Final Exam**
Week-2	Reactor core analysis	
Week-3	Core simulation and nodal methods	
Week-4	Core burnup and fuel depletion modelling	**Class Test 2, Final Exam**
Week-5	Fundamentals of reactor reload calculations	
Week-6	Models for in-core fuel managements	
Week-7	PWR in-core fuel management	
Week-8	BWR in-core fuel management	**Mid Term, Final Exam**
Week-9	VVER in-core fuel management, Gen IV in-core fuel management	
Week-10	Optimization of core reload designs and burnable poison placement	
Week-11	Nuclear fuel cycle economics	**Class Test 3, Final Exam**
Week-12	Core life time calculation	
Week-13	Fuel reshuffling and arrangement	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	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-II

	COURSE INFORMATION						
Course Code Course Title	: NE 424 : In-core Fuel Management Sessional		Lecture Contact Hours Credit Hours		: 2.0 : 1.0		
	PRE-REQUISITE						
	None						
	CURRICULUM STRUCTURE						
	Outcome Based Education (OBE)						
	SYNOPSIS/RATIONALE						
	The course is designed to learn and familiarize about the in-core fuel management system and analyze the reactor core with fuel burnup.						
	OBJECTIVES						
	1. To understand the fundamentals of in core fuel management. 2. To know the fundamentals of reactor reload calculations. 3. To identify various types of models for in-core fuel managements. 4. To evaluate nuclear fuel cycle economics, core life time calculation. 5. To know about fuel reshuffling and arrangement.						
	LEARNING OUTCOMES						
	Upon completion of the course, the students will be able to 1. Understand the operation and control of nuclear power reactor. 2. Explain nuclear reactor start-up, operational modes, transients and shutdown. 6. Compare various types of models for in-core fuel managements. 7. Evaluate nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.						
	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the operation and control of nuclear power reactor.	PO1, PO2	C2	-	-	3	T, Q, F

CO2	**Explain** nuclear reactor start-up, operational modes, transients and shutdown.	PO3	C5	-	-	4	ASG, F
CO3	**Compare** various types of models for in-core fuel managements.	PO2	C5	-	-	5	MT, F
CO4	**Evaluate** nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.	PO3	C5	1	-	6	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, OE-Online Exam)

COURSE CONTENT

1. Study of burnup of a fuel pincell with different configurations using probabilistic or deterministic code.
2. Study of burnup of a fuel assembly with different configurations using probabilistic or deterministic code.
3. Effect of burnable poisons on the burnup of an assembly.
4. Study of different thermo-mechanical properties of material using ANSYS software.
5. Study the effects of reshuffling of a reactor core using probabilistic code.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** knowledge of probabilistic or deterministic code to find the effect of reshuffling of a reactor core.	3											
CO2	**Apply** knowledge of burnup concepts to assess different parameters.		3										
CO3	**Evaluate** practical knowledge to develop basic programming skills using ANSYS with respect to core design.						3						

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to apply knowledge of probabilistic or deterministic code to find the effect of reshuffling on a reactor core, knowledge of in-core fuel management is crucial.
CO2-PO2	3	In order to apply knowledge of burnup concepts to assess different parameters to ensure proper in-core fuel management.

CO3-PO6	3	Apply practical knowledge to develop basic programming skills using ANSYS for solving complex engineering problems.

TEACHING LEARNING STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 21 - -
	Self-Directed Learning Non-face-to-face learning Revision	 42 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	90
TEACHING METHODOLOGY		
Lecture and Discussion, Co-operative and Collaborative Method, Problem Based Method		
COURSE SCHEDULE		
Weeks	**Topics**	**Remarks**
Week-1	Introduction class	
Week-2	Study of burnup of a fuel pincell with different configurations using probabilistic or deterministic code.	**Evaluation 1**
Week-3	Study of burnup of a fuel assembly with different configurations using probabilistic or deterministic code.	
Week-4	Effect of burnable poisons on the burnup of an assembly.	**Evaluation 2**
Week-5	Study of different thermo-mechanical properties of material using ANSYS software.	
Week-6	Study the effects of reshuffling on a reactor core using probabilistic code.	**Evaluation 3**
Week-7	Final exam	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Lab performance and Report	10%		
	Online-1	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

6. P. Silvennoinen, "Reactor Core Fuel Management", Pergamon Press, 1976
7. M. Driscoll, T. Downar, and E. Pilat, *The Linear Reactivity Model for Nuclear Fuel Management*

REFERENCE SITE

Level-4, Term-I

	COURSE INFORMATION		
Course Code Course Title	: NE 425 : Nuclear Reactor Design and Features	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	NE 207, NE 307		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	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.		
	OBJECTIVES		
	1. To understand the fundamentals of nuclear reactor design for criticality and burnup calculation. 2. To identify various types of principles and techniques of reactor core design methods. 3. To analyze unique designs of reactor core satisfying the parameters of the particular reactor type. 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.		
	LEARNING OUTCOMES		

	Upon completion of the course, the students will be able to 1. Identify various types of principles and techniques of reactor core design methods. 2. Analyze various unique designs of reactor core satisfying the parameters of the particular reactor type. 3. Evaluate the various reactor designs based on knowledge and data from many nuclear engineering fields including reactor physics, thermal hydraulics, and nuclear safety. 4. Formulate the design procedure of reactor parameters.						
	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Identify** various types of principles and techniques of reactor core design methods.	PO2	C2	-	-	2	T, Q, F
CO2	**Analyze** various unique designs of reactor core satisfying the parameters of the particular reactor type.	PO3	C4	-	-	3	ASG, F
CO3	**Evaluate** the various reactor designs based on knowledge and data from many nuclear engineering fields including reactor physics, thermal hydraulics, and nuclear safety.	PO2	C5	-	-	3	MT, F
CO4	**Formulate** the design procedure of reactor parameters.	PO9	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)						
	COURSE CONTENT						
	Nuclear data – compilation, evaluation, processing, validation. Use of nuclear data in fission, neutron transport, reactor design, isotope production, forensic analysis, Energy group condensation, Reactor analysis using two group and single group nuclear cross section, Reactor core calculations, solution of 1D, 2D diffusion equation using Finite Difference Method, solution of multigroup diffusion equation using Finite Difference Method, Solution of Eigen value problem using fission source, Solution of multigroup eigen value problem, PWR core design, Core size and figure, Optimization of fuel lattice, Fuel assembly design, Rod cluster control assembly, soluble boron concentration regulation, Future trends of core design, Low leakage core, MOX fuel, Neutron energy spectrum of thermal reactor and fast reactor, Different types of deterministic and Monte Carlo codes, Engineering design and features of different generation-IV advanced reactors, Burnup calculation, burnup chain, branching ratio. Burnup equation, burnup time. Normalization of neutron flux.						
	SKILL MAPPING (CO-PO MAPPING)						

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Identify** various types of principles and techniques of reactor core design methods.		3										
CO2	**Analyze** various unique designs of reactor core satisfying the parameters of the particular reactor type.			3									
CO3	**Evaluate** the various reactor designs based on knowledge and data from many nuclear engineering fields including reactor physics, thermal hydraulics, and nuclear safety.		2										
CO4	**Formulate** the design procedure of reactor parameters.									2			

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
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	3	In order to analyze various unique designs of reactor core satisfying the parameters of the particular reactor type, 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.
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, and nuclear safety, 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.
CO4-PO9	2	In order to formulate the design procedure of reactor parameters, by performing individual and group tasks through the design and analysis of different reactors.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Nuclear data – compilation, evaluation, processing, validation. Use of nuclear data in fission	**Class Test 1, Final Exam**
Week-2	Neutron transport, reactor design, isotope production	
Week-3	Forensic analysis, Energy group condensation	
Week-4	Reactor analysis using two group and single group nuclear cross section, Reactor core calculations	**Class Test 2, Final Exam**
Week-5	Solution of 1D, 2D diffusion equation using Finite Difference Method, solution of multigroup diffusion equation using Finite Difference Method	
Week-6	Solution of Eigen value problem using fission source, Solution of multigroup eigen value problem,	
Week-7	PWR core design, Core size and figure, Optimization of fuel lattice, Fuel assembly design	
Week-8	Rod cluster control assembly, soluble boron concentration regulation, Future trends of core design	**Mid Term, Final Exam**
Week-9	Low leakage core, MOX fuel, Neutron energy spectrum of thermal reactor and fast reactor,	
Week-10	Different types of deterministic and Monte Carlo codes, Engineering design and features of different generation-IV advanced reactors	
Week-11	Burnup calculation, burnup chain, branching ratio	**Class Test 3, Final Exam**
Week-12	Burnup equation, burnup time	
Week-13	Normalization of neutron flux	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C6
	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 Course Title	: NE 426 : Nuclear Reactor Design and Features Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
	PRE-REQUISITE		
	NE 425		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	This course is designed to learn and familiarize the basics of Nuclear Reactors Design and Features		
	OBJECTIVES		
	To verify the theories and concepts learned in NE 425 practically.		

	LEARNING OUTCOMES						
	1. Analyze the design and safety features of a reactor. 2. Evaluate the performance parameters of a nuclear reactor. 3. Design and Formulate the reactor core and other feature for real life application.						
	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Analyze** the design and safety features of a reactor.	PO4	C4	1	1	3	R, Q, MT
CO2	**Evaluate** the performance parameters of a nuclear reactor.	PO5	C5	2	2	5	R, F, T
CO3	**Design and Formulate** the reactor core and other feature for real life application.	PO9	C6	3	3	6	PR, 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)						
	COURSE CONTENT						

1. Study the transient behaviour of a research reactor during shutdown and start-up and to measure the thermal coefficient of reactivity change.
2. Analysis of shielding properties of water and water-iron combination against the fission neutron spectrum.
3. Analysis the critical parameter for different core state scenario.
4. Reactor Transient Scenario (Reactor Trip).
5. Reactor Transient Scenario (LOCA and SBO).
6. Performance analysis of a power rector by Monte Carlo Method.
7. Designing of a reactor core using Deterministic or Probabilistic method.
8. Burn up calculation of fuel assembly of a Nuclear Reactor using various software (COBRA, MCNP, TRACE, and ORIGEN).
9. Burn up calculation of Nuclear Reactor Core using various software (COBRA, MCNP, TRACE, and ORIGEN).
10. Analysis of reactivity feedback parameters of a power reactor.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Analyze** the design and safety features of a reactor.				3								
CO2	**Evaluate** the performance parameters of a nuclear reactor.					3							
CO3	**Design and Formulate** the reactor core and other feature for real life application.									3			

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO4	3	In order to analyze the design and safety features of a reactor, 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 evaluate the performance parameters of a nuclear reactor, 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.
CO3- PO9	3	In order to design and Formulate the reactor core and other feature for real life application, it is required function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	28
Student-Centered Learning	-
Self-Directed Learning	

	Preparation of Lab Reports	28
	Preparation of Lab Test	21
	Preparation of presentation Preparation of Quiz Engagement in Group Projects	14
	Formal Assessment	
	Continuous Assessment	1
	Final Quiz	1
	Total	121

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Study the transient behaviour of a research reactor during shutdown and startup and to measure the thermal coefficient of reactivity change	
Week-2	Analysis of shielding properties of water and water-iron combination against the fission neutron spectrum	
Week-3	Analysis the critical parameter for different core state scenario	
Week-4	Reactor Transient Scenario (Reactor Trip)	
Week-5	Reactor Transient Scenario (LOCA& SBO)	
Week-6	Performance analysis of a power reactor by Monte Carlo Method	
Week-7	Mid Term	
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	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
	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 Marks		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

<u>**Level-4, Term-II**</u>

	COURSE INFORMATION		
Course Code Course Title	: NE 427 : Nuclear Power Plant 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 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		
	1. To know the importance of Nuclear Power Plant operation. 2. To understand the features of different sections of the Nuclear Power Plant. 3. To understand the fuel handling mechanism to achieve the criticality. 4. To understand the power plant operation cost.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Apply the technical knowledge to design different types of nuclear power plants. 2. Analyze the importance of different components inside the NPP. 3. Understand fuel handling mechanism to achieve criticality. 4. Formulate features of different sections of the Nuclear Power Plant.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Apply** the design knowledge to the power plants.	PO1, PO2	C3	-	-	1	T, Q, F
CO2	**Analyze** the importance of different components inside the NPP.	PO1, PO9, PO10	C4	-	-	2	ASG, F
CO3	**Understand** fuel handling mechanism to achieve criticality.	PO5	C2	-	-	6	MT, F
CO4	**Evaluate** 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)

COURSE CONTENT

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; electrical systems; reactor grid interface.

Operation and control of nuclear power plant, reactor criticality and start-up operations, power operations (including base load and non-base load operations, reactor following and turbine following modes, etc.), transients, reactor stability, shut down and refueling operations.

Surveillance programs, review and audit, IAEA guidelines in connection with the O&M of NPPs.

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)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** the design knowledge to the power plants.	2	3										
CO2	**Analyze** the importance of different components inside the NPP.	3								2	2		
CO3	**Understand** fuel handling mechanism to achieve criticality.					2							
CO4	**Evaluate** capital and operating cost of nuclear and fossil based power plant.									2		3	

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	2	In order to apply the design knowledge to the power plants, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is required.
CO1-PO2	3	In order to apply the design knowledge to the power plants, ability to conduct experiments and analyze data is highly required.
CO2-PO1	3	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 importance of different components inside the NPP, to act as an individual, and as a team member or a leader in diverse teams is required.
CO2-PO10	2	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 fuel handling mechanism to achieve criticality, systematic approach, resources, computer based design approach and analytical tools are required.

CO4-PO9	2	In order to compare capital and operating cost of nuclear and fossil based power plant, communicating on complex engineering activities with engineers and the community at large through discussions, reports and presentations are required.
CO4-PO11	3	In order to compare capital and operating cost of nuclear and fossil based power plant, knowledge of engineering management and financial principles are required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Layout of nuclear power plants	**Class Test 1, Final Exam**
Week-2	Containment buildings; primary containment vessels; structure of reactor core; and mechanical stress in various structures	
Week-3	Description and analysis of power plant systems	
Week-4	Components including steam generator	**Class Test 2, Final Exam**
Week-5	Description and analysis of steam dryer	
Week-6	Separator, pressurizer, reheater, heat exchanger, condenser, demineralizer	
Week-7	Pumps, turbine	
Week-8	Generator, cooling tower; auxiliary cooling systems	**Mid Term, Final Exam**
Week-9	Fuel handling mechanisms; control and mechanisms; radwaste systems	
Week-10	Electrical systems; reactor grid interface and load following	
Week-11	Basic considerations in nuclear plant design; components of nuclear power cost	**Class**
Week-12	Economic comparison of nuclear and fossil fueled plants	

Week-13	Dual and multipurpose nuclear plants	**Test 3, Final Exam**
Week-14	Future trends in nuclear power cost	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C5
	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 Course Title	: NE 428 : Nuclear Power Plant Engineering Sessional	Lecture Contact Hours Credit Hours	:1.50 : 0.75
	PRE-REQUISITE		
	NE 427		
	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.		
	OBJECTIVE		

	1. To know the role of Nuclear Power Plant operation. 2. To understand the features of different sections of the Nuclear Power Plant. 3. To understand the function of fuel handling mechanism. 4. To understand the Power plant operation cost.
	LEARNING OUTCOMES

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

1. Design and solve NPP relevant problem on the basis of specified requirement by using simulating tools.
2. Apply the different thermal hydraulics and neutronics parameters to validate with measured data.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Design** and **solve** NPP relevant problem on the basis of specified requirement by using simulating tools.	PO4	C6	1	1	4	R, Q, T
CO2	**Apply** the different thermal hydraulics and neutronics parameters to validate with measured data.	PO5	C3	1	1	5	R, 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)

COURSE CONTENT

1. Design a reactor component and analyze its parameters on different condition.
2. Determine reactor power in case of different control rod position and fuel alignment by using specific simulating software.
3. Compare different reactor parameters on steady state condition and any transient state such as LOCA condition.
4. Calculation of radiation dose inside the containment and outside the containment in case of any transient situation.
5. Determination of control rod worth and Control rod differential worth inside the reactor.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Design** and **solve** NPP relevant problem on the basis of specified requirement by using simulating tools.				3								
CO2	**Apply** the different thermal hydraulics and neutronics parameters to validate with measured data.					3							

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO4	3	In order to be able to design and solve NPP relevant problem on the basis of specified requirement by using simulating tools, to analyzing data is required.
CO2-PO5	3	In order to en able to apply the different thermal hydraulics and neutronics parameters to validate with measured data, systematic approach, resources, computer-based design approach and analytical tools in the development of a product or output are required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	7
	Practical / Tutorial / Studio	14
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	42
	Revision	21
	Formal Assessment	
	Continuous Assessment	2
	Mid term	1
	Final Examination	3
	Total	90

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Design a reactor component and analyze its parameters on different condition	
Week-2	Determine reactor power in case of different control rod position and different fuel alignment by using specific simulating software	
Week-3	Compare different reactor parameters on steady state condition and any transient state such as LOCA condition	
Week-4	Calculation of radiation dose inside the containment and outside the containment in case of any transient situation	
Week-5	Determination of control rod worth and control rod differential worth inside the reactor	
Week-6	Lab Test	
Week-7	Quiz test, Viva	

ASSESSMENT STRATEGY

Components	Grading	CO	Blooms Taxonomy

Continuous Assessment (40%)	Lab participation and Report	20%	CO 1, CO2	C3, C6
	Labtest-1, Labtest-2	40%	CO 1, CO2	C3, C6
	Project/ Presentation	15%	CO 2	C3
Lab Quiz		25%	CO 1, CO2	C3, C6
Total Marks		100%		

(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 Course Title	: GEPM 381 : Project Management and Finance	Lecture Contact Hours Credit Hours	: 2.00 : 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		
	1. To introduce some aspects of business management and business organization. 2. To identify the tools and techniques needed to lead any project to its intended conclusion. 3. 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.		
	LEARNING OUTCOMES		

	Upon completion of the course, the students will be able to 1. Develop in depth idea on nuclear project management and organization to perform the Management Functions. 2. Compare between selected Theories of Management. 3. Design nuclear project and to perform the functions in the Marketing Mix. 4. Develop knowledge of effective material management; management and resource allocation; Engineering economy and assessment on ethical issues in business situations.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** in depth idea on nuclear project management and organization to perform the Management Functions.	PO1, PO11	C3	1	-	1	T, Q, F
CO2	**Compare** between selected Theories of Management.	PO1	C4	2	1	1	ASG, F
CO3	**Design** nuclear project and to perform the functions in the Marketing Mix.	PO2, PO3	C5	2	-	1	MT, F
CO4	**Apply** knowledge of effective material management, management and resource allocation; Engineering economy and assessment on ethical issues in business situations.	PO11	C6	3	1	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)						
	COURSE CONTENT						
	Project characteristics and evaluation: Definition and characteristics of projects, project life cycle and phases, Environmental assessment(EA), Initial environmental examination (IEE), Environmental impact assessment (EIA); Project management principles; Management of project planning, financing and implementation; Project scheduling, CPM, PERT, demand and supply forecasting, inventory control, and quality management; Human resource development (HRD) planning; Personnel management, importance, hierarchy, motivation, leadership, wage incentives, performance appraisal, participative management; Risk management of projects; IAEA Milestone approaches for nuclear national infrastructure development and nuclear power project management. **Cost fundamentals**: Elements of cost of products, cost centres and allocation of overhead costs; marginal costing, standard costing, cost planning and control, budget and budgetary control. **Financial and Economic Parameters of Power Plants:** Financial parameters, Economic parameters, Financial vs Economic analysis of a power plant project, Discount rate, Discounting formula, Overnight construction costs, Interest during construction (IDC), Project profitability parameters; Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), and Pay Back Period (PBP), Different types of cost concepts, Engineering, procurement, and construction (EPC) project cost, Turnkey cost, Levelized cost of electricity generation (LCOE).						

Basic Parameters of Power Plant Economics: Capital expenditures (CAPEX), Operational expenditures (OPEX), O&M costs; Fixed costs and variable costs, Relationship between OPEX and O&M costs, Components under CAPEX and OPEX, Weighted Average Cost of Capital (WACC).

Case study for project decision-making: Financial and Economic Analysis of a Power Plant Project: Calculation and analysis of LCOE of NPPs both theoretical and modelling methods, Analysis of NPV, IRR, and PBP, BCR, Sensitivity and liquidity analysis during construction and operational cases of a power plant.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** in depth idea on nuclear project management and organization to perform the Management Functions.	3										2	
CO2	**Compare** between selected Theories of Management.	3											
CO3	**Design** nuclear project and to perform the functions in the Marketing Mix.		3	2									
CO4	**Apply** knowledge of effective material management, management and resource allocation; Engineering economy and assessment on ethical issues in business situations.											3	

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The knowledge of mathematics, science, and engineering fundamentals is required to develop in depth idea on nuclear industrial management and organization to perform the Management Functions.
CO1-PO11	2	In order to develop in depth idea on nuclear project management and organization to perform the Management Functions, it is required to demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
CO2-PO1	3	The knowledge of mathematics, science, Engineering fundamentals is required to compare between selected Theories of Management.
CO3-PO2	3	In order to design nuclear project and to perform the functions in the Marketing Mix, identification, formulation, research literature and analysis of complex engineering problems are required to reach substantiated conclusion using first principles of mathematics, sciences and engineering fundamentals.
CO3-PO3	2	In order to design nuclear project and to perform the functions in the Marketing Mix, 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-PO11	3	In order to develop knowledge of effective material management; Students will learn Management and resource allocation; Engineering economy and assessment on ethical issues in Business situations, it is required to demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 28 - -
	Self-Directed Learning Non-face-to-face learning Revision	 56 14
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	104

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Definition and characteristics of projects, project life cycle and phases, Environmental assessment (EA), Initial environmental examination (IEE), Environmental impact assessment (EIA); Project management principles	
Week-2	Management of project planning, financing and implementation; Project scheduling, CPM, PERT, demand and supply forecasting, inventory control, and quality management; Human resource development (HRD) planning;	**Class Test 1, Final Exam**
Week-3	Personnel management, importance, hierarchy, motivation, leadership, wage incentives, performance appraisal, participative management; Risk management of projects; IAEA Milestone approaches for nuclear national infrastructure development and nuclear power project management	
Week-4	Elements of cost of products, cost centres and allocation of overhead costs;	
Week-5	marginal costing, standard costing, cost planning and control, budget and budgetary control	
Week-6	Financial parameters, Economic parameters, Financial vs Economic analysis of a power plant project, Discount rate,	**Mid Term, Final**
Week-7	Discounting formula, Overnight construction costs, Interest during construction (IDC), Project profitability parameters; Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR),	

Week-8	Capital expenditures (CAPEX), Operational expenditures (OPEX), O&M costs; Fixed costs and variable costs,	**Exam**
Week-9	Relationship between OPEX and O&M costs, Components under CAPEX and OPEX, Weighted Average Cost of Capital (WACC).	
Week-10	Pay Back Period (PBP), Different types of cost concepts, Engineering, procurement, and construction (EPC) project cost	**Class Test 2, Final Exam**
Week-11	Turnkey cost, Levelized cost of electricity generation (LCOE).	
Week-12	Case study for project decision-making: Financial and Economic Analysis of a Power Plant Project: Calculation and analysis of LCOE of NPPs both theoretical and modelling methods	
Week-13	Analysis of NPV, IRR, and PBP, BCR, Sensitivity and liquidity analysis during construction and operational cases of a power plant	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C3, C4, C6
	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**

Level-4, Term-I or Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 405 : Nuclear Chemical Engineering and Corrosion	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	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		
	1. 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. 2. To explain different radiochemical processes for reprocessing and producing radioisotopes by solvent extraction method, ion exchange method, The Purex process, Conversion of radioactive wastes. 3. To familiarize about the Corrosion kinetics and different types of Aqueous and Non-aqueous corrosion in nuclear power applications. 4. To discuss about the various effects of corrosion, corrosion monitoring and control in nuclear power applications.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. 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. 2. Explain principles of solvent extraction method, ion exchange method, Radiochemical processes for reprocessing irradiated fuel, The Purex process, Conversion of radioactive wastes. 3. Analyze the Corrosion kinetics and different types of Aqueous and Non-aqueous corrosion in nuclear power applications 4. Evaluate the effects of corrosion, corrosion monitoring and control in nuclear power applications.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**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.	PO1	C2	-	-	1	T, F
CO2	**Explain** principles of solvent extraction method, ion exchange method, Radiochemical processes for	PO2	C5	-	-	3	ASG, Q, F

	reprocessing irradiated fuel, The Purex process, Conversion of radioactive wastes.						
CO3	**Analyze** the Corrosion kinetics and different types of Aqueous and Non-aqueous corrosion in nuclear power applications	PO2	C4	-	-	2	MT, F
CO4	**Evaluate** the effects of corrosion, corrosion monitoring and control in nuclear power applications.	PO2	C5	-	-	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)

COURSE CONTENT

Basic chemical concepts regarding chemical thermodynamics and kinetics, technology applied and newly developed for nuclear fuel cycle, Fuel-Cycle material analysis, characteristics and analysis of nuclear spent fuels, Principles of solvent extraction extensively for purifying uranium, Properties of Irradiated Fuel and Other Reactor Materials, Radiochemical processes for reprocessing irradiated fuel, fundamentals of nuclear water technology and isotope separation methods, chemical effects induced by nuclear reactions.

Radiation damage induced core material property change, water or liquid metal side corrosion, corrosion in nuclear systems and design, Corrosion kinetics, Aqueous and Non-aqueous corrosion in nuclear power applications, Corrosion monitoring and control in nuclear power applications.

Diffusion and reaction of fission products, structural stability of metal or nonmetallic materials, radiation hardening or embrittlement and swelling, lattice defect interaction with energetic neutron, the chemical analysis using radiotracers, the chemistry of transuranic elements, scaling.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**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.	3											
CO2	**Explain** principles of solvent extraction method, Radiochemical processes for reprocessing irradiated fuel, The Purex process, Conversion of radioactive wastes.		3										
CO3	**Analyze** the Corrosion kinetics and different types of Aqueous and Non-aqueous corrosion in nuclear power applications.		3										
CO4	**Evaluate** the effects of corrosion, corrosion monitoring and control in nuclear power applications.		3										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to 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, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO2-PO2	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 monitoring and control 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Basic chemical concepts regarding chemical thermodynamics and kinetics,	**Class Test 1, Final Exam**
Week-2	Technology applied and newly developed for nuclear fuel cycle, Fuel-Cycle material analysis,	

Week-3	Characteristics and analysis of nuclear spent fuels, Isotope separation methods,	
Week-4	Principles of solvent extraction extensively for purifying uranium,	**Class Test 2, Final Exam**
Week-5	Properties of Irradiated Fuel and Other Reactor Materials, Radiochemical processes for reprocessing irradiated fuel,	
Week-6	The Purex process, fission products, and actinide,	
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 Term, Final Exam**
Week-9	Faraday's laws of electrolysis and its application in determining the corrosion rate in metal and alloys, Corrosion Kinetics	
Week-10	Aqueous corrosion in nuclear power applications: fundamental science, materials and mechanisms	
Week-11	Irradiation assisted corrosion and stress corrosion cracking (IAC/IASCC) in nuclear reactor systems and components	**Class Test 3, Final Exam**
Week-12	Electrochemical techniques for monitoring and controlling corrosion in water-cooled nuclear reactor systems,	
Week-13	the chemical analysis using radiotracers, Diffusion and reaction of fission products, structural stability of metal or nonmetallic materials,	
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.	

ASSESSMENT STRATEGY

Components		**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessmen t (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO4	C2, C5
	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

Level-4, Term-I or Term-II

	COURSE INFORMATION			
Course Code Course Title	: NE 407 : Non-Destructive Testing and Evaluation	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 with the basic principles and limitations of different Non-Destructive Tastings (NDT) and their applications in a variety of fields.			
	OBJECTIVES			
	1. To understand the basic principles of various Nondestructive testing methods. 2. To enable the students to acquire knowledge of the applications of Nondestructive testing in nuclear power plants and a variety of other fields. 3. To introduce the limitations of different NDT methods, techniques and codes, standards and specifications related to non-destructive testing technology.			
	LEARNING OUTCOMES			
	Upon completion of the course, the students will 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-destructive testing in nuclear power plants and a variety of other fields. 4. Evaluate the associated limitations of different NDT methods, techniques and codes.			

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO1	**Understand** the basic principles of various Nondestructive testing methods.	PO1	C2	-	-	2	T, Q, F
CO2	**Explain** the techniques, standards and specifications related to non-destructive testing technology.	PO2	C3	-	-	3	ASG, F
CO3	**Analyze** the applications of Non-destructive testing in nuclear power plants and a variety of other fields.	PO3	C4	-	-	2	MT, F
CO4	**Evaluate** the associated limitations of different NDT methods, techniques and codes.	PO2	C5	1	-	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)

COURSE CONTENT

NDT general knowledge; Manufacturing Processes; types discontinuities associated with manufacturing processes, Basics Of Visual Testing - principles, techniques, applications, limitations, codes, standards and specifications related to visual testing; Basics Of Liquid Penetrant Testing: principles, techniques, applications, limitations, codes, standards and specifications related to liquid penetrant testing; Basics Of Magnetic Particle Testing: principles, techniques, applications, limitations, codes, standards and specifications related to magnetic particle testing; Basics Of Ultrasonic Testing: principles, techniques, applications, limitations, codes, standards and specifications related to ultrasonic testing; Basics Of Radiographic Testing: principles, techniques, applications, limitations, codes, standards and specifications related to radiography; NDT evaluation, analysis and report, Applications of Nondestructive testing in Nuclear power plants.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basic principles of various Nondestructive testing methods.	3											
CO2	**Explain** the techniques, standards and specifications related to non-destructive testing technology.		3										
CO3	**Analyze** the applications of Non-destructive testing in nuclear power plants and a variety of other fields.		3										
CO4	**Evaluate** the associated limitations of different NDT methods, techniques and codes.		3										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	In order to understand the basic principles of various Non-destructive testing methods, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is applied.

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 in nuclear power plants and a variety of other fields, 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-PO2	3	In order to evaluate the associated limitations of different NDT methods, techniques and codes, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	NDT general knowledge	**Class Test 1, Final Exam**
Week-2	Manufacturing Processes; types discontinuities associated with manufacturing processes	
Week-3	Basics of Visual Testing - principles, techniques, applications, limitations, codes, standards and specifications related to visual testing	
Week-4	Basics of Liquid Penetrant Testing: principles, techniques, applications, limitations, codes, standards and specifications related to liquid penetrant testing	**Class Test 2, Final Exam**
Week-5	Basics of Magnetic Particle Testing: principles, techniques, applications	
Week-6	Basics of Magnetic Particle Testing: limitations, codes, standards and specifications related to magnetic particle testing	

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 Term, Final Exam**
Week-9	Basics of Radiographic Testing: principles, techniques,	
Week-10	Basics of Radiographic Testing: applications, limitations,	
Week-11	Basics of Radiographic Testing: codes, standards and specifications related to radiography	**Class Test 3, Final Exam**
Week-12	NDT evaluation, analysis and report	
Week-13	Applications of Non-destructive testing in Nuclear power plants.	
Week-14	Applications of Non-destructive testing in Nuclear power plants.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (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

<u>Level-4, Term-I or Term-II</u>

	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

	PRE-REQUISITE
	NE 301
	CURRICULUM STRUCTURE
	Outcome Based Education (OBE)
	SYNOPSIS/RATIONALE
	The course is designed to learn and familiarize with the applications of nuclear technology and 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 of image quality 3. To understand the construction, operation of imaging and processing equipment, radiation protection and quality control 4. To enable the students to acquire knowledge about the construction and operation of general radiographic and fluoroscopic equipment, radiotherapy processes.
	LEARNING OUTCOMES
	1. Define and apply the basic properties of radiotracers used for nuclear medicine and Understand clinical applications of different radiation imaging methods. 2. Explain the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET). 3. Analyze the evolution of ultrasonic and radiation imaging technologies in clinical applications. 4. Evaluate different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** and **apply** the basic properties of radiotracers used for nuclear medicine and **Understand** clinical applications of different radiation imaging methods.	PO1	C1, C3	-	-	-	T, F
CO2	**Explain** 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
CO3	**Analyze** the evolution of ultrasonic and radiation imaging technologies in clinical applications.	PO2	C4	-	-	1	MT, F
CO4	**Evaluate** different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).	PO6	C5	-	-	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)
	COURSE CONTENT

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, Mammography.
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)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** and **apply** the basic properties of radiotracers used for nuclear medicine and **Understand** clinical applications of different radiation imaging methods.	2											
CO2	**Explain** the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET).		3										
CO3	**Analyze** the evolution of ultrasonic and radiation imaging technologies in clinical applications.		3										
CO4	**Evaluate** different Nuclear medicine technologies associated with Radiation therapy processes (both external and internal radio therapy).						3						

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	2	In order to understand the basic properties of radiotracers used for nuclear medicine and clinical applications of different radiation imaging methods, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is applied.
CO2-PO2	3	In order to explain the processes related to production and distribution of radiotracers within human body and different types of medical imaging modalities (CT, SPECT and PET), 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 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	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 LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Nuclear medicine technology: introduction, Radiotracer, Properties of radiotracers for nuclear medicine, radiotracer half-life, Radiopharmaceuticals	**Class Test 1 , Final Exam**
Week-2	Radiopharmaceutical dosimetry, Radionuclide generators, The technetium generator, The distribution of technetium-based radiotracers within the body	
Week-3	Radiation therapy: External beam therapy (I)	
Week-4	Radiation therapy: External beam therapy (II)	**Class Test 2 , Final Exam**
Week-5	Radiation therapy: External beam therapy (III)	
Week-6	Radiation therapy: Brachytherapy (I)	
Week-7	Radiation therapy: Brachytherapy (II)	
Week-8	Radiation therapy: Brachytherapy (III)	

Week-9	Medical imaging modalities, Medical imaging before x-rays, X-radiography, Radioisotopes gamma camera	**Mid Term , Final Exam**
Week-10	Computed tomography (CT), Single photon emission computed tomography (SPECT), Data processing in SPECT/CT, Clinical applications of SPECT and SPECT/CT	
Week-11	Positron emission tomography (PET), Clinical applications of planar scintigraphy, Radiotracers used for PET/CT	**Class Test 3 , Final Exam**
Week-12	Ultrasound, Sonar and other early applications of acoustics, basic principles of ultrasound imaging, Evolution of ultrasound technology and clinical applications	
Week-13	Magnetic resonance imaging, Early use of nuclear magnetic resonance (NMR) spectroscopy, Principles of NMR and MRI	
Week-14	Evolution of magnetic resonance imaging (MRI) technology and clinical applications, development and applications of functional MRI.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
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

Level-4, Term-I or Term-II

	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 familiarize the different fundamental processes related to fusion reaction and its technological constrains and applications.
	OBJECTIVES
	1. To know about the electrical power system and load characteristics. 2. To understand the load curve. 3. To understand power system protection. 4. To understand power grid.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Understand the role of Electrical Power System and Power system protection units. 2. Explain the load curves, protective schemes and Grid Systems. 3. Analyze the working principle of power system protection and grid stability. 4. Evaluate the grid performance synchronization, and stability after interfacing with Nuclear power plant
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the role of Electrical Power System and Power system protection units.	PO 1	C2	-	-	3	T, F, Q
CO2	**Explain** the load curves, protective schemes and Grid Systems.	PO 2	C5	-	-	2	MT, F
CO3	**Analyze** the working principle of power system protection and grid stability.	PO 2	C4	1	1	4	ASG, F
CO4	**Evaluate** 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 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

Introduction Basics 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 systems
Power factor Improvement Power 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 curves Demand factor, diversity factor, load duration curves, energy load curve, load factor, capacity factor and plant factor.

Grid system and interfacing with NPP Typical layout of a substation, switch gear, Transmission cables and busbars, Sag, Transmission tower, Corona effect and Over-voltage phenomenon and insulation coordination. Circuit breakers & Relays, Over voltage and Lightening Protection, Instrument transformers: CT and PT, requirements for grid interfacing with NPP

Stability Swing equation, power angle equation, equal area criterion, multi-machine system, step by step solution of swing equation. Factors affecting stability: Reactive power compensation. Flexible AC transmission system (FACTS), symmetrical and unsymmetrical fault.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the role of Electrical Power System and Power system protection units.	3											
CO2	**Explain** the load curves, protective schemes and Grid Systems.		3										
CO3	**Analyze** the working principle of power system protection and grid stability.		3										
CO4	**Evaluate** the grid performance synchronization, and stability after interfacing with Nuclear power plant.										3		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	3	In order to understand the role of Electrical Power System and Power system protection units the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO2-PO2	3	In order to explain the load curves, protective schemes and Grid 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-PO2	3	In order to analyze the working principle of power system protection and grid stability 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-PO10	3	In order to evaluate the grid stability performance 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

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-

	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 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 1, Final Exam**
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	
Week-4	Calculation of power factor corrections	**Mid Term, Final Exam**
Week-5	Single line and reactance diagram of power system, Per unit system of calculation. Causes of station blackout and their remedies	
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,	**Class Test 2, Final Exam**
Week-9	Corona effect and Over-voltage phenomenon and insulation coordination	
Week-10	Circuit breakers & Relays,	
Week-11	Over voltage and Lightening Protection, Instrument transformers: CT and PT	**Class Test 3, Final Exam**
Week-12	Swing equation, power angle equation, equal area criterion, multi-machine system, step by step solution of swing equation.	
Week-13	Factors affecting stability: Reactive power compensation. Flexible AC transmission system (FACTS), requirements for grid interfacing with NPP	
Week-14	Symmetrical and unsymmetrical fault, Review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
	Class Test	20%	CO 1, CO3, CO4	C2, C4, C5

Continuous Assessment (40%)	Class Participation	5%+5% (attnd)	CO 1, CO3	C2, C4
	Mid term	10%	CO 2	C5
Final Exam		60%	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
2. Chunikhin M. Zhavoronkov , *High Voltage switch gear Analysis and Design*, Moscow , Mir publishers, 1989
3. 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

Level-4, Term-I or Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 433 : Fundamentals of Fusion Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 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		
	1. To familiarize the students about the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction. 2. To explain the different physical processes related to fusion reaction: fusion cross section, reaction rate, Lawson criteria fusion power density and radiation loses the power balance in magnetic fusion reactor. 3. To introduce the students about different Fusion confinement concept, TOKAMAK and STELLATOR concept, Blanket concept of fusion reactor. 4. To discuss about different technological constraints related to fusion engineering and calculate the critical fusion reactor design parameters.		
	LEARNING OUTCOMES		

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

1. Understand the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction.
2. 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.
3. Analyze the Fusion confinement, TOKAMAK and STELLATOR concept, Blanket concept of fusion reactor.
4. Evaluate plasma wall interactions, radiation damage to material and calculate the critical fusion reactor design parameters.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction.	PO1	C2	-	-	2	T, Q, F
CO2	**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.	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	**Evaluate** 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 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

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 MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction.	3											
CO2	**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.		3										
CO3	**Analyze** the Fusion confinement, TOKAMAK and STELLATOR concept, Blanket concept of fusion reactor.				3								
CO4	**Evaluate** plasma wall interactions, radiation damage to material and calculate the critical fusion reactor design parameters.			2	3								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to understand the role of fusion energy, Fusion reactions, difficulty of fusion reaction and thermonuclear conditions of fusion reaction, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is applied.
CO2-PO2	3	In order to 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, 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 Fusion confinement, TOKAMAK and STELLATOR concept, Blanket concept of fusion reactor, 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.
CO4-PO3	2	In order to evaluate plasma wall interactions, radiation damage to material and calculate the critical fusion reactor design parameters, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	

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

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction Of Fusion Energy, Fusion Reactions	**Class Test 1, Final Exam**
Week-2	Difficulty Of Fusion Reaction and Thermonuclear Conditions of Fusion Reaction	
Week-3	Fusion Cross Section, Reaction Rate, Sigma V Parameter Calculation	
Week-4	Fusion Power Generation Process, Fusion Power Density and Radiation Losses	**Mid Term, Final Exam**
Week-5	Plasma Ignition and Heating Processes	
Week-6	Lawson Criteria	
Week-7	The Power Balance in Magnetic Fusion Reactor,	
Week-8	Fusion Confinement	**Class Test 2, Final Exam**
Week-9	Inertial And Magnetic Confinement	
Week-10	TOKAMAK and STELLATOR Concept	
Week-11	Blanket Concept of Fusion Reactor	**Class Test 3, Final Exam**
Week-12	Design of Simple Magnetic Fusion Reactors	
Week-13	ITER and Applications of Fusion Technology	
Week-14	Review class	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
	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

Level-4, Term-I or Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 459 : Computational Fluid Dynamics (CFD)	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	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		
	1. To familiarize students with the basic steps and terminology associated with CFD. 2. To develop students' understanding of the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretization schemes and stability analysis. 3. To develop practical expertise in solving CFD problems with a commercial CFD code, ANSYS CFX. 4. To develop an awareness of limitations of CFD and its application in nuclear systems.		

LEARNING OUTCOMES

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

1. Understand basic steps and terminology associated with Computational Fluid Dynamics (CFD).
2. Explain the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretisation schemes and stability analysis.
3. Analyze variety of computational techniques that can be used for solving engineering problems.
4. 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.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** basic steps and terminology associated with Computational Fluid Dynamics (CFD).	PO1	C2	-	-	3	T, Q, F
CO2	**Explain** 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	**Analyze** variety of computational techniques that can be used for solving engineering problems.	PO3	C4	-	-	5	T, MT, F
CO4	**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.	PO5	C5	3	-	6	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

Introduction to CFD, General form of conservation law, Equations of conservation and Navier-Stokes equations, Kinematic properties of fluids, dynamic similarity, Initial and boundary conditions: practical guidelines, Turbulence: basics and introduction, Turbulence: applications of models, Computational methods- introduction to ANSYS CFX and Fluent, Defining a CFD problem, Creating and/or Importing Geometry in Design Modeler, Discretization, Solution Procedures, Post processing – analysis of results, Validation and verification, applications in nuclear systems, Complex geometry with numerical approaches.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** basic steps and terminology associated with Computational Fluid Dynamics (CFD).	3											
CO2	**Explain** the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretisation schemes and stability analysis.		3										
CO3	**Analyze** variety of computational techniques that can be used for solving engineering problems.			3									
CO4	**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.					3							

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to understand basic steps and terminology associated with Computational Fluid Dynamics (CFD), the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is applied.
CO2-PO2	3	In order to explain the conservation laws applied to fluid motion and heat transfer and basic computational methods including explicit, implicit methods, discretisation schemes and stability analysis, 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-PO3	3	In order to analyze variety of computational techniques that can be used for solving engineering problems, 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-PO4	3	In order to 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, it is required to use simulator software

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning	

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

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to CFD, General form of conservation law	**Class Test 1, Final Exam**
Week-2	Equations of conservation and Navier-Stokes equations,	
Week-3	Kinematic properties of fluids, dynamic similarity	
Week-4	Initial and boundary conditions: practical guidelines	**Class Test 2, Final Exam**
Week-5	Turbulence: basics and introduction, Turbulence: applications of models	
Week-6	Computational methods- introduction to ANSYS CFX and Fluent	
Week-7	Defining a CFD problem,	
Week-8	Creating and/or Importing Geometry in Design Modeler	**Mid Term, Final Exam**
Week-9	Discretization, Solution Procedures	
Week-10	Post processing – analysis of results	
Week-11	Validation and verification	**Class Test 3, Final Exam**
Week-12	Applications in nuclear systems,	
Week-13	Complex geometry with numerical approaches	
Week-14	Review class	

ASSESSMENT STRATEGY

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

Continuous Assessment (40%)	Class Participation and Class attendance	5+5= 10%	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. 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

Level-4, Term-I or Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 479 : Radioactive Waste Treatment and Disposal Techniques	Lecture Contact Hours Credit Hours	: 3.00 : 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		
	1. To demonstrate advanced knowledge of the general classification of nuclear waste and the basic principles of radioactive waste management. 2. To introduce students with various options of nuclear waste disposals and associated physical phenomenon. 3. To develop the analyzing ability of issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository 4. To develop the ability to evaluate long-term safety disposal facility for radioactive waste and Environmental risk		
	LEARNING OUTCOMES		

	Upon completion of the course, the students will be able to 1. Understand the general classification of nuclear waste and the basic principles of radioactive waste management. 2. Explain various options of nuclear waste disposals and associated physical phenomenon. 3. Analyze the issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository 4. Evaluate long-term safety disposal facility for radioactive waste and Environmental risk assessment
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the general classification of nuclear waste and the basic principles of radioactive waste management.	PO1	C2	-	-	3	T, Q, F
CO2	**Explain** various options of nuclear waste disposals and associated physical phenomenon.	PO2	C5	-	-	4	ASG, F
CO3	**Analyze** 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	**Evaluate** long-term safety disposal facility for radioactive waste and Environmental risk assessment	PO4	C5	3	-	6	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

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; Types of radioactive wastes, Waste treatment: current concepts and future prospects of ILW, HLW & TRU wastes, Storage of the various types of waste, R&D in treatment and storage.
Disposal of Nuclear Waste the options, deep geological disposal, The Safety Case concept for geological disposal, Multiple Barriers approaches. The geological / hydro geological and coupled subsurface-EBS R&D areas and issues that need to be addressed in developing a safety case.
Geological Disposal Concepts: Hard rock, clays/shales, evaporates, the roles of engineered barriers and the geological barrier, the requirements for subsurface characterization to support safe geological disposal. Key issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository, Public participation approaches, Assessing the long-term safety of a surface or geological disposal facility for radioactive waste , Environmental risk assessment, the ERICA tool and mixture toxicity.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12

CO1	**Understand** the general classification of nuclear waste and the basic principles of radioactive waste management.	3											
CO2	**Explain** various options of nuclear waste disposals and associated physical phenomenon.		3										
CO3	**Analyze** the issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository			3									
CO4	**Evaluate** long-term safety disposal facility for radioactive waste and Environmental risk assessment				3								

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to understand the general classification of nuclear waste and the basic principles of radioactive waste management, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is applied.
CO2-PO2	3	In order to Explain various options of nuclear waste disposals and associated physical phenomenon, identification, formulation, research the literature and analyze complex engineering problems, explaining various options of nuclear waste disposals and associated physical phenomenon are required.
CO3-PO3	3	In order to analyze the issues associated with finding and selecting a Geological Disposal Facility, Safeguards aspects and monitoring of a repository, 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-PO4	2	In order to evaluate long-term safety disposal facility for radioactive waste and Environmental risk assessment, 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 Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

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 1, Final Exam**
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.	
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	**Class Test 2, Final Exam**
Week-5	Storage of the various types of waste: Example stores, on-site storage, decay storage, R&D in treatment and storage.	
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.	**Mid Term, Final Exam**
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.	
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.	**Class Test 3, Final Exam**
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	
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	

ASSESSMENT STRATEGY

Components		**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
	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

Level-4, Term-I or Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 489 : Nuclear Power Project: Construction and Decommissioning Strategies	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	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		
	1. To familiarize the students about the different stages of a nuclear power project construction and decommissioning. 2. To introduce the different strategies related nuclear power project Construction Management at distinct phases (preparatory, after concrete pouring and commissioning). 3. To introduce the decommissioning polices, strategies and cost analysis. 4. To discuss about the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management.		
	LEARNING OUTCOMES		

	Upon completion of the course, the students will be able to 1. Understand the different stages of a nuclear power project construction and decommissioning. 2. Explain the different strategies related nuclear power project Management at distinct phases (preparatory, after concrete pouring and commissioning). 3. Analyze the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management. 4. Evaluate polices, strategies and cost analysis.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the different stages of a nuclear power project construction and decommissioning.	PO1	C2	-	-	3	T, Q, F
CO2	**Explain** the different strategies related nuclear power project Management at distinct phases (preparatory, after concrete pouring and commissioning).	PO11	C5	-	-	4	ASG, F
CO3	**Analyze** the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management.	PO7, PO11	C4	-	-	5	T, MT, F
CO4	**Evaluate** polices, strategies and cost analysis.	PO6, PO7	C5	3	-	6	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
	Nuclear Project Management Introduction to Nuclear Project Management, Nuclear Power development strategy, Nuclear Power Infrastructure development and policies **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. **Nuclear Power Project: Decommissioning Strategies** Decommissioning Policies and Strategies, Decommissioning Cost Estimating and Funding Approaches, Decommissioning Cost Data, Management for Active Phases of Decommissioning, Decommissioning Planning and Approval, Quality Assurance, Waste Management, Safety, Health And Environmental Protection.
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the different stages of a nuclear power project construction and decommissioning.	2											
CO2	**Explain** the different strategies related nuclear power project Management at distinct phases (preparatory, after concrete pouring and commissioning).											3	
CO3	**Analyze** the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management.							3				2	
CO4	**Evaluate** polices, strategies and cost analysis.						2	2					

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	2	In order to understand the different stages of a nuclear power project construction and decommissioning, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is applied.
CO2-PO11	3	In order to explain the different strategies related nuclear power project Construction Management at distinct phases (preparatory, after concrete pouring and commissioning), it is needed to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
CO3-PO7	3	In order to understand the impact of professional engineering solutions towards society and the environment, and demonstrate knowledge of and the need for sustainable development in nuclear technology, quality assurance methods in nuclear project management is required.
CO3-PO11	2	In order to analyze the subsequent radiological risk associated with decommission and quality assurance methods in nuclear project management, it is needed to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
CO4-PO6	2	In order to assess societal, health, safety, legal and cultural issues with the engineers and society relevant to professional nuclear engineering practice, evaluation of construction & decommissioning polices, strategies and cost analysis are required.
CO4-PO7	3	In order to evaluate construction & decommissioning polices, strategies and cost analysis, 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-

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

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to Nuclear Project Management,	**Class Test 1, Final Exam**
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,	
Week-4	Coordination of construction activities, Categorization of construction work packages, Project scheduling and control during the construction phase	**Class Test 2, Final Exam**
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	
Week-6	Construction infrastructure development, Security Construction Management — Construction Phase (After Concrete Pouring): Overview of organizations (site and HQ) and main activities during construction	
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	**Mid Term, Final Exam**
Week-9	Decommissioning policy, Decommissioning strategies, Decommissioning cost estimating and funding approaches: Elements of decommissioning cost estimates, Approaches for estimating costs, Funding aspects	
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	**Class Test 3, Final Exam**
Week-12	Decommissioning Planning and Approval, Quality Assurance	
Week-13	Waste Management: Waste management strategy, Waste management arrangements	
Week-14	Safety, Health And Environmental Protection: Instrument used to characterize radiation levels within decommissioning environment, Environmental Impact Assessment (EIA)	

ASSESSMENT STRATEGY				
Components		**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
	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. 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

<u>Level-4, Term-I or Term-II</u>

	COURSE INFORMATION		
Course Code Course Title	: NE 491 : Fundamentals of Plasma Engineering	Lecture Contact Hours Credit Hours	: 3.00 : 3.00
	PRE-REQUISITE		
	PHY 137, NE 105		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	The course is designed to learn and familiarize with the fundamental physics of plasmas and their applications.		
	OBJECTIVES		
	1. To make known the students about the basic plasma parameters, under what conditions an ionized gas consisting of charged particles (electrons and ions) can be treated as plasma. 2. To explain different approaches to explain plasma phenomena, the single particle approach, fluid approach and kinetic statistical approach to describe different plasma 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 time.
4. To introduce students about the conditions for plasma to be in a state of a perfect or a non-perfect thermodynamic equilibrium and formulate mathematical tool to describe waves in plasma, as a continuous media.

LEARNING OUTCOMES

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

1. Apply the principal models of the nuclear study and radioactivity.
2. Analyze the nuclear force, electron scattering, neutrino hypothesis and deuteron properties.
3. Explain the spontaneous decay of nuclei, nuclear reactions, fission and fusion process.
4. Evaluate the nuclear force, nuclear reactions methods and reaction theory.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the basic plasma parameters, under what conditions an ionized gas consisting of charged particles (electrons and ions) can be treated as plasma	PO1	C2	-	-	3	T, Q, F
CO2	**Explain** the single particle approach, fluid approach and kinetic statistical approach to describe different plasma phenomena	PO2	C5	-	-	4	ASG, F
CO3	**Analyze** 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	PO2	C4	-	-	5	T, MT, F
CO4	**Evaluate** the conditions for plasma to be in a state of a perfect or a non-perfect thermodynamic equilibrium and formulate mathematical tool to describe waves in plasma, as a continuous media.	PO2	C5	3	-	6	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

Basic plasma properties and collective behaviour, Motion of charged particles in magnetic fields, plasma confinement schemes, Collisions in Plasmas, Plasma Models, MHD models, , two-fluid hydrodynamic plasma models, the Vlasov plasma model, kinetic theory of plasma, the relation between kinetic and fluid models, wave propagation in a magnetic field, Waves and Instabilities ,simple equilibrium and stability analysis, electron plasma waves and landau damping, applications of plasma.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basic plasma parameters, under what conditions an ionized gas consisting of charged particles (electrons and ions) can be treated as plasma	3											
CO2	**Explain** the single particle approach, fluid approach and kinetic statistical approach to describe different plasma phenomena		3										
CO3	**Analyze** 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		3										
CO4	**Evaluate** the conditions for plasma to be in a state of a perfect or a non-perfect thermodynamic equilibrium and formulate mathematical tool to describe waves in plasma, as a continuous media.		3										

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to understand the basic plasma parameters, under what conditions an ionized gas consisting of charged particles (electrons and ions) can be treated as plasma the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
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 analyze 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 conditions for plasma to be in a state of a perfect or a non-perfect thermodynamic equilibrium and formulate mathematical tool to describe waves in plasma, as a continuous media, 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 STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	**Basic Description of a Plasma** • Fundamental Space and Time Scales • Plasma Parameter	**Class Test 1, Final Exam**
Week-2	**Basic Description of a Plasma** • Plasma Oscillations • Debye shielding	
Week-3	Motion of charged particles in magnetic fields	
Week-4	Plasma confinement schemes, Collisions in Plasmas	**Class Test 2, Final Exam**
Week-5	Plasma Models (MHD model)	
Week-6	Plasma Models (Two-fluid hydrodynamic plasma model)	
Week-7	Plasma Models (The Vlasov plasma model)	
Week-8	Kinetic Theory Of Plasma	**Mid Term, Final Exam**
Week-9	The Relation Between Kinetic And Fluid Models	
Week-10	Plasma Wave , Electron Plasma Waves	
Week-11	Wave Propagation In A Magnetic Field	

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

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO3, CO4	C2, C4, C5
	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
2. Goldston, R. J. and P. H. Rutherford, Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995.
3. J. A. Bittencourt, Fundamentals of Plasma Physics, 3rd edition, New York, NY: Springer, 2004

REFERENCE SITE

Level-4, Term-I or Term-II

	COURSE INFORMATION		
Course Code Course Title	: NE 493 : Nuclear Technology for Nonpower Applications	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 nonpower applications of nuclear technology.		
	OBJECTIVES		

6. To understand the nuclear techniques in agriculture and different industry.
7. To know various methods of nuclear techniques in agriculture and different industry.
8. To identify various types of techniques for enhancing food security and safety.
9. To evaluate the optimization of dosimetry and dose mapping using ionization radiation.
10. To understand the safety and quality assurance through nuclear technique in different industry.

LEARNING OUTCOMES

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

5. Explain the nuclear techniques in agriculture and different industry.
6. Understand different methods of nuclear techniques in agriculture and different industry.
7. Analyze the optimization of dosimetry and dose mapping using ionization radiation.
8. Evaluate the safety and quality assurance through nuclear technique in different industry.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the nuclear techniques in agriculture and different industries.	PO1	C2	-	-	3	T, Q, F
CO2	**Understand** the food security and food safety by irradiation technique.	PO2	C4	-	-	4	T, ASG, F
CO3	**Analyze** the optimization of dosimetry and dose mapping using ionization radiation.	PO6	C5	-	-	5	MT, F
CO4	**Evaluate** the safety and quality assurance through nuclear technique in different industries.	PO3	C6	1	-	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

Nuclear Techniques in Agriculture: Use of ionizing radiation in agriculture; Research, Industrial and Ion beam irradiators; Lethal Dose (LD50) test, Dose optimization, Dosimetry and Dose mapping; Genetic modification and new crop varieties through radiation induced mutation; Improving water use efficiency and irrigation scheduling by neutron moisture meter; Controlling pests and diseases; Reducing post-harvest loss agricultural produce, Enhancing food security and food safety by irradiation; Quarantine or phytosanitary treatments; Sterile Insects Technique (SIT); Isotope tracer techniques for soil, water and nutrients management; Isotope Hydrology; Introduction to Isotope Ratio Mass Spectrometry (IRMS); Instrument calibration, safety and quality assurance.

Industrial and others Application: Radiography: X-ray, Gamma, Neutron and Beta; Well logging by sealed gamma and neutron sources; Nucleonic gauging practices for thickness, density and liquid level measurement; Medical product sterilization; Material modification; Radiotracers; Environmental remediation for industry; Instrument calibration, safety and quality assurance.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the nuclear techniques in agriculture and different industries.	2											
CO2	**Understand** the food security and food safety by irradiation technique.		3										
CO3	**Analyze** the optimization of dosimetry and dose mapping using ionization radiation.						3						
CO4	**Evaluate** the safety and quality assurance through nuclear technique in different industries.				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 the nuclear technique in agriculture and different industry, the knowledge of radiation 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 different methods of nuclear techniques in agriculture and different industry, identification, formulation, research literature and analysis of complex engineering problems reaching substantiated solutions are required.
CO3-PO6	3	In order to analyze the optimization of dosimetry and dose mapping using ionization radiation., application of reasoning informed by contextual knowledge to a professional engineering practice is required.
CO4-PO4	3	In order evaluate the safety and quality assurance through nuclear technique in different industry, it is required to conduct investigations of complex problems using the knowledge of radiation science.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered 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	Use of ionizing radiation in agriculture; Research, Industrial and Ion beam irradiators	**Class Test 1, Final Exam**
Week-2	Lethal Dose (LD50) test, Dose optimization, Dosimetry and Dose mapping	
Week-3	Genetic modification and new crop varieties through radiation induced mutation	
Week-4	Improving water use efficiency and irrigation scheduling by neutron moisture meter	**Class Test 2, Final Exam**
Week-5	Controlling pests and diseases; Reducing post-harvest loss agricultural produce	
Week-6	Enhancing food security and food safety by irradiation	
Week-7	Quarantine or phytosanitary treatments; Sterile Insects Technique (SIT)	
Week-8	Isotope tracer techniques for soil, water and nutrients management	**Mid Term, Final Exam**
Week-9	Isotope Hydrology	
Week-10	Introduction to Isotope Ratio Mass Spectrometry (IRMS); Instrument calibration, safety and quality assurance	
Week-11	Radiography: X-ray, Gamma, Neutron and Beta; Well logging by sealed gamma and neutron sources	**Class Test 3, Final Exam**
Week-12	Nucleonic gauging practices for thickness, density and liquid level measurement	
Week-13	Medical product sterilization; Material modification; Radiotracers	
Week-14	Environmental remediation for industry; Instrument calibration, safety and quality assurance	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO4	C2, C4, C6
	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

3. LaChance, L., Aslam, J. and Langer, C., 1990. Nuclear techniques in agriculture. IAEA Bulletin, 32(3), pp.49-52.
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Industrial Applications of Nuclear Energy, IAEA Nuclear Energy Series No. NP-T-4.3, IAEA, Vienna (2017)

REFERENCE SITE

CHAPTER 6

6.1 Courses Offered by Other Departments to NE Students

6.1. a. Department of Science and Humanities

Physics:

Level 1 Term I

COURSE INFORMATION			
Course Code	**:** PHY 137	Lecture Contact Hours	: **3.00**
Course Title	**:** Waves and Oscillations, Structure of Matter and Quantum Mechanics	Credit Hours	: **3.00**

PRE-REQUISITE
N/A
CURRICULUM STRUCTURE
Outcome Based Education (OBE)
SYNOPSIS/RATIONALE
This course covers the basics of physics in the fields of waves and oscillations, structure of matter and quantum mechanics. The course will emphasize the basic concepts, theories, and solving quantitative problems that can be applicable in a wide spectrum of engineering disciplines.
OBJECTIVE
1. To define the different parameters, concepts, logical and critical thinking with scientific knowledge of waves and oscillations, structure of matter and quantum mechanics. 2. To explain the basic theories and laws of waves and oscillations, structure of matter and quantum mechanics. 3. To solve numerical and analytical problems regarding waves and oscillations, structure of matter and quantum mechanics.
LEARNING OUTCOMES & GENERIC SKILLS

No.	Course Outcomes At the end of the course, a student should be able to	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO1	**Define** different basic laws and parameters in the field of waves and oscillations, structure of matter and modern physics. such as simple harmonic motion, damped oscillations, crystal structure, crystal defects, wave function, etc.	PO1	C1	-	-	1	T, MT, F
CO2	**Explain** different basic theories in the field of waves and oscillations, structure of matter and modern physics such as the SHM, damped motion, wave motion, Bragg's law, bonding energy, Schrödinger equation, etc.	PO1	C2	-	-	1	T, MT, F
CO3	**Solve** quantitative problems in the field of waves and oscillations, structure of matter, and modern physics such as SHM, damped motion, wave motion, packing factor, Miller indices, quantum mechanics, etc.	PO1	C3	-	-	2	T, ASG, MT, F

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

C1 - Remember	C2 – Understand	C3 - Apply	C4 - Analyze	C5 – Evaluate	C6 – Create

COURSE CONTENT

Waves and Oscillations: Simple Harmonic Motion (SHM) and its properties, differential equation of a SHM and its solution, total energy and average energy of a body executing SHM, simple pendulum, torsional pendulum, spring-mass system, LC oscillatory circuit, two body oscillation and reduced mass, Composition of SHM, Damped oscillations, and its different condition, forced oscillations and its different condition, resonance, Wave motion : expression for a plane progressive wave, differential equation of wave motion, energy density of wave motion, average kinetic and potential energy of wave motion, Stationary wave.

Structure of matter : Crystalline and non-crystalline solids, single crystal and poly-crystal solids, unit cell, crystal systems, co-ordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, Miller indices, relation between inter-planar spacing and Miller indices, Bragg's law, methods of determination of inter-planar spacing from diffraction patterns; defects in solids: point defects, line defects, surface defects, bonds in solids, band theory of solids: distinction between metal, semiconductor and insulator, inter-atomic distances, calculation of cohesive and bonding energy.

Quantum mechanics : Origin of quantum theory, wave properties of matter, wave-particle duality, de Broglie's hypothesis, Heisenberg's uncertainty principle and its applications, wave function, operators, eigen value & expectation values, Schrödinger's equations, applications of quantum mechanics: particle in a box, harmonic oscillator, reflection at a step potential, transmission across a potential barrier, tunnel effect, Schrödinger's equation for the Hydrogen atom, quantum numbers, electron spin.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to Define different basic parameters in the field of waves and oscillations, structure of matter, and modern physics such as periodic motion, simple harmonic motion, undamped oscillations, crystal structure, crystal defects, wave function, etc.	√											
CO2	Be capable to Explain different basic theories in the field of waves and oscillations, structure of matter, and modern physics such as the wave motion for different systems along with energy, the packing factor, Bragg's law, Schrödinger equation, etc.	√											
CO3	Be skilled to Solve quantitative problems in the field of waves and oscillations, structure of matter, and modern physics such as energy of wave motion, wavelength, packing factor, Miller indices, quantum mechanics, etc.	√											

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42

Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision of the previous lecture at home	21
Preparation for test and examination	21
Formal Assessment	
Class Test / Mid-Term Exam	3
Final Examination	3
Total	**132**

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Lect	Topics	Remarks
Week-1	1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, assessment of the course	CT-1/ Assignment
	2	Periodic motion, oscillatory motion, simple harmonic motion (SHM), properties of SHM, differential equations, general solution of SHM, graphical representation of SHM	
	3	Velocity, acceleration, phase and epoch, time period, frequency and angular frequency of SHM	
Week-2	4	Total energy and average energy of SHM, problems	
	5	Simple pendulum, torsional pendulum, spring-mass system	
	6	LC oscillatory circuit, two body oscillations, reduced mass	
Week-3	7	Composition of SHM	
	8	Composition of SHM, problems	
	9	Damped oscillations and its differential equation	
Week-4	10	Displacement equation of damped oscillations and its different conditions, electric damped oscillatory circuit	CT-2 /Assignment
	11	Forced oscillations and its differential equation, displacement equation of forced oscillations, resonance	
	12	Wave motion: expression for a plane progressive wave, differential equation of wave motion, particle velocity, wave velocity	
Week-5	13	Energy density of a plane progressive wave, average energy in a plane progressive wave, problems	
	14	Stationary wave: node, anti-node, problems	
	15	Classification of solids, types of crystalline solids, crystal, lattice, basis, crystal structure, plane lattice, space lattice, Bravais and non-Bravais lattices	

Week-6	16	Unit cell, lattice parameters, primitive and non-primitive cells and their distinctions, lattice symbols, crystal structure of NaCl and CsCl	
	17	Unit face, axial units: linear and numerical parameters and, Miller indices	
	18	Atomic radius, packing factor and coordination number for different structures	
Week-7	19	Relation between lattice constant and density of solids and related numerical problems	Mid Term/ Assignment
	20	Inter-planer spacing, relation between inter-planar spacing and Miller indices, problems	
	21	X-ray diffraction, Bragg's law, methods of determination of inter-planar spacing from diffraction patterns, problems	
Week-8	22	Defects in solids: point defects, line defects, surface defects	
	23	Defects in solids: point defects, line defects, surface defects	
	24	Atomic arrangement in solid: different types of bonds in solids	
Week-9	25	Band theory of solids : valence band, conduction band, energy gap, distinction between metal, semiconductor and insulator	
	26	Potential, cohesive energy, binding energy, Madelung constant, inter-atomic distance, calculation of total potential energy of a pair of atoms	
	27	Calculation of total potential energy at the equilibrium separation of an ionic crystal, problems	
Week-10	28	Introduction and origin of the quantum theory	
	29	Wave properties of matter: wave-particle duality, de Broglie's hypothesis, consequences of the de Broglie's concepts, wave packet	
	30	Heisenberg's uncertainty principle, its significance and applications	
Week-11	31	Wave function (ψ), physical interpretation, limitations of ψ, wave function for a free particle	CT-3 / Assignment
	32	Normalization of ψ, operators in quantum mechanics	
	33	Expectation values, eigen function, eigen value, eigen value equation, postulates of quantum mechanics	
Week-12	34	Time dependent Schrödinger's equation	
	35	Time independent Schrödinger's equation	
	36	Applications of quantum mechanics : particle in a 1-D box	
Week-13	37	Applications of quantum mechanics : particle in a 3-D box	
	38	Applications of quantum mechanics : harmonic oscillator	
	39	Applications of quantum mechanics : harmonic oscillator	
Week-14	40	Applications of quantum mechanics : reflection at a step potential	
	41	Applications of quantum mechanics : transmission across a potential barrier, tunnel effect	
	42	Schrödinger's equation for the hydrogen atom, quantum numbers, electron spin	

ASSESSMENT STRATEGY

Components	Grading	COs	Blooms Taxonomy

Continuous Assessment (40%)	Class Test 1-3 / Assignment	20%	CO1, CO2, CO3	C1, C2, C3
	Class Attendance	5%		
	Class Performance	5%		
	Mid term	10%	CO1, CO2, CO3	C1, C2, C3
Final Exam (Section A & B)		60%	CO1	C1
			CO2	C2
			CO3	C3
Total Marks		100%		
(CO = Course Outcome, C = Cognitive Domain, A = Affective Domain, P = Psychomotor Domain)				

REFERENCE BOOKS

1. Physics for Engineers: Part-I and Part-II: Dr Giasuddin Ahmad
2. Physics, Volume I and Volume II**:** Resnick and Halliday
3. Fundamentals of Physics: Halliday, Resnick and Walker
4. Physics for Scientists and Engineers: Serway and Jewett
5. Waves and Oscillations: Brij Lal and Subramannyam
6. Introduction to Solid State Physics: Charles Kittle
7. Solid State Physics: S. O. Pillai
8. Solid State Physics: Ali Omar
9. Fundamentals of Solid State Physics**:** B.S. Saxena, R.C. Gupta, P.N. Saxena
10. B.Sc Physics : C. L. Arora.
11. Elements of Quantum Mechanics: Kamal Singh, S.P. Singh
12. Quantum Mechanics: Concepts and Applications: Nouredine Zettili

Level 1 Term I

COURSE INFORMATION			
Course Code	**:** PHY 138	Lecture Contact Hours	: **3.00**
Course Title	**:** Physics Sessional	Credit Hours	: **1.50**

PRE-REQUISITE
N/A

CURRICULUM STRUCTURE
Outcome Based Education (OBE)

SYNOPSIS/RATIONALE
This course is a laboratory course for the basic physics in the field of waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics. The course will be emphasized the fundamental experiments on different fields of physics which can be applicable in a wide spectrum of engineering disciplines. This laboratory course will enable students to understand basic physics practically as well as do work with team or individual.

OBJECTIVE
1. To develop basic physics knowledge practically 2. To practice use of basic scientific instrument

LEARNING OUTCOMES & GENERIC SKILLS							
No.	Course Outcomes At the end of the course, a student should be able to	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C1			K1	R, Q, F
CO2	**Describe** the different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C1			K1	R, Q, T, F

CO3	**Skilled** to Construct Experiments by an individual or by a group to determine different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	PO1	C2			K2	R, Q, T, F
CO4	**Prepare** a report for an experimental work.	PO1	C2			K2	R

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

COURSE CONTENT

Quantitative measurement of different parameters in the field of waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics such as:

Specific resistance of materials, high resistance, resistance of a galvanometer, Electrochemical equivalent (ECE) of copper, comparison of the E.M.F's of two cells, radius of curvature, wavelength of light, focal length of lens, specific rotation of sugar, refractive index of a liquid, frequency of a tuning fork, acceleration due to gravity, spring constant, rigidity modulus, young's modulus, moment of inertia, conservation of linear momentum, thermal conductivity of a bad conductor, temperature co-efficient of resistance, pressure co-efficient of a gas, specific heat of a liquid, surface tension, Planck's constant.

CO-PO MAPPING

No.	Course Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to Define the different parameters regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	√											
CO2	Be capable to Describe the different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	√											

CO3	Be skilled to Construct Experiments by an individual or by a group to determine different phenomena regarding waves and oscillations, optics, mechanics, electricity, modern physics and thermal physics etc.	√											
CO4	Be able to Prepare a report for an experimental work.	√											

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	7
Experiment	35
Self-Directed Learning	
Preparation of Lab Reports	20
Preparation for the Lab Test	13
Preparation of Quiz	9
Preparation of viva	9
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Final viva	1
Final lab exam	3
Total	**112**

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Project Based Method

COURSE SCHEDULE

Weeks	**Topics**	Remarks

Week-1	Introductory class: Brief discussion on total syllabus, basic requirements of the course, evaluation system of the course, grouping, visit different section of the laboratory, introduction to different basic equipment	
Week-2	Determination of the specific resistance of a wire using meter bridge or determination of ECE of copper by using copper voltameter	
Week-3	Determination of high resistance by the method of deflection and determination of resistance of a galvanometer by half deflection method or comparison of the E.M.F's of two cells by a potentiometer	
Week-4	Determination of the wavelength of sodium light by a spectrometer using a plane diffraction grating or determination of the specific rotation of sugar by polarimeter	
Week-5	Determination of the radius of curvature of a plano-convex lens by Newton's ring method or determination of focal length of a concave lens by auxiliary lens method	
Week-6	Determination of the frequency of a tuning fork by Melde's experiment or determination of the Planck's constant using photoelectric effect	
Week-7	Determination of the value of g acceleration due to gravity by means of a compound pendulum	
Week-8	Determination of the spring constant, effective mass and the rigidity modulus of the spring or determination of the Young's modulus of bar by bending method	
Week-9	Determination of the moment of inertia of a Fly-wheel about its axis of rotation or verification of the law of conservation of linear momentum	
Week-10	Determination of the thermal conductivity of a bad conductor by Lee's method or determination of specific heat of a liquid by the method of cooling	
Week-11	Determination of the pressure co-efficient of a gas at constant volume by constant volume air thermometer or determination of the temperature co-efficient of resistance of the material of a wire using a meter-bridge	
Week-12	Viva & lab final experimental exam	
Week-13	Viva & lab final experimental exam	
Week-14	Quiz exam	

ASSESSMENT STRATEGY

<table>
<tr><td colspan="3"></td><td rowspan="2">CO</td><td rowspan="2">Blooms Taxonomy</td></tr>
<tr><td colspan="2">Components</td><td>Grading</td></tr>
<tr><td rowspan="2">Continuous Assessment (40%)</td><td>Class performance/ Assignment</td><td>10%</td><td></td><td></td></tr>
<tr><td>Report Writing/ Assignment</td><td>30%</td><td>CO1, CO4</td><td>C1, C2</td></tr>
<tr><td></td><td>Lab test</td><td>30%</td><td>CO1, CO2, CO3</td><td>C1, C2</td></tr>
</table>

Final Exam (60%)	Viva	10%		
	Quiz	20%		
Total Marks		100%		
(CO = Course Outcome, C = Cognitive Domain, A = Affective Domain, P = Psychomotor Domain)				
REFERENCE BOOKS				
1. Practical physics for degree students : Dr Giasuddin Ahmad and Md. Sahabuddin 2. Practical Physics: G. L. Squires 3. B.Sc. Practical Physics: C. L Arora 4. Practical Physics: S.L. Gupta and V. Kumar				

Chemistry

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 STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/ RATIONALE		
	This course is the basic chemistry in the field of inorganic, organic and physical chemistry. The course will be emphasized on the basic concepts, theories and to solve quantitative problems which can be applicable in a wide spectrum of engineering disciplines.		
	OBJECTIVES		
	1. To define the different parameter and concepts of inorganic chemistry and physical chemistry. 2. To explain basic reaction mechanism of selective organic reactions. 3. To solve numerical problems of inorganic, organic and physical chemistry.		
	LEARNING OUTCOMES		

	Upon completion of the course, the students will be able to 1. Define 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. 2. Explain different basic theories in the field of selective organic reactions such as Oxidation-reduction, Substitution, Addition, Polymerization, Alkylation reactions etc. 3. Solve quantitative problems in the field of inorganic, organic and physical chemistry i.e. solutions, thermochemistry, chemical kinetics, electrical properties of solution etc.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Be able to **define** the different parameters and concepts regarding inorganic, organic, and physical chemistry.	PO-1	C1	-	-	1	T, F, MT
CO2	Be able to **apply** different theory on chemical bonding and hybridization to determine structure of molecules.	PO-1	C3	-	-	1,2	T, F, MT
CO3	Be able to **explain** the selective topics on organic chemistry.	PO-1	C2			1,2	
CO3	**Solve** quantitative problems in the field of inorganic, and physical chemistry.	PO-1	C3	-	-	1,2	T, F, MT, 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)
	COURSE CONTENT
	Atomic Structure: Atoms and Molecules, subatomic particles**,** Concepts of atomic structure, Different atom models, Quantum theory and electronic configurations, Heisenberg's uncertainty principle **Periodic Table:** Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases **Chemical Bonding:** Types and properties,VBT, MOT, Hybridization and shapes of

molecules
Selective topics on Organic chemistry: Different types of organic reactions (Addition, elimination, substitution, polymerization
Acids-Bases/Buffer Solution: Different concepts of acids-bases, Buffer solution, Mechanism of buffer solution, Henderson-Hasselbalch equation, Water chemistry and pH of water
Corrosion: Nature, forms and types of corrosion, electrochemical mechanism and prevention of corrosion
Solutions: Solutions and their classification, Unit expressing concentration, Colligative properties and
dilute solutions, Raoult’s law,Van’t Hoff’s law of osmotic pressure
Thermochemistry: Laws of thermochemistry, Enthalpy, Heat of reaction, Heat of formation, Heat of
neutralization, Kirchoff’s equations, Hess'slaw
Electrochemistry: Conductors and nonconductors, Difference between electrolytic and metallic conduction, Electrolytic conductance, Factors influencing the conductivity of electrolytes, Kohlrausch Law and conductometric titrations, Different types of electrochemical cells
Chemical Equilibria: Equilibrium law/constant, K_p and K_c, Homogeneous and heterogeneous equilibrium,Van’t Hoff’s reaction isotherm, Le Chatelier's principle
Phase Rule: Basic terms and phase rule derivation, Phase diagram of an one component system **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 theorem.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Be able to **define** the different parameter and concepts regarding inorganic, organic, and physical chemistry.	3											
CO2	Be able to **apply** different theory on chemical bonding and hybridization to determine structure of molecules.	2											
CO3	Be able to **explain** the selective topics on organic chemistry.	3											

CO4	**Solve** quantitative problems in the field of inorganic, and physical chemistry	**3**											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The conceptual knowledge of the natural sciences applicable to the engineering discipline
CO2-PO1	3	The theory-based knowledge of the natural sciences applicable to the engineering discipline
CO3-PO1	3	The numerical analysis-based knowledge of the natural sciences applicable to the engineering

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	General introduction, Atoms and Molecules, subatomic particles	**Class Test 1 , Final Exam**
	Concepts of atomic structure	
	Concepts of atomic structure, Different atom models	
Week-2	Hydrogen spectral lines, Heisenberg's uncertainty principle, de broglies equation	
	Schrondinger equation, Quantum numbers, Electronic configuration	
	Periodic law, Features of Periodic table	
Week-3	Classification of elements according to electronic configurations, periodicity, Periodic properties of elements	
	Properties and uses of noble gases	

	Chemical bonding (types, properties)	
Week-4	Valence Shell Electron Pair Repulsion Theory, VBT	**Class Test 2 , Final Exam**
	Hybridization of molecules	
	Shapes of the molecule	
Week-5	Molecular orbital Theory	
	Molecular orbital Theory	
	Different types of organic reactions (Addition, elimination, substitution, polymerization)	
Week-6	Different types of organic reactions (Addition, elimination, substitution, polymerization	
	Different concepts of acids-bases	
	pH, pH scale, pH of water	
Week-7	Different concepts of acids-bases	
	pH, pH scale, pH of water	
	Different concepts of acids-bases	
Week-8	Electrochemical mechanism and prevention of corrosion	**Mid Term , Final Exam**
	Solutions and their classification, Unit expressing concentration	
	Effect of temperature and pressure on solubility, Validity and limitations Of Henry'slaw	
Week-9	Colligative properties and dilute solutions, Raoult's law,deviation from Raoult's law,	
	Elevation of boiling point, Freezing point depression, Van't Hoff's law of osmotic pressure	
	Laws of thermo chemistry, Enthalpy	
Week-10	Heat of reaction, Heat of formation, Heat of neutralization	
	Hess's law, Kirchoff's equations	
	Conductor, semiconductor, non conductor, Electrolytic conduction and its mechanism	
Week-11	Faraday's law, Factors influencing the conductivity of electrolytes	**Class Test 3 , Final Exam**
	Conductrometric titrations	
	Different types of electrochemical cells	
Week-12	Reversible reactions, Characteristics of chemical equilibrium, Law of mass action, Equilibrium constant, Units of equilibrium constant	
	Relation between K_p and K_c,van't Hoff's reaction isotherm, vant' Hoff equation	
	Free energy and its significance, Heterogeneous equilibrium, Le Chatelier's principle	
Week-13	Phase Rule: Basic terms and phase rule derivation	
	Phase Diagram of an one component system	
	Pseudo and zero order reaction, Half-life	
Week-14	Determination and factors affecting the rate of a reaction	
	First order reaction, Second order reaction	

	Collision theory, Transition state theory	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment	20%	CO1, CO3	C1, C3
	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 Course Title	: CHEM 102 : Chemistry Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/ RATIONALE		

This course is a laboratory course for the basic chemistry in the field of inorganic and physical chemistry. The course will be emphasized by fundamental experiments on different fields of chemistry which can be applicable in a wide spectrum of engineering disciplines. This laboratory course will enable students to understand basic chemistry practically as well as do work with team or individual.

OBJECTIVES

1. To develop basic chemistry knowledge practically
2. To practice the use of basic scientific instrument.

LEARNING OUTCOMES

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

1. Define the different parameters regarding inorganic and physical chemistry.
2. Describe the different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.
3. Construct Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.
4. Prepare a report for an experimental work.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Define** the different parameters regarding inorganic and physical chemistry.	PO-1	C1	-	-	1	Q
CO2	**Describe** the different phenomena regarding acid-base, iod o- iodimetric, complexometric and redox titration etc.	PO-1	C1	-	-	1	T, F
CO3	**Construct** Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.	PO-9	C3	-	-	2	F
CO4	**Prepare** a report for an experimental work.	PO-10	C2	-	-	2	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)

COURSE CONTENT

Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.

Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Hydroxide (NaOH) Solution.

Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Carbonate (Na_2CO_3) Solution.

Determination of Calcium (Ca) Content in a Calcium Chloride dihydrate ($CaCl_2.2H_2O$) Solution with Standard Di-Sodium Ethylene DiammineTetraAceticAcid (Na_2EDTA) Solution.

Standardization of Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution with Standard Potassium Dichromate ($K_2Cr_2O_7$) Solution.

Estimation of Copper (Cu) Content in a Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$) (Blue Vitriol) Solutions by Iodometric Method with Standard Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3$.5H2O) Solution.

Standardization of Potassium Permanganate (KMnO4) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.

Determination of Ferrous (Fe) Content in a Ammonium Ferrous Sulphate (Mohr`s Salt) [$FeSO_4.(NH4)_2SO_4.6H_2O$] Solution with Standard Potassium Permanganate ($KMnO_4$) Solution.

Determination of Zinc (Zn) Content in a Zinc Sulphate Heptahydrate ($ZnSO_4.7H_2O$) Solution with Standard Di-Sodium EDTA (Na_2-EDTA) Solution by using Eriochrome black T indicator.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** the different parameters regarding inorganic and physical chemistry.	3											
CO2	**Describe** the different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.	3											
CO3	**Construct** Experiments by an individual or by a group to determine different phenomena regarding acid-base, iodo-iodimetric, complexometric and redox titration etc.									2			
CO4	**Prepare** a report for an experimental work.										1		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	**Corresponding Level of Matching**	**Justification**
CO1-PO1	3	The conceptual knowledge of the natural sciences applicable to the engineering discipline
CO2-PO1	3	The descriptive knowledge of the natural sciences applicable to the engineering discipline

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 STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	10
	Practical / Experiment	18
	Student-Centered Learning	-
	Self-Directed Learning	
	Preparation of Lab Reports	18
	Preparation of Lab-test	25
	Preparation of Quiz	9
	Preparation of viva	9
	Formal Assessment	
	Continuous Assessment	2
	Quiz	1
	Final lab exam	3
	Total	95

TEACHING METHODOLOGY

Lecture followed by practical experiments and discussion, Co-operative and Collaborative Method, Design Based Method

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Orientation and Introductory lecture	--
Week-2	Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution	
Week-3	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Hydroxide (NaOH) Solution.	
Week-4	Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Carbonate (Na_2CO_3) Solution	-
Week-5	Determination of Calcium (Ca) Content in a Calcium Chloride dihydrate ($CaCl_2.2H_2O$) Solution with Standard Di-Sodium Ethylenediamminetetraacetic Acid (Na_2EDTA) Solution.	
Week-6	Mid Term	
Week-7	Standardization of Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution with Standard Potassium Dichromate ($K_2Cr_2O_7$) Solution.	
Week-8	Estimation of Copper (Cu) Content in a Copper Sulphate Pentahydrate ($CuSO_4.5H_2O$) (Blue Vitriol) Solutions by Iodometric Method with Standard Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution.	-
Week-9	Standardization of Potassium Permanganate ($KMnO_4$) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.	

Week-10	Determination of Ferrous (Fe) Content in a Ammonium Ferrous Sulphate (Mohr`s Salt) [$FeSO_4.(NH_4)_2SO_4.6H_2O$] 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	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class performance	10%	CO1	C1
	Report Writing	30%	CO4	C2
Final Exam (60%)	Lab test	30%	CO1, CO2, CO3	C1, C3
	Viva	10%		
	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	: MATH 101	Lecture Contact Hours	: 3.00
Course Title	: Differential and Integral Calculus	Credit Hours	: 3.00
	PRE-REQUISITE		
	None		

	CURRICULUM STRUCTURE
	Outcome Based Education (OBE)
	SYNOPSIS/ RATIONALE
	Purpose of this course is to introduce basic knowledge of Differential Calculus and use it in engineering study.
	OBJECTIVES
	1. To impart basic knowledge on differential and integral Calculus to solve engineering problems and other applied problems. 2. Developing understanding some of the important aspects of rate of change, area, tangent, normal and volume. 3. To make proficient in imparting in depth knowledge of functional analysis such as increasing, decreasing, maximum and minimum values of a function
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to- 1. **Compute/Calculate** different engineering calculations based on differential and integral calculus. 2. **Comprehend/ Understand/Explain** basic ideas of rate of change, slope of curve, tangent, normal, arc length, area and volume. 3. **Perform/Describe** the functional analysis calculations such as increasing, decreasing, maximum and minimum values of a function and concavity. 4. **Prepare/Apply the** necessary technics for calculations based on differential and integral calculus.
	COURSE OUTCOMES& GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**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.	PO-1	C1-C2	1		3	CT, F, ASG
CO2	**Apply** the concepts or techniques of differentiation and integration to solve the problems related to engineering study.	PO-1	C3	1		3	CT, Mid Term Exam, F
CO3	**Calculate** the length, area, volume, center of gravity and average value related to engineering study	PO-1	C3	1		3	Mid Term Exam, 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)

COURSE CONTENT

	Differential Calculus: Introduction, Differential Calculus for Engineering, Function and Limit, Continuity and Differentiability of function. Cartesian differentiation Successive Differentiation, Leibnittz's Theorem, Rolle's Theorem, Mean Value Theorem, Taylor's theorem, Expansion of Finite and Infinite forms, Indeterminate form, Partial differentiation, Euler's theorem, Tangent, sub tangent and Normal, sub normal, Maxima and Minima, concavity, Curvature, Asymptotes. **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 properties, Integration as a limit of sum, Walli's formula, Improper Integrals, Beta and Gamma function, Multiple integral and its application, Arc lengths of curves, Area under a plain curve, Area of the region enclosed by two curves, Volume of solid revolution
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** different basic parameters in the field of inorganic, organic and physical chemistries., atomic structure, periodic table, chemical bonding, acids and bases, chemical equilibrium, thermo-chemistry and different types of solutions, phase rule etc.	3											
CO2	**Explain** different basic theories in the field of selective organic reactions such as Oxidation-reduction, Substitution, Addition, Polymerization, Alkylation reactions etc.	3											
CO3	**Solve** quantitative problems in the field of inorganic, organic and physical chemistry i.e. solutions, thermochemistry, chemical kinetics, electrical properties of solution etc.	3											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR 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 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.

TEACHING LEARNING STRATEGY		
Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction to Differential Calculus for Engineering study, Limit of a function and its properties.	**Class Test 1, Final Exam**
	Basic limit theorems with proofs, Limit of infinity and infinite limit, Sandwich (Squeezing) theorem with problems.	
	Concept of Differentiation, definition, classification of discontinuity and solving problems	
Week-2	Basic concept of Differentiability, definition, derivative of a function, differentiable function.	
	Differentiability – one sided derivatives (R.H.D and L.H.D), solving problems	
	Successive differentiation – Concept and problem solving	
Week-3	Leibnitz’s theorem and its applications	
	Determination of $(y_n)_0$	
	Mean Value theorem, Taylor theorem	
Week-4	Expansion of finite and infinite forms, Lagrange’s and Cauchy’s form of remainder.	**Class Test 2, Final Exam**
	Indeterminate forms – concept and problem solving,	
	L’Hospital’s rules with application	
Week-5	Partial differentiation - partial derivatives of a function of two variables and problems	
	Partial differentiation - partial derivatives of a homogeneous function of two variables, Euler’s theorem for two variables and problems	
	Partial differentiation - partial derivatives of a homogeneous function of several variables, Euler’s theorem for several (three and m) variables and problem solving	

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

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation and Class attendance	5+5= 10%	CO 3	C3
	Mid term	10%	CO 2, CO3	C3
Final Exam		60%	CO 1	CO 1
			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. Howard Anton, Irl C. Bivens, Stephen Davis, *Calculus*, 10th Edition, Wiley, 2012 2. 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 113 : Differential Equations and Linear Algebra		Lecture Contact Hours Credit Hours				: 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 linear algebra.							
	OBJECTIVES							
	1. To impart basic knowledge on ordinary and partial differential equations. 2. Developing understanding some of the important aspects of ordinary and partial differential equations. 3. To provide knowledge on using concept of Differential equations and linear algebra in engineering problems and solve other applied problems. 4. To be expert in imparting in depth knowledge on inverse linear algebra.							
	LEARNING OUTCOMES							
	Upon completion of the course, the students will be able to 1. **Compute** different engineering calculations based on differential equations. 2. **Comprehend** basic ideas of differential equations and related theories. 3. **Prepare** necessary calculations based on ordinary and partial differential equations. 4. **Perform** differential equations calculations based on wave equation, heat flow, fluid flow, temperature distribution etc.							
	COURSE OUTCOMES & GENERIC SKILLS							
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods	
CO1	**Define** various types ofdifferential equations and **Identify** the classifications of ordinary and partial differential	PO 1	C1, C2	1		3	T, F, ASG	

	equations.						

CO2	**Apply** the knowledge to identify and **solve** ordinary and partial differential equations.	PO 1	C3	1		3	T, MT, F
CO3	**Apply** the technique to obtain the inverse matrix that solve the system of linear equations.	PO 1	C3	1		3	MT, 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)						
	COURSE CONTENT						
	Differential Equations: Introduction & Formulation of DE in Engineering, Degree and order of ODE, Solution of first order differential equation by various methods. Solution of first order but higher degree DE by various methods, Solution of general linear 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, Formation PDE, Solution of linear first order PDE, Solution of Non-linear first order PDE, Standard form. Linear PDE with constant coefficients, PDEs of higher order and wave equation, particular solutions with boundary and initial condition, Applications of DE. **Linear Algebra:** Notion of a matrix, types of matrices, matrix operations, laws of matrix algebra, transpose and inverse of a matrix, quadrate forms, adjoin matrix, tridiagonal matrix, block matrix, properties of determinants, types of determinants, minor, cofactors, expansion and evaluation of __determinants, elementary row and column operations, row reduced echelon metrics. Linear equations, system of linear equations (homogeneous and non-homogeneous) and their solutions, linear dependence and independence of vectors, rank of a matrix, application of matrices and determinates for solving system of linear equations. Linear transformations, kernel and image of a linear transformation and their properties, matrix representation of linear transformations, change of bases. Eigenvalues and eigenvectors, characteristic polynomial, diagonalization, Cayley Hamilton theorem, applications .						
	SKILL MAPPING (CO-PO MAPPING)						

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** various types of differential equations and **identify** the classifications of ordinary and partial differential equations.	3											
CO2	**Apply** the knowledge to identify and **solve** ordinary and partial differential equations.	3											
CO3	**Apply** the technique to obtain the inverse matrix that solve the system of linear equations	3											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR 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	The solution of different real world phenomena like string vibration, heat flow, fluid flow, temperature distribution, loading calculations etc require the concept of ordinary and partial differential equations.
CO3-PO1	3	The solution of system of linear equations of any order require to known the apply technic of inverse matrix.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21

	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction & Formulation of DE in Engineering, Degree and order of ODE	**Class Test 1, Final Exam**
	Introduction & Formulation of DE in Engineering, Degree and order of ODE	
	Solution of first order first degree DE by various method	
Week-2	Solution of first order first degree DE by various method	
	Solution of first order but higher degree DE by various methods	
	Solution of first order but higher degree DE by various methods	
Week-3	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
	Solution of general DEs of second and higher order, Solution of Euler's homogeneous linear DEs	
Week-4	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	**Class Test 2,**
	Introduction & Formulation of DE in Engineering, Degree and order of ODE	
	Introduction & Formulation of DE in Engineering, Degree and order of ODE	**Final Exam**
Week-5	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
	Solution of DEs by methods based on factorization, Frobenious methods, Bessel's functions, Legendre's polynomial	
Week-6	Linear PDE with constant coefficient	
	Linear PDE with constant coefficients	
	Particular solutions with boundary and initial condition	
Week-7	Particular solutions with boundary and initial condition	
	Application of ODE and PDE in Eng study	
	Application of ODE and PDE in Eng study	

Week-8	Definition of Matrix, different types of matrices, Algebra of Matrices,	Mid Term, Final Exam
	Definition of Matrix, different types of matrices, Algebra of Matrices,	
	Transpose and adjoint of a matrix and inverse matrix	
Week-9	Solution of linear equation or System of Linear Equation	
	Solution of linear equation or System of Linear Equation	
	Solution of linear equation or System of Linear Equation	
Week-10	Solution of linear equation using Inverse Matrix	
	Rank, Nullity and elementary transformation	
	Rank, Nullity and elementary transformation	
Week-11	Dependent and independent of vectors	Class Test 3, Final Exam
	Dependent and independent of vectors	
	Linear transformations, kernel and image of a linear transformation and their properties	
Week-12	Linear transformations, kernel and image of a linear transformation and their properties	
	Linear transformations, kernel and image of a linear transformation and their properties	
	Matrix representation of linear transformations, change of bases	
Week-13	Matrix representation of linear transformations, change of bases	
	Matrix polynomials determination characteristic roots and vectors	
	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.	
	Cayley Hamilton theorem and its application. Finding inverse matrix using this theorem.	

ASSESSMENT STRATEGY

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

(CO = Course Outcome, C = Cognitive Domain, P = Psychomotor Domain, A = Affective Domain)
REFERENCE BOOKS
1. Howard Anton, Chris Rorres, Anton Kaul, *Elementary Linear Algebra* ,12th Edition , John Wiley & Sons, 2019 2. Dr. M.D. Raisinghania ,*Ordinary and Partial Differential Equations* , S.Chand Publishing, 2013
REFERENCE SITE

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		
	1. To impart basic knowledge on the vector analysis, Laplace transform and geometry. 2. To familiarize the students with straight lines, pair of straight lines, circles, conics in 2D and 3D co-ordinate systems. 3. 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.		

	LEARNING OUTCOMES

	Upon completion of the course, the students will be able to 1. **Compute** different engineering calculations based on Laplace transform, Vector analysis and Co-ordinate geometry. 2. **Comprehend** basic ideas of vector analysis, laplace transform and co-ordinate geometry. 3. **Prepare** necessary calculations based on vector analysis, laplace transform and co-ordinate geometry. 4. **Perform** real case studies calculations based on vector analysis, laplace transform and co-ordinate geometry.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Know** the physical explanation of different vector notation and **Define** Laplace transform, inverse Laplace transform, different types of matrices, and their properties.	PO-1	C1-C2	1	-	3	T, F, ASG
CO2	**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.	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-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

	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 (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, 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 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, 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, hyperboloidstraight lines, standard equation of coincides, sphere and ellipsoid.
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Know** the physical explanation of different vector notation and **Define** Laplace transform, inverse Laplace transform, different types of matrices, and their properties.	3											
CO2	**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.	3											
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.	3											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR 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 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	42
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	84
	Revision	21

	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation	**Class Test 1, Final Exam**
	Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation	
	Definition of Vector and scalers & vector algebra, Scaler and vector products of two vectors and their geometrical interpretation	
Week-2	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	
Week-3	Definition of line, surface and volume integral, Integration of Vectors, Green's theorem and application	
	Definition of line, surface and volume integral, Integration of Vectors, Green's theorem and application	
	Green's theorem and it's application	
Week-4	Gauss theorem and application in Engineering	**Class Test 2, Final Exam**
	Stoke's theorem and it's application.	
	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	
Week-6	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	
	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	
	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	

Week-7	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	
	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	
Week-8	Equations of parabola, ellipse in Cartesian and polar coordinates, system of circles (radical axes, coaxial circles, limiting points	**Mid Term, Final Exam**
	Equations 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 (radical axes, coaxial circles, limiting points	
Week-9	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 (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 (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	
Week-10	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	

	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	
Week-11	Sufficient condition for existence of LT	**Class Test 3, Final Exam**
	LT of derivatives and it's application	
	LT of Integration with application, LT of sine and cosine integral	
Week-12	Unit step function and it's application	
	Periodic function with examples, LT of some special function.	
	Definition of inverse Laplace Transform and it's properties	
Week-13	Partial fraction and it's application in inverse Laplace Transform	
	Heaviside formula and it's application	
	Convoulution theorem, Evaluation of improper integral, Application of LT	
Week-14	Solve ODE s by Laplace transform	
	Solve PDE s by Laplace transform	
	Application of LT in Eng study	
ASSESSMENT STRATEGY		

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO 2	C3
	Class Participation and Class attendance	5+5= 10%	CO1, CO 3	C1-C3
	Mid term	10%	CO2, CO3	C1, C2
Final Exam		60%	CO1	C1, C2
			CO2	C2
			CO3	C3
Total 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 Variable and Statistics	Lecture Contact Hours Credit Hours	: 3.00 : 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		
	1. To understand basic knowledge of Complex Number system, Fourier transformation on real 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. 2. To familiarize the students with the principle terms such as complex variables, fourier transform and statistics. 3. 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 solving complex problems.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Recognize and define complex number system, complex variable, Fourier expansion and express the definition and use of the statistical properties. 2. 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. 3. 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.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Recognize and define** complex number system, complex variable, Fourier expansion and **express** the	PO1	C1-C2	1		1	T, F, ASG

	definition and use of the statistical properties.						
CO2	I**nterpreting** 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.	PO1	C2	1		1, 2	T, MT, F
CO3	M**easure** 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	PO1	C2-C3	1		1, 2	MT, 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						
	Fourier Analysis: Real and complex form. Finite transform: Fourier Integral. Fourier transforms and their uses in solving boundary value problems. **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. **Statistics:** Measures of central tendency, Standard deviation, Frequency distribution, Graphical representation of data including stem, Leaf and Box Plot, moments, Skewness, Kurtosis. Elementary probability theory, Continuous and discontinuous probability distribution, Elementary sampling theory, Treatment of grouped sampled data, Regression and correlation, Tests of hypothesis.						
	SKILL MAPPING (CO-PO MAPPING)						

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Recognize and define** complex number system, complex variable, Fourier expansion and **express** the definition and use of the statistical properties.	3											
CO2	I**nterpreting** 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.	3											

	CO3	**M**easure 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	3											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to be able to **infer/illustrate** the physics of semiconductor devices and the operation of different electronic components for strengthening fundamental idea about basic electronics, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO2-PO1	3	In order to be able to compare the input and output characteristics of different electronic components, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO3-PO1	3	In order to be able to analyze basic electronic circuits considering existing system models to explore practical complex engineering problems, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered 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	Basic idea about Fourier Series	**Class Test 1, Final**
	Real form of Fourier Series	
	Complex form of Fourier Series, Fourier expansion of different functions	
Week-2	Finite transform: Finite Fourier sine transform	
	Finite Fourier cosine transform	
	Infinite Fourier cosine and sine transforms, Fourier Integrals	
Week-3	Complex form of Fourier Integrals, Convolution function and Convolution theorem	
	Fourier transforms in solving boundary value problems	
	Fourier transforms in solving boundary value problems with physical interpretation	
Week-4	Complex number system, Complex Variables	**Class Test 2, Final**
	Basic operations on complex numbers	
	Basic operations on complex variables	
Week-5	Absolute value property, Complex conjugate	
	Graphical presentation of complex number and variable	
	Polar form of complex numbers	
Week-6	Graphical representation in polar form	
	Euler formula, De Moivre's Theorem	
	Roots of complex number	
Week-7	General functions of a complex variable	
	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	
Week-8	Differentiation of a complex function	**Mid Term Final**
	The Cauchy-Riemann Equation	
	Line integral of a complex function, Cauchy's Integral Formula	

Week-9	Cauchy’s Residue Theorem, Liouville’s Theorem	
	Taylor’s Theorem	
	Laurent’s Theorem	
Week-10	Singular Residues	
	Introduction to Statistics	
	Frequency distribution	
Week-11	Measure of central tendency, Standard deviation	**Class Test 3, Final**
	Skewness, Moments, Kurtosis	
	Skewness, Moments, Kurtosis	
Week-12	Elementary probability theory	
	Continuous and discontinuous probability distribution	
	Continuous and discontinuous probability distribution	
Week-13	Continuous and discontinuous probability distribution	
	Elementary sampling theory	
	Regression and correlation	
Week-14	Regression and correlation	
	Tests of hypothesis	
	Tests of hypothesis	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment 1-3	20%	CO1, CO2	C1, C2
			CO3	C2, C3
	Class Participation and Class attendance	5+5= 10%	CO1, CO2, CO3	C1, C2, C3
	Mid term	10%	CO 2, CO3	C1, C2, C3
Final Exam		60%	CO 1	CO 1
			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 Course Title	: GEBS 101 : Bangladesh Studies and Bengali	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	This course has been designed for undergraduate engineering students to help them learn the rich history of Bangladesh, and to provide them with basic knowledge of historical events which eventually led to the formation of Bangladesh and constitution of Bangladesh, current trends in economic development, legislation, citizen charter, cultural aspects which will make them responsible citizen.		
	OBJECTIVES		
	1. To equip students with factual knowledge that will enable them to learn the history of Bangladesh. 2. 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. 3. To promote an understanding of the development of Bangladesh and its culture. 4. To create an awareness among the students about the Geography, Economy, Politics and Culture of Bangladesh.		

	LEARNING OUTCOMES

Upon completion of the course the students will be able to

1. Identify specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically analyze plurality of cultural identities of Bangladesh.
2. Explain the economy and patterns of economic changes through qualitative and quantitative analysis.

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Identify** specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically **analyze** plurality of cultural identities of Bangladesh.	PO-6	**C1- C2**	**-**	**-**	**-**	**T, F, MT**
CO2	**Explain** the economy and patterns of economic changes through qualitative and quantitative analysis.	PO-6	**C2**	**-**	**-**	**-**	**T, F, MT**
CO3	h¡wm¡ i¡o¡, hÉ¡LlZ J p¡¢q-aÉl ®j±¢mL ¢hou pÇf-LÑ d¡lZ¡ fËc¡ez	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

1. Bangladesh Geography: Location, Area, Boundary, Physiography, River system, Forest and Climate, Demography of Bangladesh, Maritime zones.

2. 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 .
3. 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), Public Administration in Bangladesh, State of Good Governance in Bangladesh, Art and Literature, Main traditional cultural events, Vision-2021, Digitalization, Tourism and Natural Resources, Bangladesh and International Relations.
4. p¡¢qaÉ (fËhå, NÒf J L¢ha¡), hÉ¡LlZ, i¡o¡ ¢nr¡ J ¢hlQe, ehÑ¡¢Qa fËhå(h¡‰¡m¡ i¡o¡- h¢ˆjQ¾â Q-¾f¡dÉ¡u, °am- qlfÐp¡c n¡Ù»£,¢ehÑ¡¢Qa NÒf(fy¤Cj¡Q¡- ¢hi§¢ai§oZ h-¾c¡f¡dÉ¡u, eueQ¡l¡- °puc Ju¡m£Eõ¡q), ¢ehÑ¡¢Qa L¢ha¡(¢h-cË¡q£- L¡S£ eSl¦m Cpm¡j, h‰i¡o¡- j¡C-Lm jd¤p§ce cš), hÉ¡LlZ J i¡o¡ ¢nr¡ (fË¢ja h¡wm¡ h¡e¡-el ¢eu¡,Aö¢Ü pw-n¡de,h¡NÚd¡l¡,fËh¡c fËhQe,HL Lb¡u

	fËL¡n,fËn¡p¢eL f¢li¡oi,fË¡u p-ji¡µQ¡¢la ¢ieÀ¡bÑL në, ¢h¢ieÀ n-ël ¢h¢nøi-Bñ fË-ui¡N), EµQ¡lZ¢h¢d, ¢hlQe(Cw-l¢S ®b-L h¡wmi Ae¤h¡c/Ae¤-µRc lQei,ii¡h pÇfËp¡lZ/p¡l¡wn/p¡lii¡Ñ,fœ/fË¢a-hce lQei,fËhå lQei)
	SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Identify** specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically **analyze** plurality of cultural identities of Bangladesh.						1						
CO2	**Explain** the economy and patterns of economic changes through qualitative and quantitative analysis.						1						
CO3	h¡wm¡ ii¡oi, hÉ¡LlZ J p¡¢q-aÉl ®j±¢mL ¢hou pÇf-LÑ d¡lZ¡ fËc¡ez						1						

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1- PO6	1	In order to identify specific stages of Bangladesh's political history, through the ancient, medieval, colonial and post-colonial periods and critically analyze plurality of cultural identities of Bangladesh, 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- PO6	1	In order to explain the economy and patterns of economic changes through qualitative and quantitative 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.
CO3- PO6	1	h¡wm¡ ii¡oi, hÉ¡LlZ J p¡¢q-aÉl ®j±¢mL ¢hou pÇf-LÑ d¡lZ¡ fËc¡e, j¡a«ii¡oil öÜ EµQ¡lZ ¢nr¡, f¢Wa ¢ho-ul ii¡h Ae¤d¡he Ll¡ Hhw a¡ fËL¡-n cr L-l ®a¡m¡, h¡wm¡ ii¡o¡u ®fn¡Na c¡ç¢lL fœ¡m¡f (Official Correspondence) Hhw pªSen£m lQe¡l SeÉ fË¡¢aù¡¢eL ¢nr¡ fËc¡ez

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	28
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	56
	Revision	14

	Formal Assessment Continuous Assessment Mid-Term Final Examination	 1 1 3
	Total	103

TEACHING METHODOLOGY

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

COURSE SCHEDULE

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 1, Final Exam**
Week-2	History: Overview of the ancient Bengal; anthropological identity of the Bengali race: main trends in the history of medieval Bengal	
Week-3	Bengal under the East India Company; religious and social reform movements; nationalist movements, division of the Indian sub-continent	
Week-4	Language movement 1948-1952; education movement of 1962; six-point movement of 1966: mass uprising of 1969	**Class Test 2 , Final Exam**
Week-5	War of independence and emergence of Bangladesh in 1971	
Week-6	Constitution of Bangladesh, Political Development and Democratic Transition (1971-1990), Vision-2021, Digitalizaiton, Tourism and Natural Resources	
Week-7	Political Development (1991-Present), Bangladesh's contribution to world peace and its security, Economy and National development, Development and Progress of the Millennium Development Goals (MDGs), Public Administration in Bangladesh, State of Good Governance in Bangladesh	
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, Art and Literature, Main traditional cultural events	**Mid Term , Final Exam**
Week-9	Fish, Minerals, Health, Education, Agriculture, Industries, NGOs, Population, Sociological and Cultural aspects of Bangladesh, Bangladesh and International Relations	
Week-10	pi¢qaÉ (fËhå, NÒf J L¢hai), hÉ¡LlZ, i¡oi ¢nri J ¢hlQe, ehÑ¡¢Qa fËhå(hi‰¡mi iioi-h¢ˆjQ¾â Q-–¡f¡dÉ¡u, °am- qlfÐp¡c n¡Ù»£,¢ehÑ¡¢Qa NÒf(fy¤Cj¡Q¡- ¢hi§¢ai§oZ h-¾c¡f¡dÉ¡u, eueQ¡l¡- °puc Ju¡m£Eõ¡q)	
Week-11	¢ehÑ¡¢Qa L¢hai(¢h-cË¡q£- L¡S£ eSl¦m Cpm¡j, h‰i¡oi- j¡C-Lm jd¤p§ce cš), hÉ¡LlZ J i¡oi ¢nri (fË¢ja h¡wm¡ h¡e¡-el ¢euj,Aö¢Ü pw-n¡de,h¡NÚd¡l¡,fËh¡c fËhQe	**Class Test 3, Final Exam**
Week-12	HL Lb¡u fËL¡n,fËn¡p¢eL f¢li¡oi,fË¡u p-j¡µQi¢la ¢ieÀ¡bÑL në, ¢h¢ieÀ n-ël ¢h¢nøi-Bñ fË-u¡N)	

Week-13	EµQ¡lZ¢h¢d, ¢hlQe(Cw-l¢S ®b-L h¡wm¡ Ae¤h¡c/Ae¤-µRc lQe¡,i¡h pÇfËp¡lZ/p¡l¡wn/p¡ljjÑ,fœ/fË¢a-hce lQe¡,fËhå lQe¡)
Week-14	Revision

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2	C1, C2
	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

mnvqK cvV¨eB

K| weGgG K¨v‡WU †cÖwm - evsjv|

L| evsjv e¨vKiY - W. kvnRvnvb gybxi, ÷z‡W›Um cvewj‡Kkbm|

M| cÖeÜmsMÖn - XvKv wek^we`¨vjq|

N| MímsMÖn - XvKv wek^we`¨vjq|

O| KweZvmsMÖn - XvKv wek^we`¨vjq|

P| evsjv evbvb Awfavb - evsjv GKv‡Wg KZ…©K cÖKvwkZ|

Q| evsjv D"PviY Awfavb - evsjv GKv‡Wg KZ…©K cÖKvwkZ|

R| cÖwgZ evsjv e¨vKiY I wbwg©wZ (Z„Zxq LÐ) - Aa¨vcK W. nvqvr gvgy` I Aa¨vcK W. †gvnv¤§` Avgxb|

S| evsjv fvlvi cª‡qvM I Accª‡qvM - evsjv GKv‡Wg KZ…©K cÖKvwkZ|

REFERENCE SITE

Level 1 Term II

Communicative English I

COURSE INFORMATION			
Course Code	: LANG 102	Contact Hours	: 3.00
Course Title	: Communicative English -I	Credit Hours	: 1.50
PRE-REQUISITE			
None			
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 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 diverse text types to refine their reading skills, engaging in activities and discussions that foster effective writing type. 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. Special emphasis is placed on the various forms of essay including descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, student should demonstrate proficiency in communication across diverse contexts, engage in group activities, and deliver formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. Addionally, the course emphasizes providing constructive feedback on students' oral performances.			
OBJECTIVES			
• To develop the four basics skills of English language, i.e. listening, speaking, reading and writing. • To enhance students' interpersonal skills through participation in various group interactions and activities. • To improve students' pronunciation to enhance comprehensibility in both speaking and listening. • To gain proficiency in crafting well- organized paragraphs and learn to edit and revise both their own as well as peer's writing.			
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 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)

Listening: 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; Listening to short conversations between two persons/more than two.

Reading: Reading techniques: scanning, skimming, predicting, inference; Reading Techniques: analysis, summarizing and interpretation of texts.

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.

COURSE OUTCOMES AND SKILL MAPPING

No.	COURSE OUTCOMES (COs)	PROGRAMME OUTCOMES (POs)											
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	**Communicate** in English quickly and smartly using the techniques learnt in the class.	✓											
2	**Understand** the techniques of academic reading and writing	✓											
3	**Communicate** ideas and opinions effectively within the shortest possible time										✓		
4	**Excel** in oral and written communication/ Presentation										✓		

	competency												

COURSE OUTCOMES AND GENERIC SKILLS

No.	Course Outcomes	Corresponding POs	Bloom's	CP(WP)	CA(EA)	KP(WK)	Assessment Methods
CO1	**Communicate** in English quickly and smartly using the techniques learnt in the class.	PO1	L2	-	-	1	Assignment, Quiz
CO2	**Understand** the Techniques of academic reading and writing	PO1	L3	-	-	1	Project/ Assignment, Quiz
CO3	**Communicate** ideas and opinions effectively within the shortest possible time	PO10	L4	-	-	1	Project, Assignment, Quiz
CO4	**Excel** in oral and written communication/ Presentation competency	PO10	L5	-	-	2	Project/ Assignment, Quiz

WP= Washington Accord Complex Problem Solving/ CP= Complex Problem Solving; EA= Engineering Activities/ CA= Complex Activities; WK= Washington Accord Knowledge Profile/ KP= Knowledge Profile

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face to Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	- 42 42
Guided Learning Assignment Preparation	30 -

Independent Learning Individual learning Preparation for Report	- -
Assessment	

Continuous assessment(Descriptive writing Reading Test, Listening Test, Public Speaking) Report Submission Presentation	04 - -
Total	88
TEACHING METHODOLOGY	
Lecture and Discussion, Tutorial, Assignment, Report	
TEACHING SCHEDULE	

Week	Topics	Remarks
1	Introduction to Language: Introducing basic skills of language; English for Science and Technology	Assignment, Project, Quiz
	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.	
	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.	
2	Asking and answering questions, Expressing likings and disliking; (food, fashion etc.) Asking and giving directions	
3	Discussing everyday routines and habits, making requests/ offers/ invitations/ excuses/ apologies/ complaints	
4	Describing personality, discussing and making plans (for a holiday or an outing to the cinema), Describing pictures / any incident / event	
5	Practicing storytelling, Narrating personal experiences/Anecdotes	
6	Telephone conversations (role play in group or pair); Situational talks / dialogues: Practicing different professional conversation (role play of doctor-patient conversation, teacher –student conversation)	
7	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	

8	Difference between different accents: British and American accents; Documentaries from BBC and CNN will be shown and students will try to understand	
9	Listening to short conversations between two persons/more than two	
10	Reading techniques: scanning, skimming, predicting, inference;	
11	Reading techniques: scanning, skimming, predicting, inference;	
12	Introductory discussion on writing, prewriting, drafting;	
13	Topic sentence, paragraph development, paragraph structure, describing a person/scene/picture, narrating an event	
14	Paragraph writing, Compare-contrast and cause- effect paragraph	

ASSESSMENT STRATEGY

Components	**Grading**	**CO**	**Blooms Taxonomy**
Continuous Assessment (Compulsory)		CO1, CO2, CO3, CO4	L2, L3, L4, L5
Descriptive writing	20%		
Reading Test	15%		
Listening Test	15%		
Public Speaking	20%		
Group Presentation	30%	CO1, CO2, CO3, CO4	L2, L3, L4, L5
Total Marks	100%		

REFERENCE BOOKS

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

Level 2 Term I

Communicative English II

COURSE INFORMATION			
Course Code Course Title	: LANG 202 : Communicative English -II	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
PRE-REQUISITE			
LANG 102			
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 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 diverse text types to refine their reading skills, engaging in activities and discussions that foster effective writing type. 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. Special emphasis is placed on the various forms of essay including descriptive, narrative, cause-effect, compare-contrast, and argumentative. Upon completion of this course, student should demonstrate proficiency in communication across diverse contexts, engage in group activities, and deliver formal speech for academic, professional and social purposes. This course also incorporates classroom instructions to provide guidelines on presentations and communication skills. Addionally, the course emphasizes providing constructive feedback on students' oral performances.			
OBJECTIVES			
• To develop English language skills to communicate effectively and professionally. • To strengthen students' presentation skills. • To develop competency in academic reading and writing.			
COURSE CONTENT			

Reading: 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 semi-formal, Formal/official letters, Official E-mail Applying for a job: Writing Cover Letter and Curriculum Vitae; 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; Analyzing and describing graphs or charts; Practicing analytical and argumentative writing

Speaking: 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. 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: Listening to long lecture on some topics, Listening and understanding speeches/lectures of different accent.

COURSE OUTCOMES AND SKILL MAPPING

No.	COURSE OUTCOMES (COs)	PROGRAMME OUTCOMES (POs)											
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	**Understand** the techniques of academic reading and become familiar with technical vocabularies.	✓											
2	**Understand** the techniques of effective academic writing including research article/report writing.	✓											
3	**Communicate** effectively to present their reports and research work within the shortest possible time										✓		
4	**Analyze** any problem critically, interpret data and synthesize information to provide valid conclusions.										✓		

COURSE OUTCOMES AND GENERIC SKILLS

No.	Course Outcomes	Corresponding POs	Bloom's	CP(WP)	CA(EA)	KP(WK)	Assessment Methods
CO1	**Understand** the techniques of academic reading and become familiar with technical vocabularies.	PO1	L2	-	-	1	Assignment, Quiz
CO2	**Understand** the techniques of effective academic writing including research article/report writing.	PO1	L3	-	-	1	Project/ Assignment, Quiz
CO3	**Communicate** effectively to present their reports and research work within the shortest possible time	PO10	L4	-	-	1	Project, Assignment, Quiz
CO4	**Analyze** any problem critically, interpret data and synthesize information to provide valid conclusions.	PO10	L5	-	-	2	Project/ Assignment, Quiz

WP= Washington Accord Complex Problem Solving/ CP= Complex Problem Solving; EA= Engineering Activities/ CA= Complex Activities; WK= Washington Accord Knowledge Profile/ KP= Knowledge Profile

TEACHING LEARNING STRATEGY	
Teaching and Learning Activities	Engagement (hours)
Face to Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	- 42 42
Guided Learning Assignment Preparation	30 -
Independent Learning Individual learning Preparation for Report	- -

Assessment Continuous assessment (Writing Test Reading Test Listening Test Public Speaking) Report Submission Presentation	04 - -
Total	88

TEACHING METHODOLOGY

Lecture and Discussion, Problem Based Learning (PBL)

TEACHING SCHEDULE

Week	Topics	Remarks
1	Reading Comprehension: Practice using different techniques	Assignment, Project, Quiz
2	Academic reading: comprehension from departmental or subject related passages	
3	Vocabulary for Engineers (some common Engineering terms for both general and dept specific) Reading subject specific text to develop vocabulary	
4	Writing semi-formal, Formal/official letters, Official E-mail	
5	Applying for a job: Writing Cover Letter and Curriculum Vitae Practicing storytelling, Narrating personal experiences/Anecdotes	
6	Essay writing: writing steps, principles and techniques, outlining, revising, editing, proofreading;	
7	Narrative and descriptive writing: comparison-contrast and cause – effect, argumentative and opinion expression, assignment writing;	
8	Analyzing and describing graphs or charts	
9	Practicing analytical and argumentative writing	
10	Public Speaking: Basic elements and qualities of a good public speaker	
11	Set Speech and Extempore Speech: How to get ready for any speech – set or extempore.	
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.	
13	Listening to long lecture on some topics	
14	Listening and understanding speeches/lectures of different accents	

ASSESSMENT STRATEGY

Components	Grading	CO	Blooms Taxonomy

Continuous Assessment Class participation Writing Test Reading Test Listening Test Public Speaking	 - 20% 15% 15% 20%	CO1, CO2, CO3, CO4	L2, L3, L4, L5
Group Presentation	30%	CO1, CO2, CO3, CO4	L2, L3, L4, L5
Total Marks	100%		

REFERENCE BOOKS

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

Level 1 Term I

	COURSE INFORMATION		
Course Code Course Title	: GES 101 : Fundamentals of Sociology	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	This course has been designed to understand the human inter-personal relationship and human psychology in the society and to apply this knowledge in the practical field as an engineer through the study of varied societies and cultures.		
	OBJECTIVES		
	1. To learn basics, scopes and perspectives of sociology. 2. To understand societal and cultural issues in national, global and environmental context. 3. To synthesis between social problem and social satisfaction in real life.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Understand the basic nature, scope and perspective of sociology and the criteria of social research process and methodologies. 2. Apply contextual knowledge to assess societal and cultural issues in national and global context and also environmental context for sustainable development. 3. Analyze social problem, social stratifications, socialism, capitalism and economic life and political issues.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the basic nature, scope and perspective of sociology and the criteria of social research process and methodologies.	PO10	C1		-	1	T, ASG, F
CO2	**Apply** 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	**Analyze** social problem, social stratifications, socialism, capitalism and economic life and political issues.	PO6, PO10	C2			2	MT, 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

Main Contents: Understanding society, social phenomena and social change.

Detail Contents: 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 Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basic nature, scope and perspective of sociology and the criteria of social research process and methodologies.										1		
CO2	**Apply** contextual knowledge to assess societal and cultural issues in national and global context and also environmental context for sustainable development.						2						
CO3	**Analyze** Social problem, social stratifications, socialism, capitalism and economic life and political issues.						2				1		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
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 and receive clear instructions.

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 Social problem, social stratifications, socialism, capitalism and economic life and political issues, 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-CO10	2	In order to analyze Social problem, social stratifications, socialism, capitalism and economic life and political issues, 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

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	28
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	56
	Revision	14
	Formal Assessment	
	Continuous Assessment	1
	Mid-Term	1
	Final Examination	3
	Total	103

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Definition, nature and scope of sociology, Sociological imagination	**Class Test 1, Final Exam**
Week-2	Perspectives of sociology, Orientation of sociological theories	
Week-3	Social research and its process, Research designs and techniques	
Week-4	Introducing culture and its variations, civilization	
Week-5	Defining family and its changes, Socialization process and development of self	

Week-6	Introducing globalization and its impact on human life, Factors responsible to globalization	**Class Test 2, Final Exam**
Week-7	Media and its impact in modern society, Addressing social problems of Bangladesh	
Week-8	Introducing social groups and organizations, Introducing bureaucracy and good governance	**Mid Term**
Week-9	Introducing social stratifications and social inequality, Poverty and its types and dimensions	
Week-10	Industrial revolution and aftermath, Urbanization and city development	
Week-11	Capitalism: features and influence, Socialism: features and influence	**Class Test 3, Final Exam**
Week-12	Environment and human activities, Climate change and global risk	
Week-13	Population of Bangladesh: problem or prospect, Crime and deviance: a brief analysis	
Week-14	Review	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1	C1
	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. Department of EECE

Level 1 Term I

	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 of electric and magnetic circuit as well as the analysis of DC and AC circuit.
	OBJECTIVES
	1. To familiarize students with basic Circuit laws (Ohm, Kirchhoff), techniques (Mesh, Nodal), concepts (Superposition, Source Transformation) and theorems (Thevenin, Norton). 2. 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). 3. To impart knowledge of AC power conservation and measurements to be applied in practical field. 4. To impart in depth knowledge of balanced and unbalanced 3 phase circuits, their analysis and configurations (Y, Δ). 5. To articulate the concepts of magnetically coupled circuits (mutual inductance, dot convention) three phase and poly phase circuits
	LEARNING OUTCOMES
	Upon completion of the course the students will be able to 1. Understand the basic circuit laws 2. Apply the circircut theorems to solve the AC and DC circuits 3. Analyze the magnetic circuits and three phase circuits.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** the basic circuit laws	1	C2	-	-	1	T, F, Q
CO2	**Apply** the circuit theorems to **solve** the AC and DC circuits	2	C2, C4	-		2	T, MT, F
CO3	**Analyze** the magnetic circuits and three phase circuits	1	C4	1		2	MT, 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)

	COURSE CONTENT

Laws of electric circuit: Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation.
Electrical networks: network analysis methods of branch and loop currents, method of node pair voltages, Thevenin's and Norton's theorems.
Magnetic concepts and units: magnetic field, right hand rule, magnetic flux density, Biot-Savart law, magnetic field intensity, measurement of magnetic flux, energy of magnetic field, characteristic of ferromagnetic materials, B-H curve, hysteresis loss, eddy current and eddy current loss, total core loss.
Electromagnetic forces: forces upon a current carrying conductor and charged particles moving in a magnetic field. Electromagnetic torque. Electromagnetic induction and emf;
Lenz's law, BlV rule.

General concepts of AC system: Instantaneous current, voltage and power, R, L, C, RL, RC and RLC branches.
Effective current and voltage: Average values, form factor, crest factor, real & reactive powers and power factor. Introduction to vector algebra and Phasor diagram. Impedance in polar and Cartesian forms.
Single phase circuit analysis: Impedance in series, parallel branches, series-parallel circuits. Network analysis using Thevenin's theorem.
Balanced poly phase circuits: Three phase, four wire system and three phase, three wire systems, balanced wye and delta connected loads, power in balanced systems. Balanced three phase circuit analysis and power measurement.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** the basic circuit laws	3											
CO2	**Apply** the circuit theorems to **solve** the AC and DC circuits		3										
CO3	**Analyze** the magnetic circuits and three phase circuits	3											

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	The knowledge of mathematics, science and engineering fundamentals has to be applied to learn the operation and construction of electrical machines.
CO2-PO2	3	In order to understand the design features of ac machines, the characteristics of ac machines need to be identified and analyzed.
CO3-PO1	3	In order to analyze basic electronic circuits considering existing system models to explore practical complex engineering problems the knowledge of mathematics, science and electrical science is required.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	42
Practical / Tutorial / Studio	-
Student-Centered Learning	-

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

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	**Laws of electric circuit:** Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation.	**Class Test 1, Final Exam**
Week-2	**Laws of electric circuit:** Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation (2)	
Week-3	**Electrical networks:** network analysis methods of branch and loop currents	
Week-4	**Electrical networks:** network analysis methods of branch and loop currents	**Class Test 2, Final Exam**
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,	
Week-7	Biot-Savart law, magnetic field intensity, measurement of magnetic flux, energy of magnetic field, characteristic of ferromagnetic materials, theory of ferromagnetism	
Week-8	B-H curve, hysteresis loss, eddy current and eddy current loss, total core loss. Introduction to magnetic circuits.	**Mid Term, Final Exam**
Week-9	**Electromagnetic forces:** forces upon a current carrying conductor and charged particles moving in a magnetic field.	
Week-10	Electromagnetic torque; Electromagnetic induction and emf; Lenz's law, Blv rule.	
Week-11	**General concepts and definitions:** Instantaneous current, voltage and power, R, L, C, RL, RC and RLC branches.	**Class Test 3, Final Exam**
Week-12	**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.	
Week-13	**Balanced poly phase circuits:** 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.	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1- CO3	C2, C4, C5
	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)

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.
7. Charles K. Alexander, *Fundamentals of Electric Circuits* , McGraw-Hill International.

REFERENCE SITE

Level 1 Term I

	COURSE INFORMATION		
Course Code Course Title	: EECE 120 : Fundamentals of Electrical Circuit Analysis Sessional	Lecture Contact Hours Credit Hours	:1.50 : 0.75
	PRE-REQUISITE		
	EECE 119		
	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		
	1. To learn the basic of electrical machines, their applications and unit. 2. To study the different electronic circuits and apply those in solving complex engineering problem.		
	LEARNING OUTCOMES		

	Upon completion of the course, the students will be able to 1. Apply the knowledge of basic electrical components and networks practically. 2. Vary circuit parameters in order to achieve optimized circuit operation. 3. Design different elementary circuit related projects using circuit theorems and components
	COURSE OUTCOMES & GENERIC SKILLS

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	**Vary** circuit parameters in order to achieve optimized circuit operation.	PO3, PO5	P6	1		5	R,Q,T
CO3	**Design** different elementary circuit related projects using circuit theorems and components	PO3	C5	1	1	3	R,Q,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)

COURSE CONTENT

1. Construction and operation of simple electrical circuits
2. Verification of KVL and KCL
3. Verification of Thevenin's theorem
4. Verification of Superposition theorem
5. Familiarization with AC waves and study of R-L-C series circuits
6. Practice Lab-02
7. Lab Test-02

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Apply the knowledge of basic electrical components and networks practically.	1				2							
CO2	**Vary** circuit parameters in order to achieve optimized circuit operation.			2		2							
CO3	Design different elementary circuit related projects using circuit theorems and components			3									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	1	For constructing simple electronic circuits in breadboard, minimum level of engineering knowledge is required (e.g. understanding series-parallel circuitry).
CO1-PO5	2	In some cases, students face some design related problems while constructing electronic circuit and those complex problems need to be attained by themselves too.

CO2-PO3	2	By doing project work, ability to design something that meets specified needs would be formed.
CO2-PO5	2	To study the performance characteristics of the designed system through simulation, knowledge of modern engineering tools used in the practice areas is needed.
CO3-PO3	3	In order design a communication system with defined design parameters, knowledge is needed that supports engineering design in a practice area

TEACHING LEARNING STRATEGY

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

TEACHING LEARNING STRATEGY

	Teaching and Learning Activities	Engagement (hours)
	Face-to-Face Learning	
	Lecture Practical / Tutorial / Studio Student-Centered Learning	14 28 -
	Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test Preparation of presentation Preparation of Quiz Engagement in Group Projects	 14 10 9
	Formal Assessment Continuous Assessment Final Quiz	 14 1
	Total	90

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Construction and operation of simple electrical circuits	
Week-2	Verification of KVL and KCL	
Week-3	Verification of Thevenin’s theorem	
Week-4	Verification of Superposition theorem	
Week-5	Familiarization with AC waves and study of R-L-C series circuits	
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)

REFERENCE BOOKS

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 Course Title	: EECE 221 : Electrical and Electronics Technology	Lecture Contact Hours Credit Hours	: 3.00 : 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, characteristic features, applications etc. of AC electrical machinery like synchronous generator, synchronous motor and three phase and single-phase induction motors and special motors. The emphasis has been given on both physical insight and analytical techniques. The subject material covered here will provide the basis for understanding many real-world electric machinery applications as well as the foundation for advanced courses in electric machinery design and control. To teach the students the concepts, principles and working of basic electronic circuits (Diodes, BJTs). It is targeted to provide a basic foundation for technology areas like electronics devices (rectifiers, voltage regulators and amplifiers), industrial electronics as well as instrumentation, control systems and various electronic circuit design. Finally, this course is designed to develop a designing capability involving real life practical problems.
	OBJECTIVES
	1. To impart basic knowledge on the physics of semiconductor along with the types, specification and standard values of passive and active components of electronic circuits. **2.** To develop a strong foundation on AC electrical machines (synchronous machines, induction machines, universal machines etc) with a special focus on operating principle, identification of parts and accessories, constructional features, types etc **3.** To familiarize with basic electronic circuits (rectifiers, voltage regulators and amplifiers), their working principles, design criteria and system components. **4.** To develop a broad idea on application of machines in practical industrial and domestic field.

	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Explain the fundamental operation, basic construction and classification of different AC and DC machines 2. Interpret and analyze the performance characteristics of different electrical machines e.g. transformers, DC and AC machines 3. Analyze basic electronic circuits considering existing system models to explore practical complex engineering problems. 4. Design various electronic circuits using both passive and active components to solve the real-life engineering problems.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the fundamental operation, basic construction and classification of different AC and DC machines	1	C2			1, 2	T, F
CO2	**Interpret** and **analyze** the performance characteristics of different electrical machines e.g. transformers, DC and AC machines	2	C2, C4			1-3	T, F
CO3	**Analyze** basic electronic circuits considering existing system models to explore practical complex engineering problems.	2	C4			1-3	MT, F

CO4	D**esign** 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 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						
	Transformer: Principles, types, performances and characteristics of single-phase transformers, introduction to Auto Transformer. **DC generators:** Principles, types, performances and characteristics of DC generators. **DC Motors:** Principles, types, performances and characteristics. Speed control and starters of motors, Permanent Magnet Brushless dc (BLDC) Motor Drives. **AC Machines:** Principles of single-phase induction motor and its equivalent circuits, Introduction to three phase induction motor and synchronous machines. **Electronics:** Introduction to semiconductor, characteristics of semiconductor diodes and their types, LEDs, Applications of different types of diodes, Characteristics of BJT and their DC Biasing, Use of transistors as a switch, Introduction to FET, MOSFET, IGBT, SCR.						
	SKILL MAPPING (CO-PO MAPPING)						

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** the fundamental operation, basic construction and classification of different AC and DC machines	3											
CO2	**Interpret** and **analyze** the performance characteristics of different electrical machines e.g. transformers, DC and AC machines		3										
CO3	**Analyze** basic electronic circuits considering existing system models to explore practical complex engineering problems.		3										
CO4	**Design** various electronic circuits using both passive and active components to solve the real-life engineering problems.			2									

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to be able to **infer/illustrate** the physics of semiconductor devices and the operation of different electronic components for strengthening fundamental idea about basic electronics, the knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems is to applied.
CO2-PO2	3	In order to be able to compare the input and output characteristics of different electronic components, 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 be able to analyze basic electronic circuits considering existing system models to explore practical complex engineering problems, 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	2	In order to be able to design various electronic circuits using both passive and active components to solve the real life engineering problems, , 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

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term	 2 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	**Transformer:** Principles, types, Auto Transformer	**Class Test 1, Final**
Week-2	**Transformer:** Performances and characteristics.	
Week-3	**DC generators:** Principles, types	
Week-4	**DC generators:** Performances and characteristics.	**Class Test 2, Final**
Week-5	**DC Motors:** Principles, types: Magnet Brushless dc (BLDC) Motor Drives	
Week-6	DC Motors: Performances and characteristics	
Week-7	DC Motors: Speed control and starters of motors.	
Week-8	**AC Machines:** Principles of three phase induction motor and equivalent circuits	**Mid Term Final**
Week-9	AC Machines: Introduction to synchronous machines and fractional horse power motors.	
Week-10	AC Machines: Introduction to synchronous machines and fractional horse power motors Part II	
Week-11	Electronics: Characteristics of semiconductor diodes	**Class Test 3, ASG/ Pr Final**
Week-12	Electronics: Diode Applications, Diode Rectifier	
Week-13	Characteristics of BJT and Introduction to FET, SCR, IGBT	
Week-14	DC Biasing of BJT	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2	C2, C4
	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. 7. B.L. Thereja, *Electrical Technology* , S. Chand Publishing 8. Stephen J. Chapman, *Electric Machinery Fundamentals* , McGraw-Hill International.
REFERENCE SITE

Level-2 Term-II

	COURSE INFORMATION		
Course Code Course Title	: EECE 222 : Electrical and Electronic Technology Sessional	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
	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		
	1. To learn the basic of electrical machines, their applications and unit. 2. To study the different electronic circuits and apply those in solving complex engineering problem.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 1. Practically analyze and evaluate performance characteristics of different electrical machines 2. Construct different fundamental electronic circuits and relate the theoretical knowledges to justify the performance of different electronic devices 3. Apply the acquired knowledge to design and construct a real-life based project in group		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	Practically **analyze** and **evaluate** performance characteristics of different electrical machines	PO2, PO5	C4, C5	1	-	1-3,6	R,Q,MT,T

CO2	**Construct** different fundamental electronic circuits and **relate** the theoretical knowledges to justify the performance of different electronic devices	PO2, PO5	C3	1	-	1-3,6	R,Q,T
CO3	**Apply** the acquired knowledge to **design** and **construct** a real-life based project in group	PO3, PO5, PO9, PO 10	C3, C6	1	1	1-6	PR, Pr

(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

1. Study the characteristic of single and three phase transformer.
2. Study the characteristic of DC generators.
3. Study the characteristic of DC motors.
4. Study the characteristic of three phase induction motor.
5. Study the characteristic of synchronous generator.
6. Lab Test-01
7. Study the characteristic of diode in DC.
8. Study the characteristic of diode in AC with the introduction to oscilloscope.
9. Study the characteristic of common base BJT.
10. Study the characteristic of common emitter BJT.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	Practically **analyze** and **evaluate** performance characteristics of different electrical machines		3			3							
CO2	**Construct** different fundamental electronic circuits and **relate** the theoretical knowledges to justify the performance of different electronic devices		3			3							
CO3	**Apply** the acquired knowledge to **design** and **construct** a real-life based project in group			2		2				2	2		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO2	3	The knowledge of mathematics, science and electrical engineering sciences has to be applied to find out the signal to noise ratio and channel capacity of a communication system.
CO1-PO5	3	To study the performance characteristics of the designed system through simulation, knowledge of modern engineering tools used in the practice areas is needed.

CO2-PO2	3	In order to construct different fundamental electronic circuits and relate the theoretical knowledges to justify the performance of different electronic devices, the knowledge of mathematics and engineering science must be applied.
CO2-PO5	3	To study the performance characteristics of the designed system through simulation, knowledge of modern engineering tools used in the practice areas is needed.
CO3-PO3	2	In order design electronic system with defined design parameters, knowledge is needed that supports engineering design in a practice area
CO3-PO5	2	To study the performance characteristics of the designed system through simulation, knowledge of modern engineering tools used in the practice areas is needed.
CO3-PO9	2	In order to apply the acquired knowledge to design and construct a real-life based project in group effort must be taken in individual or in group
CO3-PO10	2	In order to apply the acquired knowledge to design and construct a real-life based project in group and to present it communication skill is needed

TEACHING METHODOLOGY

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

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 28 28 -
	Self-Directed Learning Preparation of Lab Reports Preparation of Lab Test Preparation of presentation Preparation of Quiz Engagement in Group Projects	 28 21 14
	Formal Assessment Continuous Assessment Final Quiz	 14 1
	Total	120

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Study the characteristic of single and three phase transformers.	
Week-2	Study the characteristic of DC generators.	
Week-3	Study the characteristic of DC motors.	
Week-4	Study the characteristic of three phase induction motor.	
Week-5	Study the characteristic of synchronous generator.	
Week-6	Lab Test-01	
Week-7	Study the characteristic of diode in DC.	

Week-8	Study the characteristic of diode rectifier in AC with the introduction to oscilloscope.	
Week-9	Study the characteristic of common base BJT.	
Week-10	Study the characteristic of common emitter BJT	
Week-11	Quiz	
Week-12	Practice Lab-02	
Week-13	Lab Test-02	
Week-14	Viva Voce	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Conduct of Lab Tests/Class Performance	25%	CO1, CO2	C3, C4, C5 A3, A5, P2, P4
	Report Writing/ Programming	15%	CO1, CO2	C3, C4, C5 A3, A5, P2, P4
	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

<u>Level 1 Term II</u>

	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 fundamentals for learners who want to solve complex problems of real world by writing computer programs.
	OBJECTIVES
	1. To provide a basic idea of the programming concepts 2. To know the basic rules for implementing C programming. 3. To develop problem-solving skills to solve different problems and calculations using C programming.
	LEARNING OUTCOMES
	Upon completion of the course, the students will be able to 1. Explain the features of procedural language. 2. Apply C programming concepts such as control flow, conditional statements, composition of structures, array, function etc. to solve real world problem. 3. Design algorithms in a systematic way to solve any problem which can be implemented using C. 4. Develop the communication skill by presenting topics on programming phenomena.
	COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** the features of procedural language.	PO1	C1-C3	1	-	1	T, MT, F
CO2	**Apply** C programming concepts such as control flow, conditional statements, composition of structures, array, function etc. to solve real world problem.	PO2	C4	3		2	T, MT, F
CO3	**Design** algorithms in a systematic way to solve any problem which can be implemented using C.	PO3	C6	1,3		5	T, MT, F
CO4	**Develop** the communication skill by presenting topics on programming phenomena.	P10	A2		1	5	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
	Programming concepts; Program development stages; Flow charts; Structured programming language: data types, operators, bitwise operations, expressions, control structures: if-else, switch-case, loop (for loop, while loop, do-while loop). Input and Output: standard input and output, formatted input and output. Functions and program structure: function basics, parameter passing conventions, scope rules, storage classes, recursion, header files, the preprocessor, Pointer, and its uses, Arrays, Strings, Multidimensional array;

	User-defined data types: structures, unions, and enumerations. File, Variable length argument list, Command line parameters, Error Handling, Linking, Library Functions
	SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Explain** 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	**Design** algorithms in a systematic way to solve any problem which can be implemented using C.			3									
CO4	**Develop** the communication skill by presenting topics on programming phenomena.										2		

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	**3**	Achieving depth of knowledge on programming by solving complex engineering problem and understanding of the features of a programming languages.
CO2-PO2	**3**	Applying different concepts of C/MATLAB programming to find the solution of complex problems.
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 quiz and presentation.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -

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

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	1. Introduction to Computer Programming. 2. Environment Setup and introduction with the IDE. 3. Standard input and output. 4. Formatted input and output.	**Class Test 1, Final Exam**
Week-2	1. Introduction to data types, mathematical problems using data types, data type conversion, operators, bitwise operation, and expressions. 2. Program development stages-flow chart.	
Week-3	1. Introduction to the conditional statement (if-else, nested if-else, switch case). 2. Problem-solving with conditional statements.	
Week-4	1. Introduction to the loop statement (for loop, while loop, do-while loop). 2. Problem-solving with loop statements.	**Class Test 2, Final Exam**
Week-5	1. Functions and program structure: Function Basics, Parameter passing conventions, Scope Rules, Storage classes, Recursion. 2. Problem-solving with implementing Function.	
Week-6	1. Recursion 2. Problem-solving with recursions.	
Week-7	1. String 2. Problem solving with string.	
Week-8	1. Header files 2. Preprocessor 3. Pointer and its uses. 4. Problem-solving with pointers.	**Mid Term**
Week-9	1. Arrays 2. Multidimensional array 3. Problem-solving with arrays.	
Week-10	1. Structures 2. Problem-Solving with structures.	
Week-11	1. Unions 2. Enumerations	**Class Test 3,**
Week-12	1. Opening, reading, writing, and closing a file. 2. Problem-solving with implementing files.	

Week-13	1. Variable length argument list 2. Command Line parameters 3. Linking 4. Library Functions	**Final Exam**
Week-14	1. Error handling 2. Problem-solving with error handling	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO2, CO3	C1,C2,C3,C4,C6
	Class Participation and Class attendance	5+5= 10%	CO1	C2
	Mid term	10%	CO2, CO3	C2, C6
Final Examination		60%	CO1-CO3	C2, C3, C6
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. Holly Moore , *MATLAB for Engineers* , Pearson Education Inc , 2018 4. Peter Norton, *Computer Fundamentals,* 6 th 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 INFORMATION		
Course Code Course Title	: CSE 122 : Introduction to Computer Science and Programming Language Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 0.75
	PRE-REQUISITE		
	None		
	CURRICULUM STRUCTURE		
	Outcome Based Education (OBE)		
	SYNOPSIS/RATIONALE		
	The C Programming Sessional course is designed to practically introduce the fundamental principles, mechanism of programming skills and develop basic programming skills to program design and development. The lab begins with practicing introductory concepts of C programming language and then covers other important topics related to C programming language.		
	OBJECTIVES		
	5. To provide a basic idea of the programming concepts 6. To know the basic rules for implementing C programming. 7. To develop problem-solving skills to solve different problems and calculations using C programming.		
	LEARNING OUTCOMES		
	Upon completion of the course, the students will be able to 8. Apply knowledge of algorithm to find roadmap to solve problems. 9. Apply knowledge of C concepts to implement solver program.		

	COURSE OUTCOMES & GENERIC SKILLS						
No.	**Course Learning Outcome**	**Corresponding POs**	**Bloom's Taxonomy**	**CP**	**CA**	**KP**	**Assessment Methods**
CO1	**Apply** knowledge of algorithm to find roadmap to solve problems.	PO1	C3, A2	1	1	4	ASG, Q, OE, T

CO2	**Analyze** the fundamental principles, typical characteristics, and mechanisms of a structured programming language practically to implement and solve problems.	PO2	C3, A2	1	1	4	ASG, Q, OE, T
CO3	**Apply** practical knowledge to develop basic programming skills with respect to program design and development.	PO6	C6	1,3	3	7	ASG, 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, OE-Online Exam)

COURSE CONTENT

Programming concepts; Program development stages; Flow charts;
Structured programming language: data types, operators, bitwise operations, expressions, control structures: if-else, switch-case, loop (for loop, while loop, do-while loop).
Input and Output: standard input and output, formatted input and output.
Functions and program structure: function basics, parameter passing conventions, scope rules, storage classes, recursion, header files, the preprocessor, Pointer, and its uses, Arrays, Strings, Multidimensional array;
User-defined data types: structures, unions, and enumerations.
File, Error Handling, Linking, Library Functions

1.

SKILL MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Apply** knowledge of algorithm to find roadmap to solve problems.	3											
CO2	**Apply** knowledge of C concepts to implement solver program.		3										
CO3	**Apply** practical knowledge to develop basic programming skills with respect to program design and development.						3						

(3 – High, 2- Medium, 1-low)

JUSTIFICATION FOR CO-PO MAPPING

Mapping	Corresponding Level of Matching	Justification
CO1-PO1	3	In order to find out the roadmap of a complex engineering problem using c programming, knowledge of algorithm is crucial.
CO2-PO2	3	In order to identify and formulate the problem for solver program concepts of C should be applied properly.

CO3-PO6	3	Apply 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.

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	21
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	42
	Revision	21
	Formal Assessment	
	Continuous Assessment	2
	Mid-Term	1
	Final Examination	3
	Total	90

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Basic Programming, IDE, Data Type, Operations	
Week-2	If-else, switch case	**Evaluation 1**
Week-3	Loop, Nested Loop	
Week-4	Array (1D, 2D)	**Evaluation 2**
Week-5	String, Function	
Week-6	Structure, File Handling	**Evaluation 3**
Week-7	Assignment: String, Strucutre	**Online Exam**

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Lab performance and Report	10%		
	Online-1	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

8. Herbert Schildt, *Teach Yourself C*, 3rd Edition
9. Programming with C - Schaums Outline Series
10. Peter Norton, *Computer Fundamentals,* 6 th Edition McGraw-Hill Education, 2004
11. Herbert Schildt, *C, The Complete Reference,* 4th Edition
12. Dennis M. Ritchie, *C Programming Language*, 2nd Edition
13. E Balagurusamy, Programming in Ansi C, 6th Edition.

REFERENCE SITE

6.1. d. Department of ME

Level 1 Term I

	COURSE INFORMATION		
Course Code Course Title	: ME 180 : Basic Engineering Drawing	Lecture Contact Hours Credit Hours	: 3.00 : 1.50
	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		
	1. To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions. 2. To enable students to acquire requisite knowledge, techniques and attitude required for advanced study of engineering drawing.		
	LEARNING OUTCOMES		
	Upon completion of the course the students will be able to 1. Understand engineering drawings in using engineering drawing apparatus, materials and techniques. 2. Apply and analyze standard conventions used in engineering drawing.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Understand** engineering drawings in using engineering drawing apparatus, materials and techniques.	PO1	C2	1	2	1	R, Q, T
CO2	**Apply** and **analyze** 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)

COURSE 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 MAPPING (CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Understand** engineering drawings in using engineering drawing apparatus, materials and techniques.	3											
CO2	**Apply** and **analyze** standard conventions used in engineering drawing.		3		3								

(3 – High, 2- Medium, 1-low)

TEACHING LEARNING STRATEGY

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

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	28
Practical / Tutorial / Studio	28
Student-Centered Learning	-
Self-Directed Learning	
Preparation of Lab Reports	28
Preparation of Lab Test	21
Preparation of presentation Preparation of Quiz	14
Engagement in Group Projects	
Formal Assessment	
Continuous Assessment	14
Final Quiz	1
Total	120

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Introduction	**Mid-term**

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	**Final Exam**
Week-9	Solid Works Practice – Orthographic Drawing	
Week-10	Solid Works Practice – Orthographic Drawing	
Week-11	Solid Works Practice – Orthographic Drawing	
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	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (60%)	Class Participation	5%	CO1	C2
	Conduct of Lab Test	20%	CO2	C2-C4
	Report Writing	15%	CO1, CO2	C2-C4
	Mid term	20%	CO2	C2-C4
Final Evaluation (40%)	Exam	30%	CO1	C4
	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 Course Title	: ME 253 : Engineering Mechanics	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 Mechanics and its application to a range of problems of relevance to practical engineering.		
	OBJECTIVES		
	1. To impart the essential theoretical basis of Engineering Mechanics. 2. To explain the Laws of Mechanics to predict forces in and motions of machines and structures. 3. To understand the courses dealing with mechanics of machines, stress analysis and design of mechanical systems.		
	LEARNING OUTCOMES		
	Upon completion of the course the students will be able to 1. Define the components of a force in rectangular or non-rectangular coordinates. 2. Demonstrate complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram. 3. Analyze systems that include frictional forces. 4. Evaluate the second moment of an area and calculate the principal second moments of an area.		

COURSE OUTCOMES & GENERIC SKILLS

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Explain** basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts).	PO1, PO2	C2		-	1	T, Q, F

CO2	**Demonstrate** use of basic dynamics concepts- Work-Energy principle, Impulse-Momentum principle to solve dynamics problems	PO1, PO2, PO4	C3		-	2	ASG, F

CO3	**Apply** scalar and vector analytical techniques for analysing forces in statically determinate structures	PO1, PO2, PO3, PO4	C4		-	4	MT, F
CO4	**Evaluate** equilibrium of particles and bodies in real world problems.	PO2, PO3, PO4	C5, C6	1	1	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

Statics of particles and rigid bodies; Properties of forces, moments, couples and resultants; Analysis of two- and three-dimensional problems; Centroids of lines, areas and volumes; Forces in truss, frames, and cables; Friction; Moments of inertia of areas and masses; Relative motion.

Planar mechanisms, linkages, mobility; instant centres of rotation, Kennedy's theorem; Velocity and acceleration polygons; Euler's first law; angular momentum and Euler's second law.

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.

SKILL MAPPING(CO-PO MAPPING)

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Define** the components of a force in rectangular or non-rectangular coordinates.	3	3										
CO2	**Demonstrate** complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.	3	3		2								
CO3	**Analyze** systems that include frictional forces.	2	3	1	2								
CO4	**Evaluate** the second moment of an area and **calculate** the principal second moments of an area.		2	2	3								

(3 – High, 2- Medium, 1-low)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities		Engagement (hours)
	Face-to-Face Learning Lecture Practical / Tutorial / Studio Student-Centered Learning	 42 - -
	Self-Directed Learning Non-face-to-face learning Revision	 84 21
	Formal Assessment Continuous Assessment Mid-Term Final Examination	 2 1 3
	Total	153

TEACHING METHODOLOGY

Lecture and Discussion,

Co-operative and Collaborative Method, Problem Based Method

COURSE SCHEDULE

Weeks	Topics	Remarks
Week-1	Basic concepts of mechanics	**Class Test 1, Final Exam**
Week-2	Statics of particles and rigid bodies	
Week-3	Centroids of lines, areas and volumes	
Week-4	Forces in truss, frames, and cables	**Class Test 2, Final Exam**
Week-5	Forces in truss, frames, and cables	
Week-6	Friction; Moments of inertia of areas and masses; Relative motion	
Week-7	Friction; Moments of inertia of areas and masses; Relative motion	
Week-8	Kinetics of particles: Newton's second law of motion	**Mid Term , Final Exam**
Week-9	Principles of work, energy, impulse and momentum	
Week-10	System of particles	
Week-11	Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies: forces and acceleration	**Class Test 3, Final Exam**
Week-12	Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies: forces and acceleration	
Week-13	Principles of work and energy, Basic concepts of Lagrangian and Hamiltonian mechanics	
Week-14	Principles of work and energy, Basic concepts of Lagrangian and Hamiltonian mechanics	

ASSESSMENT STRATEGY

Components		Grading	CO	Blooms Taxonomy
Continuous Assessment (40%)	Class Test/ Assignment (1-3)	20%	CO1, CO4	C3, C5, C6
	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 Course Title	: ME 254 : Engineering Mechanics Sessional	Lecture Contact Hours Credit Hours	: 1.50 : 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 concepts 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.
2. Analyze the engineering systems and calculate second moment of an area as well as the principal second moments of an area

	COURSE OUTCOMES & GENERIC SKILLS						
No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods
CO1	**Demonstrate** the free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.	PO1	C2	1	2	1	R, Q, T
CO2	**Analyze** the engineering systems and **calculate** second moment of an area as well as the principal second moments of an area	PO2, PO4	C5, C6	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)						

COURSE CONTENT

List of Experiments:

1. Study of coefficient of friction by changing angle of inclination.
2. Study of impulse momentum principle
3. Study of rigid body kinematics
4. Study of planar motion of rigid body

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 Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Demonstrate** the free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.	3											
CO2	**Analyze** the engineering systems and **calculate** second moment of an area as well as the principal second moments of an area		3		3								

(3 – High, 2- Medium, 1-low)

TEACHING LEARNING STRATEGY

Teaching and Learning Activities	Engagement (hours)
Face-to-Face Learning	
Lecture	21
Practical / Tutorial / Studio	-
Student-Centered Learning	-
Self-Directed Learning	
Non-face-to-face learning	42
Revision	11

	Formal Assessment Continuous Assessment Mid-Term Final Examination	 - 1 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	CO	Blooms Taxonomy
Continuous Assessment (60%)	Class Participation	5%	CO1	C2
	Conduct of Lab Test	20%	CO2	C2-C4
	Report Writing	15%	CO1, CO2	C2-C4
	Mid term	20%	CO2	C2-C4
Final Evaluation (40%)	Exam	30%	CO1	C4
	Viva Voce/ Presentation	10%	CO2	C3
Total Marks		100%		

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

REFERENCE BOOKS

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

<u>Level 2 Term I</u>

	COURSE INFORMATION		
Course Code Course Title	: GELM 275 : Leadership and Management	Lecture Contact Hours Credit Hours	: 2.00 : 2.00
	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		
	1. To introduce different management functions and approaches. 2. To expose students to different views and styles of leadership. 3. To understand how an organization functions collaboratively with managers and engineers. 4. To understand various personality traits and its impact on leadership and management. 5. To solve real-world management problems as an engineer.		
	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.		
	COURSE OUTCOMES & GENERIC SKILLS		

No.	Course Learning Outcome	Corresponding POs	Bloom's Taxonomy	CP	CA	KP	Assessment Methods

CO1	**Familiarize** with the fundamental concepts of leadership and management skills	PO-9,10	C1-C2			1	T, R, F
CO2	**Understand** the role and contribution of a leader in achieving organizational goals	PO-9,10,11	C1-C2			1	T, ASG, R, F
CO3	**Understand** the contribution of leadership traits and management skills in decision making and solving real life problems	PO-1,8,9,10,11,12	C1-C2			1	T, ASG, R, 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						
	Management and Cultures: Definition of culture, culture theories, and their significance in organizational settings; Cultural values, beliefs, and norms shaping managerial practices; The impact of cultural diversity on global business; The relationship between organizational culture and cultural diversity; Addressing cultural biases and promoting diversity and inclusion initiatives; Fostering organization cultures and their principles among management, leaders and staffs. **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, theory and structure, span of control, authority delegation. **Personnel Planning and HR Management System:** Process of Human Resource Planning, performance management and appraisal. **Operation management:** Production planning and control (PPC) functions. **Marketing Management:** Marketing concepts & organization, strategy, industrial and consumer selling, sales promotion, channel & advertising decisions, new product strategy, patent laws. **Information Technology and Management:** Management information system (MIS), technology life cycle, technology management, management of innovation and changes, enterprise resource planning (ERP). Case Studies: Solving real-world management problems. .						
	SKILL MAPPING (CO-PO MAPPING)						

No.	Course Learning Outcome	PROGRAM OUTCOMES (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	**Familiarize** students with the fundamental concepts of human resource management, marketing management, operations management, and financial management.									3	3		
CO2	**Understand** 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 Learning Activities		Engagement (hours)
	Face-to-Face Learning	
	Lecture	28
	Practical / Tutorial / Studio	-
	Student-Centered Learning	-
	Self-Directed Learning	
	Non-face-to-face learning	56
	Revision	14
	Formal Assessment	
	Continuous Assessment	1
	Mid-Term	1
	Final Examination	3
	Total	103

TEACHING METHODOLOGY

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

COURSE SCHEDULE

Weeks	Topics	Remarks
Week 1	Definition of culture, culture theories, and their significance in organizational settings; Cultural values, beliefs, and norms shaping managerial practices; The impact of cultural diversity on global business	**Class Test, Final Exam**
Week 2	The relationship between organizational culture and cultural diversity; Addressing cultural biases and promoting diversity and inclusion initiatives; Fostering organization cultures and their principles among management, leaders and staffs.	

Week 3	Leadership styles, leadership theories, traits of a good leader, conflicts negotiation, engineer as a leader	
Week 4	Manpower control, motivation and theories, group dynamics, and participative management	**Class Test, Final Exam**
Week 5	Management functions, types and roles and responsibilities, management skills, management approaches.	
Week 6	Organizational planning, organizational development models, theory and structure, span of control, authority delegation	
Week 7	Process of Human Resource Planning, performance management and appraisal.	**Mid Term**
Week 8	Production planning and control (PPC) functions	
Week 9	Marketing concepts & organization, strategy, industrial and consumer selling, sales promotion	
Week 10	Channel & advertising decisions, new product strategy, patent laws.	
Week 11	Management information system (MIS), technology life cycle, technology management	**Class Test, Final Exam**
Week 12	Management of innovation and changes, enterprise resource planning (ERP).	
Week 13	Case Studies: Solving real-world management problems. .	
Week 14	Revision class	

ASSESSMENT STRATEGY

Assessment strategies			CO	Bloom's Taxonomy
Components		Grading		
Continuous Assessment (40%)	Class test 1-2	20%	CO 1	C1-C2, P1
			CO 2	C1-C2
	Class Participation and Class attendance	5+5= 10%	CO 1	C1-C2, P1, A1
			CO 2	C1-2, P1-P2, A1
	Mid Term	10%	CO 1	C1-C2, P1, A1
			CO 2	C1-C2, P1-P2, A1-A2
			CO 3	C1-C2, P1-P2, A1-A2
Final Exam		60%	CO 1	C1-C2, P1, A1
			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

Ser	Old Courses (2020-2023)				New Courses (2023-2025)			
	Course Code	**Course Name**	**Cr Hr**	**Ct Hr**	**Course Code**	**Course Name**	**Cr Hr**	**Ct Hr**
1.	ENG 102	Communicative English - I	1.50	3.00	LANG 102	Communicative English-I	1.50	3.00
2.	RUS 172	Introduction to Russian Language - I	0.75	1.50	LANG 172	Introduction to Russian Language - I	0.75	1.50
3.	RUS 174	Introduction to Russian Language - II	0.75	1.50	LANG 174	Introduction to Russian Language - II	0.75	1.50
4.	Gen 377	Engineering Ethics and Morale Philosophy	2.00	2.00	GEEM 351	Engineering Ethics and Moral Philosophy	2.00	2.00
5.	Phy 101	Physics - I	3.00	3.00	PHY 137	Waves and Oscillations, Structure of Matter and Quantum Mechanics	3.0	3.0
6.	Phy 102	Physics- I Sessional	1.50	3.00	PHY 138	Physics Sessional	1.5	3.0
7.	Chem 101	Chemistry - I	3.00	3.00	CHEM 101	Fundamentals of Chemistry	3.0	3.0
8.	Chem 102	Chemistry Sessional - I	1.50	3.00	CHEM 102	Fundamentals of Chemistry Sessional	1.5	3.0
9.	Math 101	Differential and Integral Calculus	3.00	3.00	MATH 101	Differential and Integral Calculus	3.0	3.0
10.	Math 103	Differential Equations and Matrix	3.00	3.00	MATH 103	Differential Equations and Matrix	3.0	3.0
11.	Math 201	Vector Analysis, Laplace Transform and Coordinate Geometry	3.00	3.00	MATH 201	Vector Analysis, Laplace Transform and Coordinate Geometry	3.0	3.0
12.	EECE 119	Fundamentals of Electrical Engineering	3.00	3.00	EECE 119	Fundamentals of Electrical Circuit Analysis	3.0	3.0
13.	EECE 120	Fundamentals of Electrical Engineering Sessional	0.75	1.50	EECE 120	Fundamentals of Electrical Circuit Analysis Sessional	0.75	1.5
14.	ME 180	Basic Engineering Drawing	1.50	3.00	ME 180	Basic Engineering Drawing	1.5	3.0

15.	ME 253	Engineering Mechanics	3.00	3.00	ME 253	Engineering Mechanics	3.0	3.0
16.	ME 254	Engineering Mechanics Sessional	0.75	1.50	ME 254	Engineering Mechanics Sessional	0.75	1.5

17.	CSE 121	Introduction to Computer Science and Programming Language	3.00	3.00	CSE 121	Introduction to Computer Science and Programming Language	3.0	3.0
18.	CSE 122	Computer Science & Programming Language Sessional	0.75	1.50	CSE 122	Introduction to Computer Science and Programming Language Sessional	0.75	1.5
19.	NE 101	Introduction to Nuclear Engineering	3.00	3.00	NE 101	Introduction to Nuclear Engineering	3.0	3.0
20.	NE 105	Fundamental of Atomic an d Nuclear Physics	3.00	3.00	NE 105	Fundamentals of Atomic and Nuclear Physics	3.0	3.0
21.	NE 141	Fundamental of Thermodynamics	3.00	3.00	NE 141	Fundamentals of Thermodynamics	3.0	3.0
22.	NE 207	Reactor Theory and Analysis - I	3.00	3.00	NE 207	Reactor Theory and Analysis-I	3.0	3.0
23.	NE 244	Fundamentals of Heat Transfer and Thermal Engineering Sessional	1.50	3.00	NE 244	Fundamentals of Heat Transfer and Thermal Engineering Sessional	1.5	3.0
24.	NE 203	Introduction to Nuclear and Radio Chemistry	3.00	3.00	NE 203	Introduction to Nuclear and Radio Chemistry	3.0	3.0
25.	NE 204	Introduction to Nuclear and Radio Chemistry Sessional	0.75	1.50	NE 204	Introduction to Nuclear and Radio Chemistry Sessional	0.75	1.5
26.	NE 261	Numerical Methods in Nuclear Engineering Analysis	3.00	3.00	NE 261	Numerical Methods in Nuclear Engineering Analysis	3.0	3.0
27.	NE 262	Numerical Methods in Nuclear Engineering Sessional	1.50	3.00	NE 262	Numerical Methods in Nuclear Engineering Analysis Sessional	1.5	3.0
28.	NE 251	Nuclear Materials	3.00	3.00	NE 251	Nuclear Materials	3.0	3.0
29.	NE 252	Nuclear Materials Sessional	1.50	3.00	NE 252	Nuclear Materials Sessional	1.5	3.0
30.	NE 301	Radiation Detection and Measurement	3.00	3.00	NE 301	Radiation Detection and Measurement	3.0	3.0

31.	NE 302	Radiation Detection and Measurement Sessional	0.75	1.50	NE 302	Radiation Detection and Measurement Sessional	0.75	1.5
32.	NE 305	Nuclear Reactor Thermal Hydraulics	3.00	3.00	NE 355	Nuclear Reactor Thermal Hydraulics	3.0	3.0

33.	NE 306	Nuclear Reactor Thermal Hydraulics Sessional	1.50	3.00	NE 356	Nuclear Reactor Thermal Hydraulics Sessional	1.5	3.0
34.	NE 409	Nuclear Fuel Cycle and Radioactive Waste Management	3.00	3.00	NE 409	Nuclear Fuel Cycle and Radioactive Waste Management	3.0	3.0
35.	NE 333	Reactor Instrumentation and Control	3.00	3.00	NE 333	Reactor Instrumentation and Control	3.0	3.0
36.	NE 351	Fluid Mechanics and Machinery	3.00	3.00	NE 305	Fluid Mechanics and Machinery	3.0	3.0
37.	NE 352	Fluid Mechanics and Machinery Sessional	0.75	1.50	NE 306	Fluid Mechanics and Machinery Sessional	0.75	1.5
38.	NE 321	Reactor Operation and Safety	3.00	3.00	NE 321	Reactor Operation and Safety	3.0	3.0
39.	NE 317	Nuclear Security and Safeguard Engineering	3.00	3.00	NE 317	Nuclear Security and Safeguard Engineering	3.0	3.0
40.	NE 353	Mechanics of Materials	3.00	3.00	NE 353	Mechanics of Materials	3.0	3.0
41.	NE 354	Mechanics of Materials Sessional	0.75	1.50	NE 354	Mechanics of Materials Sessional	0.75	1.5
42.	NE 331	Automation, Robotics and Linear Control Systems	3.00	3.00	NE 331	Automation and Control Engineering	3.0	3.0
43.	NE 307	Reactor Theory and Analysis - II	3.00	3.00	NE 307	Reactor Theory and Analysis - II	3.0	3.0
44.	NE 320	Industrial Training	1.00	0.00	NE 320	Industrial Training	1.5	0.00
45.	NE 427	Nuclear Power Plant Engineering	3.00	3.00	NE 427	Nuclear Power Plant Engineering	3.0	3.0
46.	NE 400	Final Year Design and Research Project	6.00	12.00	NE 400	Final Year Design and Research Project	6.0	12.0
47.	NE 417	Nuclear Accidents Analysis and Radiological Emergency	3.00	3.00	NE 417	Nuclear Accidents Analysis and Radiological Emergency	3.0	3.0

48.	NE 431	Power System Engineering and Grid Interface with Nuclear Power Plants	3.00	3.00	NE 431	Power System Engineering and Interface of Nuclear Power Plant with Grid System	3.0	3.0
49.	NE 459	Computational Fluid Dynamics (CFD)	3.00	3.00	NE 459	Computational Fluid Dynamics (CFD)	3.0	3.0
50.	NE 433	Fundamentals of Fusion Engineering	3.00	3.00	NE 433	Fundamentals of Fusion Engineering	3.0	3.0
51.	NE 413	Medical Applications of Nuclear Technology	3.00	3.00	NE 413	Medical Applications of Nuclear Technology	3.0	3.0
52.	NE 405	Nuclear Chemical Engineering and Corrosion	3.00	3.00	NE 405	Nuclear Chemical Engineering and Corrosion	3.0	3.0
53.	NE 407	Non-Destructive Testing and Evaluation	3.00	3.00	NE 407	Non-Destructive Testing and Evaluation	3.0	3.0