MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

SYLLABUS
FOR THE DEGREE OF B. Sc. IN
NUCLEAR SCIENCE AND ENGINEERING

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(Changed / Modified on April 2018)

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

SUB-COMMITTEE FOR SYLLABUS OF NSE DEPARTMENT

The proposed syllabus of the Department of Nuclear Science and Engineering (NSE) of Military Institute Science and Technology (MIST) has been reviewed by the sub-committee as mentioned under. The review syllabus is recommended for implementation from academic year 2017-2018 to 2019-2020.

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CHAPTER 1
GENERAL INFORMATION

1.1 Introduction

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 31 January 1999**.** Bachelor courses on Electrical, Electronic & Communication Engineering and Mechanical Engineering started its journey on 08 February 2003. Bachelor of Science program on Aeronautical Engineering (AE) has started from Feb 2009. Department of Naval Architecture & Marine Engineering (NAME) has been commenced on February 2013. 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). From 2016, two more departments, Industrial Production and Engineering and Petroleum Mining Engineering have started their journey to fulfill the motto of MIST.

1.2 Aim

The aim of MIST is to conduct undergraduate and post graduate courses in various disciplines of Engineering according to syllabi leading to Bachelor of Science in Engineering (B. Sc. Engineering) Masters of Science in Engineering (MSc Engineering) M.Phil. and Ph.D. Programs to be conferred by the Bangladesh University of Professionals (BUP) for officers of the armed forces and civil students from home and abroad.

1.3 Objectives

The objectives of MIST are to offer the following courses with a view to meeting the increasing demand in the Armed Forces as well as in the country:

- To conduct under-graduate programs leading to B.Sc. Engineering Degree in the Armed Forces as well as in the country.

    - Civil Engineering (CE)
    - Computer Science and Engineering (CSE)
    - Electrical, Electronic and Communication Engineering (EECE)
    - Mechanical Engineering (ME)
    - Aeronautical Engineering (AE)
    - Naval Architecture & Marine Engineering (NAME)
    - Bio- Medical Engineering (BME)
    - Nuclear Science and Engineering (NSE)
    - Environmental Water Resources and Coastal Engineering (EWCE)
    - Industrial and Production Engineering (IPE)
    - Petroleum & Mining Engineering (PME)
    - Architecture

- To conduct post graduate programs like M.Sc Engg. M Engg and Ph.D in different disciplines.
- To produce well disciplined self-motivated, dedicated and skilled engineers, computer professionals and business administration experts.
- To conduct diploma and certificate courses in different departments.
- To conduct professional advanced courses.
- To make provisions for research and development and dissemination of knowledge in appropriate fields of science and technology.

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 Defence College (NDC) and Defense Services Command and Staff College (DSCSC) and Bangladesh University of Professionals (BUP) - three international standard education centers.

1.5 Eligibility of Students for Admission in MIST

The students must fulfil the following requirements:

- **For Bangladeshi Students**

Minimum qualifications to take part in the admission test are as follows:

- Applicants must have passed SSC/Dhakhil/equivalent examination from Board of Intermediate and Secondary Education/ Madrasa Education Board/ Technical Education Board in Science group with minimum GPA 4.00 in a 5-point scale.

- Applicants must have passed HSC/Alim/equivalent examination from Board of Intermediate and Secondary Education/ Madrasa Education Board/ Technical Education Board in Science group with minimum GPA 4.00 in a 5-point scale.

- In HSC/Alim/equivalent examination the applicant must have obtained minimum 'A' grade in any two (02) subjects out of four (04) subjects including Mathematics, Physics, Chemistry & English and minimum 'A-' (A minus) grade in rest two (02) subjects.

- Applicants with GCE 'O' Level/equivalent background must have to qualify in minimum five (05) subjects including Mathematics, Physics, Chemistry and English with minimum 'B' grade in average.

- Applicants with GCE 'A' Level/equivalent background must have to qualify in minimum three (03) subjects including Mathematics, Physics and Chemistry with minimum 'B' grades separately.

- Applicants who have passed HSC or equivalent examination in the current year or one year before the notification for admission can apply.

- Sex: Male and Female.

- **For Foreign Students**

Foreign student may also be admitted. Vacancies are offered to foreign through Armed Forces Division (AFD), Prime Minister's Office of the Government of the People's Republic of Bangladesh. The candidates must fulfill the following requirements:

- Equivalent qualifications as that of Bangladeshi Students.

- Sex - Male and Female.

- Must have security clearance from respective Embassy/ High Commission in Bangladesh.

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

1.6 Admission Procedure

1.6.1 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. Admission test will be conducted in Bengali and English of 200 marks (03 hours duration). The distribution of marks is given below:

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

1.6.2 Final Selection

Students will be selected on the basis of results of the written admission test-75%, GPA of SSC/equivalent examination without 4th subject-10% and GPA of HSC/equivalent examination without 4th subject-15%. Individual choice for selection of departments will be given preference as far as possible. 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.

1.6.3 Medical Checkup

Civil candidates selected through admission test will go for medical checkup in MIST/CMH. 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.

1.7 Students Withdrawal Policy

1.7.1 For Poor Academic Performance

The under graduate (BSc) Engineering programs, in the disciplines of CE, EECE, ME, CSE and AE are planned for 04 regular levels, comprising of 08 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:

- Students failing in maximum two courses/subjects in any level, each comprising of two regular terms will be allowed to appear in the referred/re-examination on failed course(s)/subject(s) after a short term as per academic schedule.
- Referred/re-examination, after a short term is to be conducted within 02 (two) weeks of commencement of the next academic session at the latest.
- Students failing in maximum one course/subject in the referred/re-examination will be promoted to the next higher level. The failed course/subject will be termed as “Backlog” subject and the students have to pass the “Backlog” subject in the next scheduled referred/re-examination, but without any short term. Otherwise, he/she will be withdrawn permanently from the course/program.
- No student will be allowed to appear in the referred/re-examination in the same subject more than twice in the whole undergraduate program.
- Students in all levels will be allowed to appear in the referred/re-examination on two courses/subjects including the “Backlog” one.
- Students will be promoted to the second term of each level irrespective of their results in the first term of the level.
- Students failing in three or more courses/subjects in any level, comprising of two regular terms, will be allowed to repeat the level once. Students repeating a level will be granted exemption for that/those subject(s) in which they earned “B+” and above grade in the previous academic year. For a military student, repeating a level will be subject to the approval of the respective Services Headquarters.
- Students will be allowed to repeat a particular level only once in the whole undergraduate program.
- After level-4 referred/re-examination, if any military student fails in maximum one course/subject, but not the “Backlog” subject, then he/she will leave MIST and will be allowed to appear in the next scheduled referred/re-examination of the respective course. In that examination if he/she cannot pass the course/subject, or if he/she does not appear in the referred examination within 06 (six) years of registration

will lose the scope of completing graduation. This failure will also be recorded in the dossier of military student officers.

- 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 from the date of his/her registration.

- Whatever may be the cases, students have to complete the whole undergraduate program within 06 (six) academic years from the date of registration.

- Failure to secure/achieve minimum CGPA of 2.20 in two consecutive levels will also lead to withdrawal of the student from the program.

1.7.2 Expulsion / Withdrawal on Disciplinary Ground

1.7.2.1 Unfair Means

Adoption of unfair means may result in expulsion of a student from the program and so from the Institution. The Academic Council will authorize such expulsion on the basis of recommendation of 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:

- Communication with fellow students for obtaining help in the examination.
- Copying from another student's script/report/paper.
- Copying from desk or palm of a hand or from other incrimination documents.
- Possession of any incriminating document whether used or not.

1.7.2.2 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.

1.7.2.3 Other Indiscipline Behavior

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/program or is considered detrimental to MIST' s image.

1.7.2.4 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.

1.7.3 Withdrawal on Own Accord

A student who has already completed some courses and has not performed satisfactorily may apply for a permanent withdrawal. A student, if he/she applies, may be allowed to withdraw temporarily from the program, subject to the approval of Academic Council of MIST, but he/she has to complete the whole program within 06 (six) academic years from the date of his/her registration.

CHAPTER 2
THE DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING

2.1 Introduction

The Department of Nuclear Science and Engineering provides (NSE) education for students interested in developing the peaceful applications of nuclear science and 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 science and 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.

2.1.1 Aim

To buildup professionals in the following fields of NSE:

- Reactor Simulation, Control and Instrumentation
- Safety and Waste Management
- Reactor Design and Fuel Management
- Application of Nuclear Engineering

2.1.2 Applications of Nuclear Science and Engineering

New technological breakthroughs and increasing societal needs have enlarged the role of nuclear engineering in society. Probably the most familiar nuclear engineering application is the production of electricity by means of nuclear power. Over 20% of electricity in the USA is derived from nuclear power. Concerns about greenhouse warming have led to a resurgence of interest in the design of advanced nuclear reactors which, as is true of all nuclear reactors, release no greenhouse gasses. In the country, governments are working on meeting the energy crisis by increasing the electricity production, 10% of that energy may be from nuclear power.

Nuclear engineers also play a vital role in the national security of the country. These activities include the development of advanced reactors for our naval fleet, and new diagnostics for monitoring stockpile reduction activities, as well as the disposition of long-lived fissile materials and non-fissile nuclear waste from commercial nuclear power plants. Another major area of nuclear engineering energy research is controlled thermonuclear fusion. The promise of electricity generation by the fusion process remains spectacular: unlimited fuel easily accessible to all, and power plants that are virtually pollution free with very low radioactivity.

Often unanticipated are the non-energy applications of nuclear engineering. For example, the area of radiation science and technology is currently experiencing substantial growth, particularly the sub-area of bio nuclear science and technology. This sub-area focuses on medical applications of nuclear technology, and includes the use of radiation for diagnostics (e.g., imaging), therapy (e.g., boron neutron capture synovectomy for rheumatoid arthritis), and the development of accelerator-based technology for the production of hard-to-obtain medical isotopes.

Finally, nuclear engineers make important contributions to materials science and industrial material processing. One important application is the development and associated scientific research of neutron beam diagnostics, allowing for the first time an understanding of materials behavior on the mesoscopic length scale (i.e., hundreds of molecular diameters). Another industrial application involves the increasing use of plasma processing for the semiconductor industry. Our understanding of plasma behavior, which has fostered these new applications, derives largely from years of fusion science research.

2.2 Laboratory Facilities of the Department

The department endeavors to provide its faculty members and students adequate laboratory, library and other facilities, departmental undergraduate courses are laboratory intensive and these requirements are catered for by following laboratories:

1. Health Physics & Radiation Detection Lab
2. Nuclear Chemistry Lab
3. Nuclear Reactor & Control System Design Lab

4. Nuclear Material & NDT Lab
5. Thermo Fluid Dynamics Lab
6. Modeling and Simulation Lab
7. Nuclear Fuel Safety and Security Lab
8. Nuclear Waste Safety Lab

Students in Level - 1 (fresher) and Level - 2 (sophomore) have to undertake laboratory courses (sessionals) in Physics, Chemistry, Workshop, Mechanical Engineering, Electrical Engineering and Civil Engineering too. If necessary undergraduate students can have the access to the facilities of other departments and centers like BUET, Dhaka University, Bangladesh Atomic Energy Commission (BAEC) during their project, thesis and research works.

CHAPTER 3
RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAM

3.1 Number of Terms in a Year (Level)

There will be two regular terms (Term I and Term II) in an academic year. Those who will not be able to clear all the subjects, will require to appear in the re-examination after a short term of about 6 weeks and fulfilling the other conditions as per examination policy.

3.2 Duration of Terms

The duration of each of Term will be as follows:

Events	**Durations**			**Remarks**
	Academic	Others	Total	
Classes	7 weeks			
Mid Term vacation		1 week		
Classes (7 weeks min), Makeup Class and Preparatory leave	9 Weeks			
Term Final Examination	2 weeks			May change
Term End Vacation		2 weeks		May change
Total	18 weeks	3 weeks	**21 weeks**	

The duration for short term and re examination will be as follows:

Short term/ Preparatory Leave	* 6 weeks	* Duration may vary depending on the situation.
Examination	1 weeks	
Total	**7 Weeks**	

3.3 Course Pattern and Credit Structure

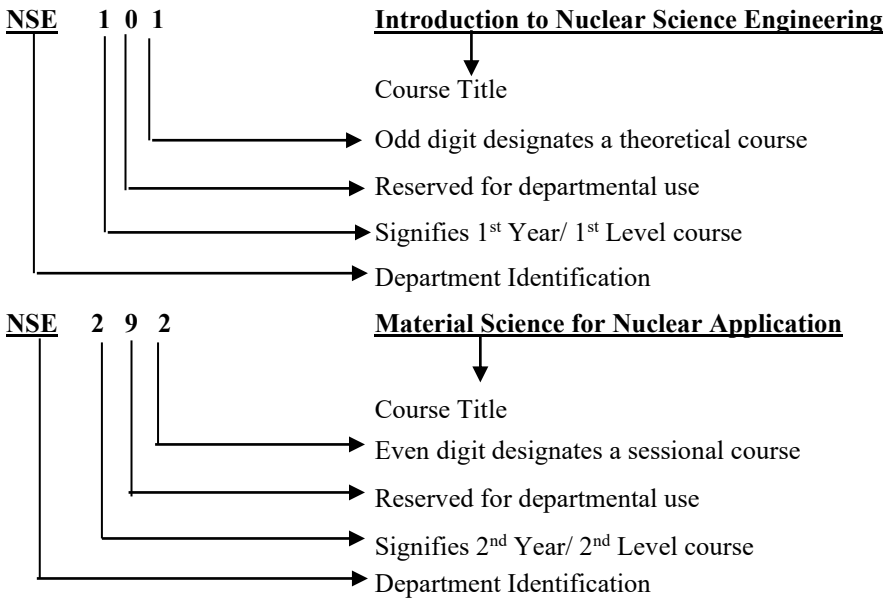
The undergraduate program is covered by a set of theoretical courses along with a set of laboratory courses (Sessionals) to support them.

3.3.1 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:

- The first 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
- The last digit is an odd number for theoretical courses and an even number for laboratory courses.
- The course designation system is illustrated as follows:

For Example,



3.3.2 Assignment of Credits

The assignment of credits to theoretical course is different from that of laboratory course, which is stated as follows:

- For theoretical courses one-hour lecture per week per term is equivalent to one credit.
- For laboratory courses two hours sessional per week per term is equivalent to one credit.
- Credits are also assigned to project work taken by the students. The amount of credits assigned to such works may vary from one discipline to another.

3.3.3 Types of Courses

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

- **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.

- **Prerequisite Courses**

Some of the core courses are identified as prerequisite courses for a specific subject. A prerequisite course is one, which is required to be completed before some other course(s) can be taken.

- **Elective Courses**

Apart from the core courses, the students can choose from a set of Elective courses. A required number of Elective courses from a specified group have to be chosen.

3.4 The Grading System

3.4.1 The Letter Grade

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 evaluation, class participation, homework assignment and a term final examination. The assessment in laboratory courses is made by evaluating performance of the students at work during the class, viva-voce during laboratory hours and quizzes. Each course has a certain number of credits, which describes its corresponding weightages. A letter grade with a specified number of grade points is awarded in each course for which a student is registered. 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 awarded in accordance to the provisions shown below:

Numerical Marks	**Letter Grade**	**Grade Points**
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
< 40%	F*	0.00
-	I	Incomplete
-	W	With down
-	X	Project/Thesis continuation

* Subject in which the student gets F grades shall not be counted towards credit hours requirements and for the calculation of Grade Point Average (GPA)

3.4.2 Distribution of Marks (For Theoretical course only)

Thirty percent (30%) of marks of a theoretical course shall be allotted for continuous assessment, i.e. quizzes, home assignments, class evaluation and class participation. The rest of the marks will be allotted to the Term Final Examination that is conducted centrally by the Dhaka University. There are internal and external examiners for each course in the Term Final Examination of
3-hour duration. Distribution of marks for a given course is as follows:

Class Participation/Observation	5%
Class Attendance	5%
Homework assignment and quizzes	20%
Final Examination (3 hours)	70%
Total	**100%**

Basis for awarding marks for attendance will be as follows:

Attendance	Marks
90% and above	100%
85% to less than 90%	90%
80% to less than 85%	80%
75% to less than 80%	70%
70% to less than 75%	60%
65% to less than 70%	50%
60% to less than 65%	40%
Below 60%	00%

The number of quizzes of a course shall be at least n+1 where n is the number of credits of the course. Evaluation of performance in quizzes will be on the basis of the best n quizzes. The scheme of continuous assessment that a particular teacher wishes to follow for a course will be announced on the first day of classes.

3.4.3 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

$$GPA = \frac{\sum_{i=1}^{n} C_i * G_i}{\sum_{i=1}^{n} C_i}$$

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

$$CGPA = \frac{\sum_{i=1}^{n} TC_i * GPA_i}{\sum_{i=1}^{n} TC_i}$$

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

Course	Credits, C_i	Grade	Grade Points, G_i	C_I*G_i
PHY 151	3	A-	3.50	10.5
MATH 191	3	A	3.75	11.25
CHEM 171	3	B+	3.25	9.75
NSE101	3	A+	4	12
EECE 119	3	B	3	9
CHEM 172	1.5	A	3.75	5.625
PHY 152	1.5	A-	3.50	5.25
EECE 120	0.75	B	3	2.25
SHOP 114	1.5	A+	4	6
Total	**20.50**			71.625

GPA = 71.625/20.50 = 3.49

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

Level	Term	Credit Hours Earned, TC_I	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

3.4.4 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 GPA requirement for obtaining a Bachelor's degree in engineering and other discipline is 2.20.

3.5 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 for any reason 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).

CHAPTER 4
COURSE REQUIREMENT FOR THE UNDERGRADUATE STUDY OF NUCLEAR SCIENCE AND ENGINEERING

4.1 Introduction

The list of courses offered to the Undergraduate students of Nuclear Science and Engineering (NSE) is categorized into Core courses and Elective courses. Some of the core courses are offered by the Department of NSE and some of these are offered by other departments. Students have the flexibility to choose from amongst the Elective courses.

4.2 Core Courses

The students have to complete all the core courses enlisted below.

4.2.1 List of Course offered by NSE Department to NSE Students (Core Courses)

Ser	Course Code	Course Title	Level-Term	Contact Hr	Credit Hr
1.	NSE 101	Introduction to Nuclear Science and Engineering	1-I	3	3.0
2.	NSE 153	Fundamental of Nuclear Physics	1-II	3	3.0
3.	NSE 201	Neutron Transport and Rector Physics	2-1	3	3.0
4.	NSE 241	Introduction to Thermal Engineering	2-I	3	3.0
5.	NSE 273	Introduction to Nuclear and Radio Chemistry	2-I	3	3.0
6.	NSE 274	Nuclear and Radio Chemistry Lab	2-I	1.5	0.75
7.	NSE 242	Thermal Engineering Sessional	2-I	1.5	0.75
8.	NSE 261	Numerical Methods in Nuclear Engineering Analysis	2-II	3	3.0
9.	NSE 262	Modeling and Simulation Sessional	2-II	3	1.5
10.	NSE 281	Nuclear Materials	2-II	3	3.0
11.	NSE 282	Nuclear Materials Sessional	2-II	3	1.5
12.	NSE 301	Radiation Detection and Measurement	3-I	3	3.0
13.	NSE 302	Radiation Detection and Measurement Sessional	3-I	1.5	0.75
14.	NSE 305	Nuclear Reactor Thermal Hydraulics	3-I	3	3.0
15.	NSE 306	Nuclear Reactor Thermal Hydraulics Sessional	3-I	3	1.5
16.	NSE 309	Nuclear Fuel Cycle and Radioactive Waste Management	3-I	3	3.0
17.	NSE 313	Reactor Instrumentation and Control	3-I	3	3.0
18.	NSE 320	Industrial Training	3-II	4 Weeks	1.0
19.	NSE 325	Fluid Mechanics and Machinery	3-II	3	3.0
20.	NSE 326	Fluid Mechanics and Machinery Sessional	3-II	1.5	0.75
21.	NSE 329	Reactor Operation and Safety	3-II	3	3.0
22.	NSE 357	Nuclear Security and Safeguard Engineering	3-II	3	3.0
23.	NSE 375	Automation, Robotics and Control	3-II	3	3.0
24.	NSE 384	Project	3-II	3	1.5
25.	NSE 391	Engineering Ethics	3-II	2	2.0
26.	NSE 393	Reactor Theory and Analysis	3-II	3	3.0

27.	NSE 403	Nuclear Power Plant Engineering	4-I	3	3.0
28.	NSE 453	Radiation Protection and Environmental Monitoring of NPPs	4-I	3	3.0
29.	NSE 419	Nuclear Reactor Design and Features I	4-I	3	3.0
30.	NSE 420	Nuclear Reactor Laboratory Sessional	4-I	3	1.5
31.	NSE 431	Power Generation and Grid Stability	4-I	3	3.0
32.	NSE 400	Thesis	4-I	6	3.00
33.	NSE 429	Nuclear Reactor Design and Features II	4-II	3	3.0
34.	NSE 437	Nuclear Accidents Analysis and Radiological Emergency	4-II	3	3.0
35.	NSE 475	In-core Fuel Management	4-II	3	3.0
36.	NSE 481	Radiation Interactions and Shielding	4-II	2	2.00
37.	NSE 400	Thesis	4-II	6	3.00

4.2.2 List of Courses offered by other departments to NSE Students

38.	EECE 119	Fundamental of Electrical Engineering	1-I	3	3.0
39.	EECE 120	Fundamental of Electrical Engineering Sessional	1-I	1.5	0.75
40.	MATH 191	Differential and Integral Calculus	1-I	3	3.0
41.	ME 153	Basic Engineering Thermodynamics	1-I	3	3.0
42.	PHY 151	Structure of Matter, Modern Physics and Wave Mechanics	1-I	3	3.0
43.	PHY 152	Physics Sessional	1-I	3	1.5
44.	SHOP 114	Foundry, Welding and Machine Shop	1-I	3	1.5
45.	CHEM 171	Introduction to Chemistry	1-II	3	3.0
46.	CHEM 172	Inorganic Quantitative Analysis Sessional	1-II	3	1.5
47.	CSE 121	Introduction to Computer Science and Programming Language	1-II	3	3.0
48.	CSE 122	Computer Science & Programming Language Sessional	1-II	1.5	0.75
49.	HUM 105	English and Communication Skill	1-II	3	3.0
50.	HUM 106	English and Communication Skill Sessional	1-II	3	1.5
51.	MATH 193	Differential Equations (ODE & PDE)	1-II	3	3.0
52.	ME 180	Basic Engineering Drawing	1-II	3	1.5
53.	EECE 219	Electronics, Signals and Measurement	2-I	3	3.0
54.	EECE 220	Electronics, Signals and Measurement Sessional	2-I	3	1.5
55.	HUM 252	Introduction to Russian Language-I	2-I	1.5	0.75
56.	HUM 262	Introduction to German Language-I	2-I	1.5	0.75
57.	HUM 272	Introduction to Japanese Language-I	2-I	1.5	0.75
58.	MATH 291	Vector Analysis, Matrices and Coordinate Geometry	2-I	3	3.0
59.	HUM 207	Principle of Accounting	2-II	3	3.0
60.	HUM 254	Introduction to Russian Language-II	2-II	1.5	0.75
61.	HUM 264	Introduction to German Language-II	2-II	1.5	0.75

62.	HUM 274	Introduction to Japanese Language-II	2-II	1.5	0.75
63.	MATH 293	Fourier Analysis, Harmonic functions, Laplace Transform and Complex variable	2-II	4	4.0
64.	ME 253	Engineering Mechanics	2-II	3	3.0
65.	ME 254	Engineering Mechanics Sessional	2-II	1.5	0.75
66.	HUM 307	Engineering Economics	3-I	2	2.0
67.	ME 373	Mechanics of Materials	3-I	3	3.0
68.	ME 374	Mechanics of Materials Sessional	3-I	1.5	0.75
69.	ME 497	Industrial Management	4-I	3	3.0

4.2.3 List of Courses Offered by NSE Department to NSE Students (Elective Courses)

Ser	Course Code	Course Name	Level-Term	Contact Hours	Credit Hours
1.	NSE 405	Nuclear Chemical Engineering and Corrosion	4-I or 4-II	3.0	3.00
2.	NSE 407	Non-Destructive Testing and Evaluation	4-I or 4-II	3.0	3.00
3.	NSE 411	Nuclear Act, Regulations and Procedures	4-I or 4-II	3.0	3.00
4.	NSE 413	Medical Applications of Nuclear Technology	4-I or 4-II	3.0	3.00
5.	NSE 421	Risk and Disaster Management	4-I or 4-II	3.0	3.00
6.	NSE 433	Fundamentals of Fusion Engineering	4-I or 4-II	3.0	3.00
7.	NSE 459	Computational Fluid Dynamics (CFD)	4-I or 4-II	3.0	3.00
8.	NSE 479	Radioactive Waste Treatment and Disposal Techniques	4-I or 4-II	3.0	3.00
9.	NSE 485	Nuclear Weapon Engineering	4-I or 4-II	3.0	3.00
10.	NSE 487	Nuclear Forensic Analysis	4-I or 4-II	3.0	3.00
11.	NSE 489	Nuclear Project Management	4-I or 4-II	3.0	3.00
12.	NSE 491	Safety Criticality Management	4-I or 4-II	3.0	3.00

4.2.4 Prerequisite Courses for NSE Students.

Course Code	Course Title	Prerequisite Course Code
NSE 261	Numerical Methods in Nuclear Engineering Analysis	CSE 121
NSE 310	Industrial Training	Completion of Level 2
NSE 400	Thesis	Completion of Level 3
NSE 403	Nuclear Power Plant Engineering	NSE 241

NOTE : Satisfactory class performance of any prerequisite subjects will fulfill its condition as prerequisite.

4.2.5 Final Year Project/Thesis

Project/thesis will have to be undertaken by students under a supervisor in partial fulfillment of the requirement of his degree. Credit allotted to the project/thesis will be 6 having 12 contact hours.

4.2.6 Term Wise Distribution of Courses for B.Sc. Engg. in Nuclear Science and Engineering (NSE) Syllabus

Level – 1, Term – I

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 101	Introduction to Nuclear Science and Engineering	3	3.0
2.	PHY 151	Structure of Matter, Modern Physics and Wave Mechanics	3	3.0
3.	MATH 191	Differential and Integral Calculus	3	3.0
4.	ME 153	Basic Engineering Thermodynamics	3	3.0
5.	EECE 119	Fundamental of Electrical Engineering	3	3.0
Theory Total			**15**	**15.0**
6.	PHY 152	Physics Sessional	3	1.5
7.	EECE 120	Fundamental of Electrical Engineering Sessional	1.5	0.75
8.	SHOP 114	Foundry, Welding and Machine Shop	3	1.5
Sessional Total			**7.5**	**3.75**
Term Total			**22.5**	**18.75**

Level – 1, Term – II

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	CSE 121	Introduction to Computer Science and Programming Language	3	3.0
2.	NSE 153	Fundamental of Nuclear Physics	3	3.0
3.	CHEM 171	Introduction to Chemistry	3	3.0
4.	MATH 193	Differential Equations (ODE & PDE)	3	3.0
5.	HUM 105	English and Communication Skill	3	3.0
Theory Total			**15.0**	**15.0**
6.	CSE 122	Computer Science & Programming Language Sessional	1.5	0.75
7.	ME 180	Basic Engineering Drawing	3	1.5
8.	CHEM 172	Inorganic Quantitative Analysis Sessional	3	1.5
9.	HUM 106	English and Communication Skill Sessional	3	1.5
Sessional Total			**10.5**	**5.25**
Term Total			**25.5**	**20.25**

Level – 2, Term – I

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 201	Neutron Transport and Reactor Physics	3	3.0
2.	NSE 241	Introduction to Thermal Engineering	3	3.0
3.	MATH 291	Vector Analysis, Matrices and Coordinate Geometry	3	3.0
4.	NSE 273	Introduction to Nuclear and Radio Chemistry	3	3.0
5.	EECE 219	Electronics, Signals and Measurement	3	3.0
Theory Total			**15.0**	**15.0**
6.	NSE 242	Thermal Engineering Sessional	1.5	0.75
7.	EECE 220	Electronics, Signals and Measurement Sessional	3	1.5
8.	NSE 274	Nuclear and Radio Chemistry Lab	1.5	0.75
9.	Hum[1]	Select from the Prescribed Courses	1.5	0.75
Sessional Total			**7.5**	**3.75**
Term Total			**22.5**	**18.75**

[1] Students can choose from a number of humanities courses as follows, offered by Humanities Dept:
HUM 252: Introduction to Russian Language-I
HUM 262: Introduction to German Language-I
HUM 272: Introduction to Japanese Language-I

Level – 2, Term – II

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 261	Numerical Methods in Nuclear Engineering Analysis	3	3.0
2.	NSE 281	Nuclear Materials	3	3.0
3.	ME 253	Engineering Mechanics	3	3.0
4.	MATH 293	Fourier Analysis, Harmonic functions, Laplace Transform and Complex variable	4	4.0
5.	HUM 207	Principle of Accounting	3	3.0
Theory Total			**16.0**	**16.0**
6.	NSE 262	Modeling and Simulation Sessional	3	1.5
7.	NSE 282	Nuclear Materials Sessional	3	1.5
8.	ME 254	Engineering Mechanics Sessional	1.5	0.75
9.	Hum[2]	Select from the Prescribed Courses	1.5	0.75
Sessional Total			**9.0**	**4.5**
Term Total			**25.0**	**20.5**

[2]Students can choose from a number of humanities courses as follows, offered by Humanities Dept:

HUM 254: Introduction to Russian Language-II
HUM 264: Introduction to German Language-II
HUM 274: Introduction to Japanese Language-II

Level – 3, Term – I

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 301	Radiation Detection and Measurement	3	3.0
2.	NSE 305	Nuclear Reactor Thermal Hydraulics	3	3.0
3.	NSE 309	Nuclear Fuel Cycle and Radioactive Waste Management	3	3.0
4.	NSE 313	Reactor Instrumentation and Control	3	3.0
5.	ME 373	Mechanics of Materials	3	3.0
6.	HUM 307	Engineering Economics	2	2.0
Theory Total			**17.0**	**17.0**
7.	NSE 302	Radiation Detection and Measurement Sessional	1.5	0.75
8.	NSE 306	Nuclear Reactor Thermal Hydraulics Sessional	3	1.5
9.	ME 374	Mechanics of Materials Sessional	1.5	0.75
Sessional Total			**6**	**3.0**
Term Total			**23.0**	**20.0**

Level – 3, Term – II

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 325	Fluid Mechanics and Machinery	3	3.0
2.	NSE 329	Reactor Operation and Safety	3	3.0
3.	NSE 357	Nuclear Security and Safeguard Engineering	3	3.0
4.	NSE 375	Automation, Robotics and Control	3	3.0
5.	NSE 391	Engineering Ethics	2	2.0
6.	NSE 393	Reactor Theory and Analysis	3	3.0
Theory Total			**17.0**	**17.0**
7.	NSE 326	Fluid Mechanics and Machinery Sessional	1.5	0.75
8.	NSE 384	Project	3	1.5
9.	NSE 320	Industrial Training	4 Weeks	1.0
Sessional Total			**4.5+4 Weeks**	**3.25**
Term Total			**21.5+4 Weeks**	**20.25**

Level – 4, Term – I

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 403	Nuclear Power Plant Engineering	3	3.0
2.	NSE 453	Radiation Protection and Environmental Monitoring of NPPs	3	3.0
3.	-	Elective Course-1	3	3.0
4.	ME 497	Industrial Management	3	3.0
5.	NSE 419	Nuclear Reactor Design and Features I	3	3.0
6.	NSE 431	Power Generation and Grid Stability	3	3.0
Theory Total			**18.0**	**18.0**
7.	NSE 420	Nuclear Reactor Laboratory Sessional	3	1.5
8.	NSE 400	Thesis	6	0.0
Sessional Total			**9.0**	**4.5**
Term Total			**27.0**	**19.50**

Level – 4, Term – II

Ser	Course Code	Course Title	Contact Hr	Credit Hr
1.	NSE 429	Nuclear Reactor Design and Features II	3	3.0
2.	NSE 437	Nuclear Accidents Analysis and Radiological Emergency	3	3.0
3.	-	Elective Course-2	3	3.0
4.	-	Elective Course-3	3	3.0
5.	NSE 475	In-core Fuel Management	3	3.0
6.	NSE 481	Radiation Interactions and Shielding	2	2.0
7.	NSE 400	Thesis	**6**	**6.0**
Term Total			**23.0**	**23.0**

*The minimum credit hour requirement for B. Sc. Engg. (NSE) degree is 161

4.2.7 Contact Hours and Credit Hours in Eight Terms

Level-Term	Contact Hours for Theory Courses	Contact Hours for Sessional Courses	Cumulative Contact Hours	Cumulative Credit Hours
1-I	15	7.5	22.5	18.75
1-II	15	10.5	48.0	39
2-I	15	7.5	70.5	57.75
2-II	16	9	95.5	78.25
3-I	17	6	118.5	98.25
3-II	17	4.5+4wks	140.0+4wks	118.5
4-I	18	9	167.0+4wks	141.0
4-II	17	6	190.0+4wks	161.0
Total	130	60+4wks	190.0+4wks	161.0

4.2.8 Distribution of Credit Hours for Different Categories of Courses

Level-Term	Humanities Cr Hr	Math Cr Hr	Basic Science Cr Hr	Dept Engg Cr Hr	Allied Engg Cr Hr	Optional Courses Cr Hr	Total Cr Hr
1-I	-	3+0.0	3+1.5	3+0.0	6+2.25	-	18.75
1-II	3+1.5	3+0.0	3+1.5	3+0.0	3+2.25	-	20.25
2-I	0+0.75	3+0.0	0+0.00	9+1.5	3+1.5	-	18.75
2-II	3+0.75	4+0.0	-	6+3.0	3+0.75	-	20.5
3-I	2+0.0	-	-	12+2.25	3+0.75	-	20.0
3-II	-	-	-	17+3.25	-	-	20.25
4-I	-	-	-	12+4.5	3+0.0	3.0+0	22.5
4-II	-	-	-	11+3.0	-	6.0+0.0	20.0
Total	8+3.0	13+0	6+3.0	73+17.5	21+7.5	9.0+0.0	161
% of total credit	6.8%	8.07%	5.5%	56.21%	17.70%	5.5%	

****Students can take courses offered by CSE, ME and EECE Dept.

CHAPTER 5
DETAIL OUTLINE OF UNDERGRADUATE COURSES OFFERED BY NSE DEPARTMENT TO NSE STUDENTS

Nuclear Engineering is generally taught as an elective course in the curriculum of IIT Bombay. Recently several post graduate nuclear engineering programs have been initiated at many places in India. This course can become a foundation course that gives a complete overview of the various aspects involved with nuclear power reactors. A good blend of mathematical treatment and elaboration of application principles is intended to be brought out. Several problems have been formulated to illustrate the applications.

NSE 101: Introduction to Nuclear Science and Engineering
3.00 Contact Hour, 3.00 Credit Hour

Introduction to nuclear engineering, elements of nuclear power reactor system, a short review of nuclear physics, basic concepts in neutron reactions, neutron moderation and diffusion, power reactors, nuclear reactor safety and licensing.

The fission chain reaction; non-nuclear components of nuclear power plants; components of nuclear reactors; the history of radiation effects; radiation units; exposure, radiation dose and biological dose; population dose; the biological effects of radiation; natural and man-made radiation sources; fissile material, fissionable material, fertile material; ionizing and non-ionizing radiation; neutron moderation and basics; radiation shielding, alpha, beta, gamma, neutron radiation; attenuation formula, attenuation coefficient; half value layer.

Text and Reference Books

1. Lamarsh, J.R. and Baratta, A.J., "Introduction to Nuclear Engineering", 3rd Edition, Prentice Hall, 2001.
2. Glasstone, S. and Sesonske, A, "Nuclear Reactor Engineering: Reactor Design Basics", 4th Edition, Elsevier, 1996.
3. Fundamentals of Nuclear Science and Engineering Third Edition 3rd Edition, 2016 by J. Kenneth Shultis (Author), Richard E. Faw
4. Glasstone, S. and Sesonske, A, "Nuclear Reactor Engineering: Reactor System Engineering", 4th Edition, Elsevier, 1996.
5. D.C.Tayal, Nuclear Physics, Himalayan Publication house, Bombay ,1980.

NSE 153: Fundamental of Nuclear Physics
3.00 Contact Hour, 3.00 Credit Hours

The nucleus: nuclear size, packing fraction and binding energy; radioactivity: radioactive decay laws, carbon dating, half life and mean life; radioactive series: alpha, beta and gamma emission, positron emission, electron capture , internal conversion, pair production and annihilation; neutrino hypothesis, nuclear reaction: different types of reactions, nuclear fusion in stars; general properties of nucleus: nuclear density distribution, iso-spin, magnetic moments, g-factor; the deuteron : ground state of deuteron, deuteron ground state wave function, magnetic and quadrupole moments of the deuteron; neutron-proton scattering at low energies; scattering length; spin dependence of n-p scattering, effective range theory in the n-p scattering; coherent and incoherent scattering, nuclear force: central and non-central forces; exchange forces; nuclear stability conditions; symmetry and charge effects; charge independence of nuclear force; mirror nuclei and coulomb energy, nuclear reactions : reaction cross-section, direct reactions: definition and classification, the methods of direct reaction theory; analysis of stripping and pick-up reactions; magic numbers and nuclear shell model, l-s coupling scheme; j-j coupling scheme, collective model, optical model.

Text and Reference Books

1. R. R. Roy and B. P. Nigam, “Nuclear Physics: Theory and Experiment”,1996.
2. Irving Kaplan, "Nuclear Physics", Narosa Book Distributors, 2002.
3. Kenneth s. Krane, “Introductory Nuclear Physics” John Willy & Sons, 1987.
4. Meyerhoff, “Nuclear Physics”, 1967.
5. H.M. Sen Gupta, “Nucleo Padartha Bidya”

NSE 201: Neutron Transport Theory and Reactor Physics
3.00 Contact Hour, 3.00 Credit Hour

Neutron transport: Four and six-factor formula, neutron transport and diffusion theory, derivation of the neutron transport equation (NTE), fundamental properties of the NTE, neutron interactions and development of one-group neutron diffusion theory with point, plane, and fission sources, application to one-and two-region reactors, introduction to buckling, multiplication constants, critical size, neutron slowing down, and resonance capture, applications using two-group theory, methodologies of neutron flux calculations.

The chain-reacting systems, thermal nuclear reactor, the calculation of the multiplication factor for a homogenous thermal reactor, heterogeneous thermal reactor, the critical size of a thermal reactor, power and breeding, fission and fusion reaction, fission characteristics, chain reaction, fast and thermal spectrum calculations, reactor dynamics, reactivity, reactivity effects on reactor power, in-hour equation, delay neutron, doppler effect, production and transmutation of radionuclide in nuclear reactors.

Text and Reference Books

1. Duderstadt, J.J. and Hamilton, L.J., "Nuclear Reactor Analysis", John Wiley and Sons, 1976.
2. J. Duderstadt and W.R. Martin: Transport Theory.
3. G.I. Bell and S. Glasstone: Nuclear Reactor Theory.
4. M. Ash: Nuclear Reactor Kinetics.

NSE 241: Introduction to Thermal Engineering
3.00 Contact Hour, 3.00 Credit Hour

Study of fuels; sources of energy conventional and renewable, environmental pollution; laws of thermodynamics and their corollaries; stem generating units with accessories; study of steam generators and turbines. Introduction to internal combustion engines and their cycles; study of SI engines and gas turbines with their accessories.

Refrigeration and air conditioning: their applications; study of different refrigeration methods; refrigerants; psychometrics; study of air-conditioning systems with their accessories. Types of fluid machinery; study of impulse and reaction turbines: pelton wheel and kaplan turbines; study of centrifugal and axial flow machines; pumps, fans, blowers and compressors; study of reciprocating pumps.

Text and Reference Books

1. Heat Engines – D. A Low.
2. Principles of Energy Conversion – A W Culp, Publisher-Mc Graw- Hill Senes 1999.
3. A Text Book of Thermal Engineering – R. S. Khurmi & J. K. Gupta.
4. Basic Mechanical Engineering –R K Rajput, Engineering Fluid Mechanics – K. L. Kumar.
5. Refrigeration and Air conditioning – by Ahmadul Ameen.

NSE 242: Thermal Engineering Sessional
1.5 Contact Hour, 0.75 Credit Hour

Sessional based on NSE 241.

Experiment 1: Determination of Calorific Value of a Gaseous Fuel by Boy's Calorimeter
Experiment 2: Study of a Boiler
Experiment 3: Dismantling and Assembling of an SI engine
Experiment 4: Study of a Psychrometer
Experiment 5: Study of Refrigeration and Air Conditioning Unit

Text and Reference Books

1. 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

NSE 273: Introduction to Nuclear and Radio Chemistry
3.00 Contact Hour, 3.00 Credit Hour

History of nuclear and radio chemistry; definitions (atomic nucleus, isotopes etc); property of nuclear matter; mass and stability of the atomic nucleus; production of radionuclides; Activation analysis of radiochemical separation of different radioisotopes. Nature of nuclear reaction; production & separation of medical radio isotopes; Different

separation methods like solvent extraction method, ion exchange method, separation of cesium, strontium, plutonium, americium etc., isotope dilution analysis, uses of isotopes in different sector.

Text and Reference Books

1. "Nuclear Chemistry'' by Navratil, O, et al.
2. "Nuclear and Radio Chemistry" by Friendleander and Kennedy.
3. "Principle of Nuclear Chemistry'' by Williams.
4. "Nuclear Chemistry Volume I & II'' by Yaffe.
5. "Introduction to Nuclear Physics and Chemistry'' By Harvey.

NSE 274: Nuclear and Radio Chemistry Sessional
1.5 Contact Hr 0.75 Credit Hr

Introductory radiochemistry laboratory. Emphasis is on nuclear radiation detection and radiochemical techniques including activation analysis, isotope dilution, liquid scintillation counting, hot-atom chemistry, x-ray fluorescence, nuclear spectroscopy, and radiochemical separations.

Experiment 1: Calibration of a gamma spectrometer in terms of energy and activity
Experiment 2: Calibration of a silicon surface barrier detector for alpha spectrometry in terms of energy and activity
Experiment 3: Preparation of and measurements for environmental samples: air, soil, water and food stuffs
Experiment 4: Effect of shielding materials in radiation protection
Experiment 5: In-situ measurement of environmental gamma dose rate using portable HPGe detector
Experiment 6: Calibration of a silicon surface barrier detector for alpha spectrometry in terms of energy and activity
Experiment 7: Calibration of ZnS (Ag) scintillation counter for alpha and beta activity measurements

Text and 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

NSE 261: Numerical Methods in Nuclear Engineering Analysis
3.00 Contact Hour, 3.00 Credit Hour

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 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; statistical analysis of curve fitting.

Text and Reference Books

1. Applied Numerical Analysis (5th edition) – Curtis F. Gerald, Patrick O. Wheatley, Publisher-Addison-Wesley Publishing Company.
2. Numerical Methods for Engineers (4th edition) – Steven C. Chapra, Raymond P. Carale, Publisher – Tata McGraw-Hill Publishing Company Ltd.
3. NUMERICAL METHODS: Using Matlab, Fourth Edition, 2004 John H. Mathews and Kurtis D. Fink ISBN 0-13-065248-2 Prentice-Hall Pub. Inc.
4. Numerical Methods – E. Balagurusamy- Tata MacGraw Hill

NSE 262: Modeling and Simulation Sessional
3.00 Contact Hour, 1.5 Credit Hour

Numerical solution of problems in Engineering; Introduction to CAD.
Experiment 1: Introduction to MATLAB programming, input handling, conditional logic, loops, and string manipulation.
Experiment 2: Creating functions to sum arithmetic sequences, including even, odd, and squared terms.
Experiment 3: Basic 2D plotting to construct geometric logos using coordinate-based line drawing.
Experiment 4: Advanced plotting of mathematical functions with multiple layers, labels, and legends.
Experiment 5: Implementing finite difference tables for polynomial interpolation and data approximation.
Experiment 6: Applying root-finding algorithms (Newton-Raphson, Fixed-Point) with absolute error convergence.

Experiment 7: Solving linear systems using Gaussian elimination with matrix reduction and back-substitution.

Text and 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. 2. E. Balagurusamy – Numerical Methods –- 25th Reprint Edition, New Delhi, Tata MacGrawHill, 2008

NSE 281: Nuclear Materials
3.00 Contact Hour, 3.00 Credit Hour

Phase diagram-different types of material phases, diffusion, nonequilibrium cooling, homogenization, different types of mechanical test, Charpy impact test, tensile test, hardness test, structure of the metals, crystallography, crystal defects, dislocation, precipitation, segregation, cold work, fatigue, fracture mechanics, heat treatment, stress corrosion cracking, iron carbide equilibrium diagram, heat treatment of the metal, alloy steels, swelling, creep, atom and ion movement in solid, atomic bonding and material property-imperfection and atomic arrangements.

Requirements of reactor materials, fuel materials, plutonium, uranium and thorium and their alloys and compound core materials, beryllium, graphite control and shielding materials- magnesium and its alloys, aluminum and its alloys- corrosion reactor materials-mechanical properties of materials, characteristics of fission materials-density - melting point- electrical and thermal conductivity-fission cross section- coolants- cladding materials.

Text and Reference Books

1. Kopelman, Materials for nuclear reactors, McGraw Hill, 1970.
2. Kenneth Joy, Nuclear Power-Today and Tomorrow, Methven, 1961.
3. RE. Fand J.K.Shultis, Radiological Assessment, Prentice Hall, 1993.
4. Nuclear Materials Science by Karl Whittle, 2016.

NSE 282: Nuclear Materials Sessional
3.00 Contact Hour,, 1.5 Credit Hour

Sessional based on NSE 281

Experiment 1: Introduction to Metallographic and Metallographic Sample Specimen Preparation.
Experiment 2. Study of Phase Diagrams.
Experiment 3. Microstudy of steels
Experiment 4. Heat treatment of steels-1
Experiment 5. Heat treatment of steels-2
Experiment 6. Microstudy of cast irons-1
Experiment 7. Microstudy of cast irons-2

Text and Reference Books

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

NSE 301: **Radiation Detection and Measurement**
3.00 Contact Hour, 3.00 Credit Hour

Detection of nuclear radiation: (a) detection of charged particles; nuclear interaction with matter; bubble chamber; photographic emulsion, spark chamber; scintillation detectors; Cerenkov detector; p.m. Tubes; semiconductor detector; track etch detector; thermoluminescent dosimeter; (b) neutral particle detection; neutron detection; detector based on boron reaction; time of flight technique; proton recoil telescope; neutron detection by activation foils. Detector efficiencies: standardization of radioactive sources; calibration of detectors; absolute counting; source geometry; source absorption; air and window effects; source dilution; measurement of very short and very long half lives.

Radiation sources: fast electron sources, heavy charged particles sources, sources of electromagnetic radiation, and neutron sources; statistics of radiation counting: characteristics of data, statistical models, applications of statistical models, propagation of errors, optimization of counting experiments, limits of detectability, distribution of time intervals, and curve fitting; characteristics and utilization of various detectors: simplified detector model, modes of

detector operation, pulse height spectra, sensitivity, energy resolution, detection efficiency, dead time; radiation dose measurements of ionization chambers, variants of the proportional counter design, GM survey meters;

Text and 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.

NSE 302: Radiation Detection and Measurement Sessional
1.5 Contact Hour, 0.75 Credit Hour

Sessional based on NSE 301

Experiment 1: Background Radiation Measurement
Experiment 2: Search for lost point radioactive sources by using radiation survey meter or mobile gamma spectrometry
Experiment 3: Determining the linear absorption coefficient of Al & Pb using Beer's Law
Experiment 4: Evaluation of gamma ray energy and identifying unknown radioisotope
Experiment 5: Determination of the efficiency of NaI (TL) scintillation detector for different energies of gamma ray

Text and Reference Books

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

NSE 305: Nuclear Reactor Thermal Hydraulics
3.00 Contact Hour, 3.00 Credit Hour
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.

Text and Reference Books

1. Todreas, N.E. and Kazimi, M. S. Nuclear Systems I Thermal Hydraulic Fundamentals, Taylor & Francis, 1993.
2. Cengel, Y. A. and Boles, M. A. Thermodynamics, McGraw-Hill, 2006.
3. Anthony, V.N.J.; A Guide Book to Nuclear Reactors, 1979.
4. Cameron, J. R.; Nuclear Fission Reactors, Springer US, 1982.
5. Wakil, M. M. E.; Nuclear Energy Conversion, Amer Nuclear Society; Revised edition (June 1, 1982).
6. El-Wakil, M.M., Nuclear Heat Transport, International Text Book, 1971.
7. Rust, J.H., Nuclear Power Plant Engineering, Haralson, 1979.

NSE 306: Nuclear Reactor Thermal Hydraulics Sessional
3.00 Contact Hour, 1.5 Credit Hour

Sessional based on NSE 305
Experiment 1: Determination of thermal conductivity of a metal by steady state method
Experiment 2: Determination of thermal contact conductance
Experiment 3: Forced convection over a Flat Plate
Experiment 4: Forced convection heat transfer in a circular tube
Experiment 5: Study of free convection of Fin/Flat plate/Pipe Bundle
Experiment 6: Study of forced convection of Fin/Flat plate/Pipe Bundle
Experiment 7: Study of thermal radiation unit

Text and 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.

NSE 309: Nuclear Fuel Cycle and Radioactive Waste Management
3.00 Contact Hour, 3.00 Credit Hour

Nuclear Fuel Cycle
An overview of the fuel cycle, mining and milling of uranium, purification and conversion to uf_6, uranium enrichment, fuel fabrication, properties of irradiated fuel, nuclear fuel reprocessing, Separative Work Unit (SWU), analysis of SWU, recycling of uranium and plutonium, spent fuel management, disposal of nuclear waste and emerging nuclear technologies.

Radioactive Waste Management
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; decontamination of radioactive element, treatment process of gaseous, aqueous and solid wastes, conditioning process of HLW,ILW,LLW and spent fuels, treatment and conditioning processes- incineration, compaction, cementation, bituminization, calcination, vitrification, synroc and composite waste forms, glass-ceramic composites, engineered encapsulation, transportation and storage systems of nuclear waste, disposal ; different disposal techniques, shallow disposal, deep disposal, dry cask storage and spent fuel pool, policy, governance, social and political issues, environmental impact assessment.

Text and Reference Books

1. Peter. D. Wilsion, "The nuclear fuel cycle from ore to waste" oxford science publications, Oct 1996.
2. "Radioactive Waste Management"- An IAEA Source Book
3. OECD Nuclear Energy Agency "Advanced nuclear fuel cycles and radioactive waste management" 2006.
4. F. Barker "management of radioactive wastes" 1998.
5. Donald R. Wily "the chemistry of nuclear fuel waste deposal" polytechnic international press, 2002.

NSE 313: Reactor Instrumentation and Control
3.00 Contact Hour, 3.00 Credit Hour

Overview of reactor systems; out core sensors; in core sensors; sensor performance and reliability test, calibration, process instrumentation, instrumentation failure in nuclear accidents, signal conditioning, transfer function measurement systems; control rod drives and indicating systems; power supplies; installation of instrumentation systems; quality assurance and reliability; protection systems; instrumentation systems of nuclear power plants. Microprocessor, micro controller and nuclear electronics, analytical nuclear instrumentation, data acquisition and data analysis, basic principles of measurements, characteristics and behavior of typical measuring systems, measurements of temperature, flow, pressure, heat flux.

Text and Reference Books

1. Physics and Engineering of Radiation Detection, 2nd Edition, by Joseph M. Harrer
2. Experimental Methods for Engineers (6th edition) – J. P. Holman, Publisher – Mc Graw – Hill Inc.
3. Mechanical Measurements (5th edition) Thomas G. Beckwith, Roy D. Marangoni, John H. Lientard.

NSE 325: Fluid Mechanics and Machinery
3.00 Contact Hour, 3.00 Credit Hour

Fundamental concept of fluid as a continuum; fluid statics: basic hydrostatic equation, pressure variation in static incompressible and compressible fluids; manometers; forces on plane and curved surfaces; buoyant force; stability

of floating and submerged bodies; pressure distribution of a fluid in a rotating system. Relation between system approach and control volume approach; continuity, momentum and energy equations; special forms of energy and momentum equations and their applications; pressure, velocity and flow measurement devices.

Dimensional analysis and similitude; fundamental relations of compressible flow; speed of sound wave; stagnation states for the flow of and ideal gas; flow through converging-diverging nozzles; normal shock; real fluid flow; frictional losses in pipes and fittings. Types of fluid machinery; rotodynamic and positive displacement machines; velocity diagrams and Euler pump/turbine equation; impulse and reaction turbines; centrifugal and axial flow pumps; deep well turbine pumps; dimensional analysis applied to fluid machinery: specific speed, unit power, unit speed, unit discharge; performance and characteristics of turbines and pumps; design of pumps; cavitation; reciprocating pump, gear and screw pumps; fans, blowers and compressors; hydraulic transmission: fluid coupling and torque converter; system analysis and selection of fluid machine.

Text and 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, Publisher – Mc Graw-Hill companies, 8th edition, 1985.
3. Introduction to Fluid Mechanics – Robert W. Fox, T. Mcdonald, Publisher – John wiley and sons, 2003.
4. Fluid Mechanics – Frank M. White, Publisher – Mc Graw-Hill, 1979, Engineering Fluid Mechanics – K. L. Kumar.
5. Fluid Flow Machines–Govinda Rao, Publisher-TATA MC GRAW HILL, 1983.
6. Fluid Mechanics and Thermodynamics of Turbomachinery, By S. Larry Dixon, Cesare Hall, 7th Edition, 2014, Published by Elsevier Inc.

NSE 326: Fluid Mechanics and Machinery Sessional
1.5 Contact Hour, 0.75 Credit Hour

Sessional based on NSE 325
Experiment 1: Verification of Bernoulli's equation
Experiment 2: Study of flow through a Venturimeter
Experiment 3: Fluid friction in a pipe
Experiment 4: Introduction to centrifugal pump characteristics
Experiment 5: Study of propeller turbine characteristics

Text and 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.

NSE 329: Reactor Operation and Safety
3.00 Contact Hour, 3.00 Credit Hour

Safety characterization and safety features of nuclear power plants, reactor safety principles and criteria design-basis and beyond-design-basis events, accident phenomena, including severe accidents, safety systems, containment performance, deterministic safety analysis (basic elements), accident modeling simulation codes, Probabilistic safety analysis (basic elements), analysis of operation transients, accidents and severe accidents. Emergency operation procedure, accident management, safety issues and safety issue resolution, operating experience, regulation and safety culture.

Text and Reference Books

1. B. Pershagen, Light Water Reactor Safety, Pergamon Press, 1989
2. Nuclear Reactor Safety Edited by F. Farmer, 1977.
3. Nuclear Safety by Gianni Petrangeli, 2006.

NSE 357: Nuclear Security and Safeguard Engineering
3.00 Contact Hour, 3.00 Credit Hour

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.

Text and Reference Books

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

NSE 375: Automation, Robotics and Control
3.00 Contact Hour, 3.00 Credit Hour

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 control (PLC), microcontroller, relay etc.

Text and Reference Books

1. Francis H. Raven, Automatic Control, 5th Edition, McGraw Hill, 1994. ISBN: 0070513414.
2. Richard C. Dorf, Modern Control System, 11th Edition, Prentice Hall, 2007. ISBN: 0132270285.
3. D. Roy Choudhury, Modern Control Engineering, Illustrated Edition, PHI Learning Pvt. Ltd., 2005. ISBN: 9788120321960.
4. U. A. Bakshi, V. U. Bakshi, Control System Engineering, Technical Publications, 2008. ISBN: 9788184314632.
5. Craig J J, Introduction to Robotics, Mechanics and Control, Addison Wesley 1993

NSE 391: Engineering Ethics
2.00 Contact Hour, 2.00 Credit Hour

Introduction to the course: purpose, objectives, scope, methods, discussion, introduction to ethics, introduction to philosophy of engineering, introduction to engineering ethics: codes of ethics, whistle blowing, case study methodology, different case studies. Solving ethical problems: discussion of heroes, journeys, and virtue in mythology, individual, professional, and institutional values, leadership in engineering and industry, competency with good character, recap of semester so far; introduction to codes of ethics, safety; introduction to narrative ethics, ethical terminology.

Text and References Books

1. Davis, M., ed. Engineering Ethics. Burlington, VT: Ashgate Publishing Co., 2005. ISBN: 0754625249.
2. Harris, C. E., et al. Engineering Ethics. 2nd ed. Belmont, CA: Wadsworth, 1999. ISBN: 0534533973.

NSE 393: Reactor Theory and Analysis
3.00 Contact Hour, 3.00 Credit Hour

Reactor kinetics and transfer function, Propagation of a neutron beam in a passive medium. Scalar neutron flux and neutron current. The multi neutron diffusion equation. Solution of the neutron diffusion equation for passive media with an external neutron source. Reactor criticality calculations, Nodal Analysis, S_n method, D_n method, Perturbation Theory and its applications: Reactivity Worth of Partially Inserted Control Rod Elastic scattering kinematics, Fermi age calculation, and neutron migration length, criticality analysis of heterogeneous and homogeneous reactors.

Text and Reference Books

1. E.E. Lewis, Fundamentals of Nuclear Reactor Physics, Elsevier, Amsterdam, 2008.
2. A.E. Waltar et al., Fast Spectrum Reactors, Springer, New York, 2012.
3. Nuclear Reactor Analysis by Hamilton
4. Nuclear Reactor Theory by Bell and Glasstone
5. Lamarsh, J.R. and Baratta, A.J., "Introduction to Nuclear Engineering", 3rd Edition, Prentice Hall, 2001.

NSE 384: Project
3.00 Contact Hour, 1.5 Credit Hour

Miniature project design based on Nuclear Engineering knowledge.

NSE 320: Industrial Training
04 Weeks duration, 1.0 Credit Hour

This course will be conducted after the completion of Level-3, at any convenient time as can be arranged by the department. Intensive training will be conducted in particular industries prescribed by the department.

NSE 403: Nuclear Power Plant Engineering
3.00 Contact Hour, 3.00 Credit Hour (Prerequisite: NSE 241)

Layout of nuclear power plants; containment buildings; primary containment vessels; structure of reactor core; and mechanical stress in various structures. Description and analysis of power plant systems and components including steam generator, steam dryer and separator, pressurizer, reheater, heat exchanger, condenser, demineralizer, pumps, turbine, generator, cooling tower; auxiliary cooling systems. Fuel handling mechanisms; control and mechanisms; radwaste systems; electrical systems; reactor grid interface and load following. Basic considerations in nuclear plant design; components of nuclear power cost; economic comparison of nuclear and fossil fueled plants; dual and multipurpose nuclear plants; future trends in nuclear power cost.

Text and References Books

1. Rust, J. H., Nuclear Power Plant Engineering, Haralson, 1979.
2. El-Wakil, M.M., Nuclear Energy Conversion, International Text Book, 1982
3. Pedersen, E.S., Nuclear Power, Ann Arbor Science, 1978.
4. El-Wakil, M.M., Power Plant Technology, McGraw-Hill, 1984.
5. Lish, K.C., Nuclear Power Plant Systems & Equipment, Industrial Press Inc., 1972.

NSE 453: Radiation Protection and Environmental Monitoring of NPPs
3.00 Contact Hour, 3.00 Credit Hour

Radiation protection standards, basic principles for control of external and internal exposures and absorbed dose estimation, health physics instrumentation and personal dosimetry systems.

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, evaluation and monitoring of radiation level in air, water, and soil in the vicinity the NPPs and public awareness systems during reactor operation, maintenance, and decommissioning periods, national monitoring system of the radioactivity, environmental impact assessment methodology due to contamination of air, water and soil in case of accidents, atmospherics dispersion analysis with a reliable computer code.

Text and Reference Books

1. Nuclear Power - Operation, Safety and Environment-Edited by Pavel Tsvetkov, ISBN 978-953-307-507-5, 380 pages, Publisher: InTech, Chapters published September 06, 2011 under CC BY-NC-SA 3.0 license
2. James E. Turner, Atoms, Radiation, and Radiation Protection, John Wiley&Sons, Inc. (2008), ISBN: 9783527616985.
3. Martin, A. and Harbison, An Introduction to Radiation Protection, 3rd Ed., Chapman & Hill, 1986.
4. Eichholz, G. G., Environmental Aspects of Nuclear Power, Ann Arbor Science, Inc., 1976.
5. Eisenbud, M., Gesell T. F., Environmental Radioactivity, 4th Edition, Academic Press, 1997. ISBN: 9780080505800.

NSE 419: Nuclear Reactors Design and Features I
3.00 Contact Hour, 3.00 Credit Hour

Definition of typical nuclear power plant design, Advanced nuclear plant designs, Evolutionary designs and Innovative designs, Principles of nuclear reactor and core design, Nuclear Steam Supply System (NSSS), Reactor pressure vessel & primary coolant pump, pressurizer, steam generator, separator & dryer, design of reactor shielding and reflector, containment building, Nuclear Island, Balance of Plant (BOP), Plant layout. Plant Performance, Description of safety concept and safety parameters of reactors, Fundamentals of SMR Designs, SMART, Salient features of the SMRS and SMART with respect to vendor and type of reactor (LWRs, HWRs, GCRs, FRs etc)**.**

Text and 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.

NSE 420: Nuclear Reactor Laboratory Sessional
3.00 Contact Hour, 1.5 Credit Hour

Sessional based on NSE 419

Experiment 1: Introduction to Monte Carlo simulation using OpenMC.
Experiment 2: Modeling a simple fuel assembly for neutronics.
Experiment 3: Applying variance reduction for flux calculations.
Experiment 4: Running burnup simulations for isotopic changes.
Experiment 5: Full-core modeling with criticality analysis.
Experiment 6: Data post-processing and visualization in Python.
Experiment 7: Final project combining criticality and burnup analysis.

Text and 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

NSE 431: Power Generation and Grid Stability
3.00 Contact Hour, 3.00 Credit Hour

Basics of nuclear power generation from NPPs, power requirements (stability, quality, reliability) power transmission systems, emergency power supply system and power requirements. Introduction: Circuit interruption and protection, Terminologies and general characteristics of relays and breakers. AC/DC converter. Load curves: Demand factor, diversity factor, load duration curves, energy load curve, load factor, capacity factor and plant factor. Circuit breakers: control systems, arc extinction, and recovery voltage. Air, oil, air blast circuit breaker, vacuum, SF_6 and high voltage DC circuit breakers, testing of circuit breakers. Relays: over current, directional, differential, distance, sequence, pilot-wire and carrier-current protection. Busbar arrangement, grounding.

Unit protection: generator, motor, transformer, bus and line protection. Protective schemes, instrument transformers. Basic static and microprocessor-based relays. Trip Circuits. Unit protection schemes: Generator, Unit transformer, Auxiliary transformer, motor, bus bar, transmission and distribution lines, Instrument transformers: CT and PT. Grid system: Typical layout of a substation, High tension switch gear, Low tension switch gear, Transmission cables, Transmission tower, Corona, High voltage measurements and testing. Over-voltage phenomenon and insulation coordination. Lightning and switching surges, basic insulation level, surge diverters and arresters. Causes of station blackout and their remedies.

Text and Reference Books

1. Switchgear and Protection, Sunil S. Rao
2. High Voltage switch gear Analysis and Design, Chunikhin M. Zhavoronkov, 1st edition, 1989, Mir publishers Moscow
3. Switch gear and Finite Automata Theory, Kohavi, 2nd edition, 2005, Tata Mc Graw Hill

NSE 400: Thesis
6.00 + 6.00 Contact Hour, 3.00 + 3.00 Credit Hour

In this course, students are required to undertake a major project in engineering analysis, design, and development of research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgment. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Along with products if any. Use of locally available materials in manufacturing and feasibility study of local industrial units will be emphasized.

NSE 429: Nuclear Reactor Design and Features II
3.00 Contact Hour, 3.00 Credit Hour

Criticality calculation with MOC for square unit pin cell, hexagonal unit pin cell, sphere cell, 1D-cylinderical cell, burnup calculation with different codes MCNP, COBRA, ORIGEN, TRACE/TRAC, MSRAC. Unique design of reactor core satisfying the parameters of the particular reactor type (LWRs, fast breeder) and of various pro-type reactors like Small modular reactors. The output of power and the limiting temperatures, etc., the size of core and the size, the number, the interval and the operating temperatures, etc. of fuel rods must be determined by probabilistic and deterministic methods, reactor safety features (active and passive). Design based cost-benefit analysis of various pro-type reactors like small modular reactors using various software of IAEA. It also includes principles and techniques of economic analysis to determine capital and operating costs, fuel management and optimization, thermal limits on reactor performances, thermal converters, instrumentation and control, transient problems, commissioning and licensing of reactor operation.

Nuclear data library process with ENDF, JENDL, NJOY, JEFF etc., NR approximation, Hyperfine neutron energy group structure of heterogeneous and homogeneous thermal reactors. Neutron spectrum in fast and thermal reactors. Reflected spherical reactor. Multigroup theory. Solution of the multigroup neutron diffusion equation for design of heterogeneous and homogeneous nuclear reactor. The transverse leakage approximation, and the zero-dimensional solution. Reactivity feedback. Point kinetics equation, neutron lifetime, and delayed neutrons. Solution of the point kinetics equation. The in-hour equation. Multigroup perturbation theory. Xenon poisoning in thermal nuclear reactors. Samarium poisoning in thermal nuclear reactors. Xenon oscillations and fuel burnup.

Text and Reference Books

1. E.E. Lewis, Fundamentals of Nuclear Reactor Physics, Elsevier, Amsterdam, 2008.
2. Design Features to Achieve Defense in Depth in Small and Medium Sized Reactors (SMRs)- By IAEA Nuclear Energy Series NP-T-2.2
3. Nuclear Reactor Theory by Bell and Glasstone
4. Nuclear Reactor Engineering: Reactor Design Basics by Samuel Glasstone Paperback
5. Nuclear Reactor Engineering: Reactor Systems Engineering, 4th Edition, Vol. 2 by Samuel Glasstone

NSE 437: Nuclear Accidents Analysis and Radiological Emergency
3.00 Contact Hour, 3.00 Credit Hour

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

Text and Reference Books

1. ACCIDENT ANALYSIS FOR NUCLEAR POWER PLANTS- International Atomic Energy Agency, Vienna, 2002
2. IAEA Guideline

NSE 475: In-core Fuel Management
3.00 Contact Hour, 3.00 Credit Hour

Introduction to fuel management, variables of core management, reactor core analysis, core simulation and nodal methods, core burnup and fuel, depletion modeling, fundamentals of reactor reload calculations, models for in-core fuel managements, PWR in-core fuel management, BWR in-core fuel management, fuel management of other reactor types, optimization of core re-load designs and burnable poison placement, nuclear fuel cycle economics, core life time calculation, fuel reshuffling and arrangement.

Text and 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

NSE 481: Radiation Interactions and Shielding
2.00 Contact Hour 2.00 Credit Hour

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, medical facility shielding, special techniques for neutrons, transport solutions: straight-ahead approximation, , discrete ordinates, method of moments; albedos and duct penetration methods; sky shine and air scatter.

Textbook and Reference Books

1. P. H. McGinley, Shielding Techniques for Radiation Oncology Facilities, Medical Physics Publishing, 1998.
2. R. G. Jaeger (Editor-In-Chief), Engineering Compendium on Radiation Shielding, Springer-Verlag, New York, 1968.
3. Principles Of Radiation Interaction in Matter and Detection, Claude Leroy, Pier-Giorgio Rancoita
4. Lamarsh, J.R. and Baratta, A.J., "Introduction to Nuclear Engineering", 3rd Edition, Prentice Hall, 2001.

NSE 400: Thesis
6.00 + 6.00 Contact Hour; 3.00 + 3.00 Credit Hour

In this course, students are required to undertake a major project in engineering analysis, design, and development of research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgment. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Along with products (if any). Use of locally available materials in manufacturing and feasibility study of local industrial units will be emphasized.

CHAPTER 6
DETAIL OUTLINE OF UNDERGRADUATE COURSES OFFERED BY NSE DEPT TO NSE STUDENTS AS ELECTIVE SUBJECTS

NSE 405: Nuclear Chemical Engineering and Corrosion
3.00 Contact Hour 3.00 Credit Hour

Basic chemical concepts regarding chemical thermodynamics and kinetics, technology applied and newly developed for nuclear fuel cycle, characteristics and analysis of nuclear spent fuels, fission products, and actinide, 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, diffusion and reaction of fission products, structural stability of metal or non-metallic materials, radiation hardening or embrittlement and swelling are studied and analyzed in terms of lattice defect interaction with energetic neutron, the chemical analysis using radiotracers, the chemistry of transuranic elements, scaling.

Text and Reference Books

1. Nuclear Chemical Engineering (McGraw-Hill series in nuclear engineering) 2nd Edition, Manson Benedict, Thomas H. Pigford, Hans Wolfgang Levi
2. The Science and Engineering of Materials, Donald R. Askeland, Pradeep Phule, 4th Edition, Thompson Books/Cole
3. The Science and Design of Engineering Materials, James P. Schaffer, Ashok Saxena, Stephen D. Antolovich, Thomas H. Sanders, Steven B. Warner, WCB McGraw-Hill Publishers.
4. CHAMBERLAIN, J. -- TRETHEWEY, K. Corrosion for Science and Engineering, Essex, England Longman, 1995, 0-582-23869-2
5. HENRY, S. -- SANDERS, B. Corrosion: understanding the basic, United States of America ASM International, Davis &Associates, 2003, 0-87170-641-5

NSE 407: Non Destructive Testing and Evaluation
3.00 Contact Hour, 3.00 Credit Hour

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.

Text and References Books

1. Introduction to Nondestructive Testing: A Training Guide by Paul E. Mix P.E. E.E.
2. Handbook of Nondestructive Evaluation, Second Edition by Chuck Hellier, Rao, S.S. Mechanical Vibrations, SI Edition, Pearson Prentice Hall, 2005.
3. Thomson, W.T. Theory of Vibration with Applications, 4th edition Stanley Thornes, 1998.
4. Rao B.K.N. - Handbook of Condition Monitoring 1999;
5. Mitchell, J, Introduction to Machinery Analysis and Monitoring 1993;

NSE 411: Nuclear Act, Regulations and Procedures
3.00 Contract Hour, 3.00 Credit Hour

Introduction, national and international nuclear laws, regulations and guides, application for a construction permit for typical nuclear facility, preparation and evaluation of safety analysis report, evaluation for environmental report, technical specification for operating license, regulation of plant operation and nuclear facilities. Statement of organization and general information, Rules of practice for domestic licensing proceedings and issuance of orders, Interpretations, Criteria and procedures for determining eligibility for access to restricted data or national security information or an employment clearance, Criteria and procedures for determining eligibility for access to or control over special nuclear materials.

Text and Reference Books

1. IAEA Guideline
2. BAERA Act, Regulations and Guidelines

NSE 459: Computational Fluid Dynamics (CFD)
3.00 Contract Hour, 3.00 Credit Hour

Introduction to laminar and turbulent flows; comparison of ideal and real flows; potential flow; elementary flows and their separations. Introduction to finite difference and finite volume methods; basic concept of discretization, consistency and stability; finite element techniques for various types of problems related to mechanical structures and finite element analysis program; application methods to select models.

Text and Reference Books

1. Fundamental of Thermal Fluid Sciences by Cengel and Turner, McGraw Hill.
2. Computation Fluid Mechanics and Heat Transfer by Anderson

NSE 479: Radioactive Waste Treatment and Disposal Techniques
3.00 Contact Hour, 3.00 Credit Hour

Waste minimization and immobilization techniques, contaminants and hazard, heavy metal contaminations, nuclear waste regulations, principles of nuclear waste management, sources of nuclear waste, basic management approaches and characterization of radioactive waste, pre-treatment of radioactive wastes, treatment of liquid radioactive wastes, treatment of solid wastes, hydraulic cements in waste immobilization, technology, glasses for radioactive waste immobilization, technology, long term durability of silicate glasses, ceramic and metallic matrices, nuclear waste transportation and storage, disposal facility-shallow land disposal, geological disposal, sea-bed disposal techniques.

Text and Reference Books

1. F. Barker "Management of radioactive wastes" 1998.
2. Donald R. Wily "The chemistry of nuclear fuel waste deposal" polytechnic international press, 2002

NSE 421: Risk and Disaster Management
3.00 Contact Hour, 3.00 Credit Hour

Introduction to risk concepts; nuclear plant example, identification and understanding of hazards, logistic and probabilistic descriptions of risk, quantifying failure: FMEA, event trees, fault trees, comparing risks and setting disparate risks in context, risk management in large industrial companies, probability modelling using distributions. Chernobyl case study, strategies for managing nuclear risk, culture, ethics and public tolerability, introduction to the j-value method for assessing health and safety spend, particularly for averting radiation dose, application of risk methods to big nuclear accidents such as Chernobyl and Fukushima.

Text and Reference Books

1. IAEA Guideline.
2. Risk Management of Knowledge Loss in Nuclear Industry Organizations by IAEA.

NSE 491: Safety Criticality Management
3.00 Contact Hour, 3.00 Credit Hour

Nuclear hazard, hazard monitoring, risk issue, nuclear hazard assessment, procedure, methodology; nuclear safety audit, checklist analysis, what if analysis, nuclear safety review, preliminary, hazard analysis, hazard operability studies, fault tree analysis and event tree analysis for nuclear accidents, methodology, case study of safety criticality models

Text and Reference Books

1. Loss Prevention in Process Industries, Frank P. Less Butterworth, Hein UK 1990 (Vol.I, II & III)

2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK

NSE 433: Fundamentals of Fusion Engineering
3.00 Contact Hour, 3.00 Credit Hour

Basic Plasma Physics, Principles of Thermonuclear Fusion, Components of Fusion Reactors, Plasma Confinement and Heating, Thermal Hydraulics of Fusion Reactor, Plasma Kinetics and Neutronics, Shielding Design and Application of Fusion Reactors.

Text and Reference Books

1. Plasma physics and controlled nuclear fusion, Kenro Miyamoto
2. Principles of Fusion Energy, A A Harms, D R Kingdon, 2000.

NSE 413: Medical Applications of Nuclear Technology
3.00 Contact Hour, 3.00 Credit Hour

Physical principles, statistics of radionuclide decay and highlights into the most current instrumentation to utilize in-vivo radionuclides for both diagnostic imaging and therapy. Also includes brachy therapy. Principles and applications of radiation producing units, exposure and dose measurements, and calibration. External beam physics parameters and application to fixed field and rotational field treatment planning. Principles and applications of X-ray production and interactions. Images production concepts including X-ray film, intensifying screens, grids, fluoroscopy, image intensification and television monitors. Image quality analysis and assessment.

Text and Reference Books

1. Medical Applications of Nuclear Physics by K. Bethge, G. Kraft, P. Kreisler, Gertrud Walter

NSE 485: Nuclear Weapon Engineering
3.00 Contact Hour, 3.00 Credit Hour

History of explosives; types and properties of explosives; initiation systems, quantity distance procedures; effect of blast, fragmentation and shaped charge warheads; quarry blasting and explosive demolition; blast waves and interactions, blast on structures, blast analysis and structural design; survivability of structures. Kinetic energy of penetrations; propellant charges ; fuses, initiators, detonators and safe / arm devices; dynamics of unguided weapons : fin and spin stabilization., Missile guidance techniques; physics and accuracy of missile sensors and effect on guidance; advanced guidance and sensor system; prediction techniques for missile aerodynamics; aerodynamics and dynamics of layout, control, propulsion and their integration with other system; storage, maintenance, transport and launch considerations.

Text and Reference Books

Hand notes provided by the teacher/instructor.

NSE 487: Nuclear Forensic Analysis
3.00 Contact Hour, 3.00 Credit Hour

Natural versus synthetic materials, Overview, characterization and interpretation nuclear forensics, recovery of actinides from the earth, electromagnetic isotope separation for forensic analysis, gaseous diffusion, thermal diffusion, gas centrifugation, aerodynamic enrichment, laser isotope separation, tracers in organic analysis, heavy elements and fission product chronometers, grand daughter and spoof detection, detection of incomplete fuel reprocessing, radiochemical milking, mass spectrometry and micro analysis, various laboratory analysis methods, materials fingerprinting, various isotopes fingerprinting like Pb, O etc. criminalistics comparisons, material compositions, forensic analysis of highly enriched uranium, nuclear smuggling, cold fusion

Text and Reference Books

1. Nuclear Forensic Analysis by Kenton J Moody
2. IAEA Handouts on Nuclear Forensic Analysis

NSE 489: Nuclear Project Management
3.00 Contact Hour, 3.00 Credit Hour

Essentials of project management, Programme management, Portfolio management, Project context, Project sponsorship Project success & benefits management, Stakeholder management, The Project Management Plan, Options appraisal, Risk Management, Scope Management, Scheduling, Resource Management, Change Control, Estimating The Business Case, Project Monitoring & Control, Budget & Cost management, Project Lifecycles, Handover and closeout, Project reviews, Organizational roles, Communication, Conflict Management, Teamwork, Leadership

Text and Reference Books

Hand notes provided by the teacher/instructor.

CHAPTER 7
DETAIL OUTLINE OF UNDERGRADUATE COURSES OFFERED BY OTHER DEPARTMENTS TO NSE STUDENTS

PHY 151: Structure of Matter, Modern Physics and Wave Mechanics.
3.00 Contact Hour, 3.00 Credit Hour

Structure of matter: States of matter: solid, liquid, and gas. Classification of solids: amorphous, crystalline, ceramic and polymers; Plasticity and Elasticity, Atomic arrangement in solid; different types of bonds in solids: metallic and Vander Waal's, covalent and ionic bond. Packing in solids, Inter atomic distances and forces of equilibrium, X-ray diffraction, Bragg's law, Defects in solids band theory of solids, distinction between metal, insulator and semiconductor.

Modern physics: Galilean and Lorentz transformation, special theory of relativity, relative velocity, length contraction, time dilation, mass energy relation, massless particles, photoelectric effect, Compton effect, de-Broglie waves, uncertainty principle, Bohr atomic model, Bohr radius of the hydrogen atom, energy levels and spectra, correspondence principle, nuclear composition, nuclear binding energy, radioactive decay, half life, mean life, nuclear reaction, elementary particles.

Wave mechanics: Fundamental postulates of wave mechanics, wave function, wave equation, Schrödinger's equation and its different form, steady state Schrödinger's equation for one electron atom, particle in a box, finite potential well, Schrödinger's equation for the hydrogen atom, quantum numbers, spin-orbit coupling, Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics, dying stars.

Text and Reference Books

1. "Elementary Solid state physics" by M. Ali Omar
2. "Concept of Modern Physics" by Arther Beiser
3. "Perspective of Modern Physics" by Arther Beiser
4. "Modern Physics" by -B.L. Theraja
5. "Fundamentals of Physics" by Halliday, Resnick and Walker
6. "Introduction to Quantum Mechanics" by David J. Griffiths

PHY 152: Physics Sessional
3 Contact Hour, 1.5 Credit Hour

Sessional based on PHY 151
Experiment 1: Determination of the specific resistance of a wire using meter bridge or determination of ECE of copper by using copper voltameter.
Experiment 2: 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.
Experiment 3: 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.
Experiment 4: 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.
Experiment 5: Determination of the frequency of a tuning fork by Melde's experiment or determination of the Planck's constant using photoelectric effect.
Experiment 6: Determination of the value of g acceleration due to gravity by means of a compound pendulum.
Experiment 7: 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.
Experiment 8: 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.
Experiment 9: 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.
Experimental 10: 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.

CHEM 171: Introduction to Chemistry
3.00 Contact Hour, 3.00 Credit Hour

Section - A
Concepts of atomic structure, Different atom models, Quantum numbers, Electronic configuration, Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases, Chemical bonding (types, properties, Lewis theory, VBT, MOT), Hybridization and shapes of molecules, Selective organic reactions such as- addition, substitution, oxidation- reduction, alkylation and polymerization, Phase rule, Phase diagram of mono component system.

Section - B
Solutions and their classification, Unit expressing concentration, Colligative properties of dilute solutions, Thermo chemistry, Chemical kinetics, Chemical equilibrium, pH and buffer solutions, and Electrical properties of solution.

CHEM 172: Inorganic Quantitative Analysis Sessional
3.00 Contact Hour, 1.5 Credit Hour

Sessional based on CHEM 171
Experiment 1: Standardization of Sodium Hydroxide (NaOH) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.
Experiment 2: Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Hydroxide (NaOH) Solution.
Experiment 3: Standardization of Hydrochloric Acid (HCl) Solution with Standard Sodium Carbonate (Na_2CO_3) Solution.
Experiment 4: Determination of Calcium (Ca) Content in a Calcium Chloride dihydrate ($CaCl_2.2H_2O$) Solution with Standard Di-Sodium Ethylene Diammine Tetra Acetic Acid (Na_2EDTA) Solution.
Experiment 5: Standardization of Sodium Thiosulphate Pentahydrate ($Na_2S_2O_3.5H_2O$) Solution with Standard Potassium Dichromate ($K_2Cr_2O_7$) Solution.
Experiment 6: 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.
Experiment 7: Standardization of Potassium Permanganate (KMnO4) Solution with Standard Oxalic Acid dihydrate ($C_2H_2O_4.2H_2O$) Solution.
Experiment 8: 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.
Experiment 9: 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.

MATH 191: Differential and Integral Calculus
3.00 Contact Hour, 3.00 Credit Hour

Section-A (Differential Calculus)
Limit, continuity and differentiability, successive differentiation of various types of functions, Leibnitz theorem, Rolle's theorem, Mean Value theorem, expansion in finite and infinite forms, Lagrange's form of remainder, Cauchy's form of remainder (expansion of remainder), expansions of functions differentiation and integration, indeterminate form, Cartesian differentiation, Euler's theorem, tangent and normal, sub tangent and subnormal in Cartesian and polar coordinates, maxima and minima of functions of single variables, curvature, asymptotes.

Section-B: (Integral Calculus)
Definition of integrations, integration by the method of substitution, integration by parts, standard integrals, integration by the method of successive reduction, definite integrals and its use in summing series, Walli's formula, improper integrals, beta function and gamma function, multiple integral and its application, area, volume of solid revolution, area under a plain curve in Cartesian and polar coordinates, area of the region enclosed by two curves in Cartesian and polar coordinates, arc lengths of curves in Cartesian and polar coordinates.

MATH 193: Differential Equations (ODE &PDE)
3.00 Contact Hour, 3.00 Credit Hour

Section-A (Ordinary Differential Equations)
Formulation of Differential Equations. Degree and order of Ordinary differential equations, Solution of first order but higher degree differential equations Solution of first order differential equations by various method Solution of general linear equations of second and higher orders with constant co-efficient. Solution of Homogeneous linear

equations and its applications. Solution of differential equations by the methods based on the factorization of the operators, Frobenious methods, Bessel's functions, Legendre's polynomials and properties.

Section-B (Partial Differential Equations)
Introduction, Linear and non-linear first order equations. Standard forms of linear equations of higher order, Equation of second order with variable coefficients. Wave equations, Particular solutions with boundary and initial conditions, Integral surface passing through given curve; Nonlinear PDE of order One (Complete, particular, singular and general integrals), Charpit's Method, Second order PDE and classifications to canonical (standard)-parabolic, elliptic, hyperbolic solution by separation of variables, Linear PDE with constant coefficients.

MATH 291: Vector Analysis, Matrices and Coordinate Geometry
3.00 Contact Hour, 3.00 Credit Hour

Section-A (Vector Analysis and Matrices)

Vector analysis: Definition of vector, Equality of direction ratios and vectors, Addition and multiplication of vectors, Triple products and multiple products, Differentiation of vectors, Gradient of scalar functions, Divergence and curl of point functions, Physical significance of gradient, divergence and curl, integration of vectors (line, surface and volume integrals); Green's, Stoke's and Gauss's theorem and their application.

Matrices: Definition of matrix, algebra of matrices, multiplication of matrices, transpose of a matrix, inverse of matrix, rank and elementary transformation of matrices, solution of linear equations, linear dependence and independence of vectors, quadratic forms, matrix polynomials, determination of characteristic roots and vectors, null space and nullity of matrix, characteristic subspace of matrix.

Section-B (Coordinate Geometry- 2D & 3D)

Two Dimensions. Transformation of co-ordinates, equation of conics, its reduction to standard forms, pair of straight lines, 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 and system of circles, orthogonal circles, radical axis and its properties, radical centers, coaxial circles and limiting points, equations of parabola, ellipse in Cartesian and polar coordinates.

Three Dimensions. System of coordinates, projection, direction cosines, equations of planes and lines, angle between lines and planes, distance from a point to a plane, co-planner lines. Shortest distance between two given straight lines, standard equation of conicoid, sphere and ellipsoid.

MATH 293: Fourier Analysis, Harmonic Functions, Laplace Transform and Complex Variable
4.00 Contact Hour 4.00 Credit Hour

Section-A (Fourier Analysis and Complex Variables)

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 Cruchy-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.

Section-B (Harmonic Functions and Laplace Transform)

Harmonic Functions: Definition of harmonics. Laplace's equation in Cartesian, polar cylindrical and spherical co-ordinates. Solutions of these equations together with applications. Gravitational potential due to a ring, Steady-state temperature. Potential inside or outside of a sphere. Properties of harmonic functions.

Laplace Transform: Definition. Laplace transforms of some elementary functions. Sufficient conditions for existence of Laplace transform. Inverse Laplace transforms. Laplace transforms of derivatives. The unit step function. Periodic function, Some special theorems on Laplace transform. Partial fraction, Solutions of differential equations by Laplace transform. Evaluation of improper integral.

HUM 105: English and Communication Skill
3.00 Contact Hour, 3.00 Credit Hour

Section-A
Introduction; Importance and Mastering various approaches to learning English; Phonetics - Phonetic systems, correct English pronunciation; Grammatical problems – Grammar and usages; Approaches to communication - communication today, business communication; Methods of Writing - business letter, tenders and quotations, resumes and job letters.

Section-B

Comprehension, paragraph writing, précis writing, amplification; Report Writing – Purpose of a report, classification of reports, organizing a report, writing short report, preparing complete analytical report, analysis and illustration of a report, problems in writing reports; journal articles, technical and scientific presentation.

Text and Reference Books

1. Business correspondence and report writing – R. C. Sharma & Krisnamohon.
2. A guide to correct speech – S. M. Amanullah.
3. Advance learners Degree general English – Chowdhury and Hossain.
4. The most common mistakes in English usage – Thoma's Ellioft Berry.

HUM 106: English and Communication Skill Sessional
3.00 Contact Hour 1.50 Credit Hour

Tutorial Discussion – On a given topic to test the proper use of phonetics, pronunciation grammar, logic and confidence; Public Speaking – Demonstration by teacher for a short specific period, speaking by students (each student minimum twice) on different but easy given topic, well in advance as per a schedule maximum for 3 to 4 minutes for each student; Extempore – Minimum two presentations by each student for a duration of maximum 3 to 4 minutes; Debriefing on public speaking and extempore presentation ; Presentation – On a given professional topic or on a given research paper using power point for 40 minutes followed by question and answer session. Group presentation or different given topics by the students using power point.

Text and Reference Books

1. Business correspondence and report writing – R. C. Sharma & Krisnamohon.

HUM 207: Principles of Accounting
3.00 Contact Hour, 3.00 Credit Hour

Section-A
A study of accounting as an informational system, fundamental accounting concepts and principles used to analyze and record business transactions, Recording system: Double-entry book keeping and accounting, accounting equation, measuring and recording business transactions. Accounting cycle: Journal, ledger, trail balance, preparation of financial statements considering adjusting and closing entries, Financial statements analysis and interpretation: Ratio analysis – tests for profitability, liquidity, solvency and overall measure.

Section- B
Cost in general: Objectives and classifications. Overhead costs: Allocation and apportionment. Product costing: Cost sheet under job costing, process costing, costing by products and joint products.
Marginal costing: Tools and techniques; Cost-volume-profit analysis: Meaning, break-even analysis, contribution margin technique, sensitivity analysis, designing the optimal product mix.
Relevant costing: Analysis, profitability within the firm. Guidelines for decision-making: Short-run decisions.
Long run planning and control: Capital budgeting; the master budget, flexible budget and standard cost, variance analysis.

Text and Reference Books

1. Accounting Principles- Jerry J. Weygandt, Donald E. Kieso, and Paul D. Kimmel Publisher: Wiley; 8th edition
2. Cost Accounting: Theory and Practice- Bhabatosh Banerjee;
3. Publisher: Prentice-Hall of India Pvt.Ltd; 12Rev Ed edition
4. Cost and Management Accounting- Duncan Williamson; Publisher: Prentice Hall

5. Introduction to Management Accounting- Charles T. Horngren, Gary L. Sundem, William O. Stratton, and Jeff Schatzberg; Publisher: Prentice Hall; 14th edition
6. Managerial Accounting 10/e Update Edition- Ray; Noreen, Eric Garrison; Publisher: McGraw-Hill
7. Fundamental Accounting Principles- Kermit Larson, John Wild, and Barbara Chiappetta; Publisher: McGraw-Hill/Irwin; 16th edition

HUM 252: Introduction to Russian Language-I
1.5 Contact Hour, 0.75 Credit Hour
Sessional based on Russian Language

HUM 262: Introduction to German Language-I
1.5 Contact Hour, 0.75 Credit Hour
Sessional based on German Language

HUM 272: Introduction to Japanese Language-I
1.5 Contact Hour, 0.75 Credit Hour
Sessional based on Japanese Language

HUM 254: Introduction to Russian Language-II
1.5 Contact Hour, 0.75 Credit Hour
Sessional based on Mid Level Russian Language

HUM 264: Introduction to German Language-II
1.5 Contact Hour, 0.75 Credit Hour
Sessional based on Mid Level German Language

HUM 274: Introduction to Japanese Language-II
1.5 Contact Hour, 0.75 Credit Hour
Sessional based on Mid Level Japanese Language

HUM 307: Engineering Economics
2.00 Contact Hour 2.00 Credit Hour

Section A
Microeconomics: Definition of economics; Fundamentals of economics; Market and government in a modern economy; Basic elements of supply and demand; Choice and utility; indifference curve technique; Analysis of cost; Short run long run theory of production; Analysis of Market; Optimization; Theory of distribution

Section B
Macroeconomics: key concept of macroeconomics; Saving, consumption, investment; National income analysis; Inflation, Unemployment; Fiscal and monetary policy

Development: Theories of developments**;** Economic problem of developing countries; Planning in Bangladesh

Text and Reference Books

1. Economics by Samuelson
2. Economics by John Sloman
3. Economic Development by Michael Todaro

SHOP 114: Foundry, Welding & Machine Shop
3.00 Contact Hour, 1.5 Credit Hour

Foundry. Introduction to foundry, tools and equipment; Patterns: function, pattern making; Molding: molding materials sand preparation, types of mold, procedure; Cores: types, core making materials; Metal melting and casting; Inspection of casting and casting defects.

Welding. Metal joints: riveting, grooving, soldering, welding; Welding practice: electric arc - steel, aluminum; Types of electrodes; Welding defects: visual, destructive and non-destructive tests of welding. Gas welding and equipment; Types of flame; Welding of different types of materials; Gas welding defects; Test of gas welding.

Tools: common bench and hand tools, marking and layout tools, measuring tools, cutting tools, machine tools; Bench work on jobs; Practices on machine tools: drilling machine, lathe machine, shaper machine, milling machine, grinding machine.

Text and Reference Books

1. Machine Shop Practice – James Anderson, W. A. Chapman.

ME 153: Basic Engineering Thermodynamics
3.00 Contact Hour, 3.00 Credit Hour

Fundamental concepts; Properties of gases and vapours; Laws of thermodynamics and their corollaries. Non-flow and flow processes; Ideal gases and their cycles; Power cycles, refrigeration cycles and reciprocating compressors; Second law of thermodynamics: availability, irreversibility and entropy. Thermodynamic relations and equations of state; Mixtures of gases and vapours; Psychrometrics; Real gases; Fuels and combustion.

Text and Reference Books

1. Fundamentals of Engineering Thermodynamics- Michael J. Moran & Howard N. Shapiro. Publisher- John Wiley & Sons, Inc.
2. Fundamentals of Thermodynamics – R E Sonntag, C. Borgnakke, G J. Van Wylen, Publisher – John Wiley & Sons, Inc, 5th edition, 2000
3. Thermodynamics – Yunus A Cengel & Michael A Boles

ME 180 : Basic Engineering Drawing
3.00 Contact Hour 1.50 Credit Hour

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.

Introduction to CAD and its applications; Fasteners, gears, keys and springs; Sectional views and conventional practices; Auxiliary views; Specifications for manufacture; Working drawings; Surface development and intersections. Basic 3D drawing commands and drafting of 3D drawings on computer.

Text and Reference Books

1. Metric Drafting – Paul Wallah, Publisher – Glenceo Publishing Co, Inc; 1979.
2. Drafting Technology and Practice – William P. Spence, Publisher – Chas A. Bennett Co, Inc, 1973.
3. Technical Drawing – Frederick E Giesecke, Alva Mitchell, Henry C. Spencer, Publisher – Prentice Hall; 12th edition, 2002.
4. Metric Drafting – Paul Wallah, Publisher – Glenceo Publishing Co, Inc; 1979.
5. Drafting Technology and Practice – William P. Spence, Publisher – Chas A. Bennett Co, Inc, 1973.
6. Technical Drawing – Frederick E Giesecke, Alva Mitchell, Henry C. Spencer, Ivan Leroy Hill, John T. Dygdon, James E. Novak, Ival L. Hill, Publisher – Prentice Hall; 12th edition, 2002.

ME 253: Engineering Mechanics
3.00 Contact Hour, 3.00 Credit Hour

Basic concepts of mechanics; Statics of particles and rigid bodies; Centroids of lines, areas and volumes; Forces in truss, frames, and cables; Friction; Moments of inertia of areas and masses; Relative motion.
Kinetics of particles: Newton's second law of motion; Principles of work, energy, impulse and momentum; System of particles; Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies: forces and acceleration; Principles of work and energy, Basic concepts of Lagrangian and Hamiltonian mechanics

Text and Reference Books

1. Vector Mechanics for Engineers: Statics and Dynamics – Ferdinand P. Beer, E Russell Jr. Johnstone, Publisher – Mc Graw-Hill Companies, 5th edition 1988.

2. Engineering Mechanics, Statics and Dynamics – Joseph F Shelley, Publisher – Mc Graw-Hill, 1980.

ME 254: **Engineering Mechanics Sessional**
1.5 Contact Hour, 0.75 Credit Hour

Sessional based on the theory of ME 253
Experiment 1: Introduction to force systems, including graphical and trigonometric methods for determining the magnitude and direction of resultant forces using the parallelogram law and triangle rule.
Experiment 2: Cartesian vector representation of forces, including conversion of forces into vector form and computation of resultant magnitude and coordinate direction angles.
Experiment 3: Equilibrium of particles and force analysis in three-dimensional cable systems, including tension limits and support reactions.
Experiment 4: Analysis of plane trusses using the method of joints or sections to determine forces in members and identify tension or compression.
Experiment 5: Moment calculations, force-couple systems, and replacement of force systems with equivalent single forces applied at specified points.

Text and Reference Books

1. William Nash, Strength of Materials, 4th edition, USA: Mcgraw-hill International Editions, 2002
2. 2. A C Mandal & M. Quamrul Islam, Mechanics of Material with Solved Problems, published by IUT, OIC, 2011.
3. 3. Andrew Pytel, Ferdinand L. Singer. Strength of Materials ,4th edition, USA: Mcgraw-hill International Editions ,1990.

ME 373: Mechanics of Materials
3.00 Contact Hour, 3.00 Credit Hour

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; Introduction to reinforced concrete beams and slabs.

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.

Text and Reference Books

1. Mechanics of material with solved problems A C Mandal & M. Quamrul Islam, published by IUT, OIC, 2011
2. Strength of Materials (4th edition) – Andrew Pytel, Ferdinand L. Singer.
3. Strength of materials (4th edition) William Nash, Publisher Mcgraw-hill International Editions, Schaum's Outline Series.
4. Strength of Materials – Beer and John Stone.

ME 374: Mechanics of Materials Sessional
1.5 Contact Hour, 0.75 Credit Hour

Experiments based on ME 373
Experiment 1: Study and Calibration of a Universal Testing Machine (UTM)
Experiment 2: Tensile Test of Mild Steel Specimen
Experiment 3: Hardness Test of Metal Specimen
Experiment 4: Impact Test of Metal Specimen
Experiment 5: Support Reactions for a Point Loaded Simple Supported Beam
Experiment 6: Column Test of Mild Steel Specimen

Text and Reference Books

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

ME 497: Industrial Management
3.00 Contact Hour, 3.00 Credit Hour

Management Functions and Organization: Evolution; Management functions: organization, theory and structure, span of control, authority delegation, manpower planning. Personnel Management: Importance, need hierarchy, motivation, leadership, wage incentives, performance appraisal, participative management; Operation Management Production planning and control (PPC) functions, quantitative methods applied in production, quality management, location and layout planning, safety and loss management. Cost management elements of cost of products, cost centers and allocation of overhead costs ; Management accounting : marginal costing, standard costing, cost planning and control, budget and budgetary control; Development and planning process; annual development plan; National budget, Financial management : objectives, strategy, financing, performance analysis of enterprise, investment appraisal, criteria of investment Management Accounting : Cost planning and control, budget and budgetary control. Marketing Management: Concepts, strategy, sales promotion, patent laws. Technology Management; Management of innovation and changes, technology life cycle, Case studies.

Text and Reference Books

1. Operational management for competitive advantage – by chase Aquilano Jacobs.
2. Management – Jams A. F. Stoner, R, Edward Freeman, Daniel R Gilbert.
3. Management – Stephen P. Rubbiins, Mar Conlter, Robiin Stuart kotze.
4. Industrial management – by John Christie Sunncan.
5. Industrial management – by B. Narayan in books.

EECE 119: Fundamentals of Electrical Engineering
3.00 Contact Hour, 3.00 Credit Hour

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, theory of ferromagnetism, B-H curve, hysteresis loss, eddy current and eddy current loss, total core loss. Introduction to magnetic circuits. Electromagnetic forces: forces upon a current carrying conductor and charged particles moving in a magnetic field. Electromagnetic torque; electric motor. Electromagnetic induction and emf; Lenz's law, BLV rule, elementary A.C. generator.

General concepts and definitions. Instantaneous current, voltage and power, R-, L-, C-, RL-, RC- and RLC-branches, 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. Balanced poly phase circuits: three phase, four wire system of generated emfs, three phase, three wire systems, balanced wye loads, balanced delta loads, power in balanced systems, power factor. Balanced three phase circuit analysis and power measurement.

Text and Reference Books

1. Introductory Circuit Analysis – R. L. Boylestad.
2. Introductory Circuit for Electrical & Computer Engineering – James W. Nilson.
3. Alternating Current Circuits – Russel M Kerchner and George F Corcoran.

EECE 120: Fundamentals of Electrical Engineering Laboratory
1.5 Contact Hour, 0.75 Credit Hour

Laboratory experiments based on EECE 119.
Experiment 1: Construction & Operation of Simple Electrical Circuits
Experiment 2: Verification of KVL
Experiment 3: Verification of KCL

Experiment 4: Verification of Superposition Theorem
Experiment 5: Verification of Thevenin's Theorem
Experiment 6: Familiarization with Alternating Current (AC) waves

Text and 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

EECE 219: Electronics, Signals and Measurement
3.00 Contact Hour, 3.00 Credit Hour

Introduction to Transducers, Sensors, Introduction to Signals and Systems; Time and Frequency Domain, Digital signal processing and conditioning in electronics, Fourier Transform and Fourier Series, Protoboarding Techniques, Sampling, and Aliasing, Resistor Networks-1, Resistor Networks-2, Measuring the Temperature Coefficient of Resistors, Equivalent Circuits, Power Transfer, Dependent Sources, Op Amps, Current Sources, Capacitors and Inductors, Sinusoidal Steady State Response of RL and RC Circuits, Sinusoidal Steady State Response: Impedance, Filters, Filters, Bandwidth, Q Factor, Transients, Diodes, Signal Conditioning, Voltage Regulation, Introduction to BJT, BJT Biasing and Amplification, Introduction to the Op Amp, Comparators and Schmitt Trigger, Schmitt Trigger Oscillator.

Text and Reference Books

1. Electric Machines and Transformers – Irving L. Kosow.
2. Electrical Machines Fundamentals – Stephan J. Chapman.
3. A Text Book of Electrical Technology (AC, DC Machines) –B L Theraja and A. K. Theraja.
4. Electronic Devices and Circuit Theories – R. L. Boylsted.

EECE 220: Electronics, Signals and Measurement Sessional
3.00 Contact Hour 1.50 Credit Hour

Laboratory experiments based on EECE 219
Experiment 1: Study of Diode Characteristics
Experiment 2: Study of Diode Rectifier Circuits.
Experiment 3: Study Of N-P-N CB (Common Base) Transistor Characteristics.
Experiment 4: Study Of N-P-N CE (Common Emitter) Transistor Characteristics.
Experiment 5: Study the Characteristics of JFET
Experiment 6: Mathematical Operations Using Op-Amp
Experiment 7: Mathematical Operations (Integrator) Using Op-Amp
Experiment 8: Study of an R-C Phase Shift Oscillator and Wien Bridge Oscillator
Experiment 9: Determining the Frequency response curve of High pass filter using OP-Amp.
Experiment 10: Determining the Frequency response curve of Low pass filter using OP-Amp.

Text and 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.

CSE 121: Introduction to Computer Science and Programming Language
3.00 Contact Hour, 3.00 Credit Hour

Number system binary octal hexadecimal, binary arithmetic, Basic programming concepts; program development stages; logic charts, algorithm; Introduction to structured programming; data types and expressions, Operators,

Libraries and keywords, Statements, Arrays and strings, Functions, Control statements, Pointers, Input and output systems; Introduction and familiarization with MATLAB software.

Text and Reference Books

1. Computer Fundamentals by Peter Norton.
2. Teach Yourself C by Herbert Schildt.
3. Turbo C/C++ Complete Reference by Herbert Schildt

CSE 122: Computer Science and programming Language Sessional
1.50 Contact Hour, 0.75 Credit Hour

Sessional based on CSE 121.

Experiment 1: Orientation with IDE, Building First Program, Compile and Run
Experiment 2: Problem solving with Variable and constants, operators, expressions, if-else
Experiment 3: Problem solving with "if-else if" ladder, switch-case,
Experiment 4: Problem solving using for loop, while Loop, do while
Experiment 5: Pattern printing using nested loop
Experiment 6: Problem solving using Arrays and String
Experiment 7: Problem solving using Function
Experiment 8: Problem solving using File Input/ Output and structure

Text and Reference Books

1. Herbert Schildt, Teach Yourself C, 3rd Edition
2. Programming with C - Schaums Outline Series
3. Peter Norton, Computer Fundamentals, 6th Edition McGraw-Hill Education, 2004
4. Herbert Schildt, C, The Complete Reference, 4th Edition
5. Dennis M. Ritchie, C Programming Language, 2nd Edition