B.Tech. (Full Time) – Nuclear Science and Engineering
Curriculum & Syllabus

2009- 2010

Faculty of Engineering & Technology
SRM University
SRM Nagar, Kattankulathur – 603 203

SRM UNIVERSITY
B.TECH. NUCLEAR SCIENCE AND ENGINEERING
CURRICULUM AND SYLLABUS
2009-2010

Semester – I

Code	Category	Course	L	T	P	C
Theory						
LE0101	G	English	1	0	2	2
MA0101	B	Mathematics – I	3	2	0	4
PH0101	B	Physics	3	0	0	3
CY0101	B	Chemistry	3	0	0	3
GE0101	E	Basic Engineering – I	4	0	0	4
Practical						
PD 0101	G	Personality Development – I*	0	0	2	0
GE 0107	G	NSS/NCC/NSO/YOGA	0	0	2	1
GE0105	B	Computer Literacy	0	0	2	1
PH0103	B	Physics Laboratory	0	0	2	1
CY0103	B	Chemistry Laboratory	0	0	2	1
ME0120/ME0130	E	Workshop Practice / Engineering Graphics	0/1	0	4	2/3
		Total	**14/15**	**2**	**16**	**22/23**
		Total Contact Hours	**32/33**			

Semester – II

Code	Category	Course	L	T	P	C
Theory						
GE0108	G	Value Education	1	0	0	1
MA0102	B	Mathematics – II	3	2	0	4
PH0102	B	Materials Science	2	0	2	3
GE0102	B	Biology for Engineers	2	0	0	2
GE0104	B	Principles of Environmental Science	2	0	0	2
GE0106	E	Basic Engineering – II	4	0	0	4
NE0102	P	Elements of Nuclear Science and Engineering	3	0	0	3
Practical						
PD0102	G	Personality Development – II*	0	0	2	0
CS0140	B	Computer Practice	1	0	2	2
ME0130/ME0120	E	Engineering Graphics / Workshop Practice	1/0	0	4	3/2
		Total	**18/17**	**2**	**10**	**24/23**
		Total Contact Hours	**30/29**			

G: General programme comprising language/communication skills, humanities and social sciences, economics and principles of management, and NSS/NCC/NSO/YOGA.
B: Basic sciences comprising Computer Literacy with Numerical Analysis, Mathematics, Physics, and Chemistry.
E: Engineering Sciences and Technical Arts comprising Engineering Graphics, Workshop Practice, Basic Engineering, etc.
P: Professional subjects corresponding to the Branch of Studies, which will include core subjects, electives, and project work.

* Audit course

Semester – III

Code	Category	Course	L	T	P	C
Theory						
LE0201/ LE0203/LE0205	G	German / Japanese / French Language Phase – I	2	0	0	2
MA0211	B	Mathematics – III	3	2	0	4
NE0201	E	Mechanics of Materials	3	0	0	3
NE0203	P	Neutron Physics	3	0	0	3
NE0205	P	Materials for Nuclear Applications	3	0	0	3
NE0207	P	Nuclear Thermo Hydraulics – I	3	0	0	3
NE0209	P	Thermodynamics	3	0	0	3
Practical						
PD0201	G	Personality Development – III	0	0	2	1
NE0211	P	Thermodynamics Lab	0	0	3	2
NE0213	P	Nuclear Thermo Hydraulics Lab – I	0	0	3	2
		Total	**20**	**2**	**8**	**26**
		Total Contact Hours	**30**			

Semester – IV

Code	Category	Course	L	T	P	C
Theory						
LE0202/ LE0204 /LE0206	G	German / Japanese / French Language Phase – II	2	0	0	2
MA0232	B	Probability and Random Processes	3	2	0	4
NE0204	P	Nuclear Thermo Hydraulics - II	3	0	0	3
NE0206	P	Controlled Thermonuclear Fusion	3	0	0	3
NE0208	P	Design in Nuclear Engineering	3	0	0	3
NE0210	P	Applied Radio Chemistry	3	0	0	3
NE0212	P	Engineering Mechanics and Fluid Mechanics	3	0	0	3
Practical						
PD0202	G	Personality Development – IV	0	0	2	1
NE0214	P	Nuclear Thermo Hydraulics Lab - II	0	0	3	2
NE0216	P	Fluid Mechanics Lab	0	0	3	2
NE0218	P	Comprehension –I[#]	0	2	0	1
		Total	**20**	**4**	**8**	**27**
		Total Contact Hours	**32**			

Review of the core subjects studied up to the current semester

Semester – V

Code	Category	Course	L	T	P	C
Theory						
MB0301	G	Engineering Economics and Management	3	0	0	3
NE0315	E	Molecular and Cell Biology	3	0	0	3
NE0317	E	Computer in Reactor Analysis	3	0	0	3
NE0319	P	Nuclear Reactor Theory – I	3	0	0	3
NE0321	P	Reactor Theory and Kinetics	3	0	0	3
NE0323	P	Biological Effects of Radiation	3	0	0	3
Practical						
PD0301	G	Personality Development – V	1	0	2	2
NE0325	P	Simulation Lab	0	0	3	2
NE0327	P	Nuclear Measurement Lab – I	0	0	3	2
NE0329	P	Industrial Training –I*	0	0	2	1
		Total	**19**	**0**	**10**	**25**
		Total Contact Hours	**29**			

* An industrial training of minimum two weeks has to be undergone by the student in the winter/summer vacation of the III/IV semester.

Semester – VI

Code	Category	Course	L	T	P	C
Theory						
NE0320	E	Fuzzy Approaches in Engineering	3	0	0	3
NE0322	P	Nuclear Reactor Theory – II	3	0	0	3
NE0324	P	Nuclear Fuel Systems	3	0	0	3
	P	Elective I	3	0	0	3
Practical						
PD0302	G	Personality Development – VI	1	0	2	2
NE0326	P	Nuclear Measurement Lab – II	0	0	3	2
NE0328	P	Reactor Lab	0	0	3	2
NE0330	P	Comprehension – II[#]	0	2	0	1
NE0332	P	Computer Skills	1	0	2	2
		Total	**14**	**2**	**10**	**21**
		Total Contact Hours	**26**			

Review of the core subjects studied up to the current semester

Semester – VII

Code	Category	Course	L	T	P	C
Theory						
NE0431	P	Applied Reactor Analysis	3	0	0	3
NE0433	P	Fast Reactor Theory	4	0	0	4
	P	Elective II	3	0	0	3
	P	Elective III	3	0	0	3
Practical						
NE0435	P	Radiology Measurement Lab	0	0	3	2
NE0437	P	Industrial Training – II[**]	0	0	2	1
NE0439	P	Seminar	0	0	2	1
		Total	**13**	**0**	**7**	**17**
		Total Contact Hours	**20**			

[**]An industrial training of minimum two weeks has to be undergone by the student in the winter/summer vacation of the V/VI semester.

Semester – VIII

Code	Category	Course	L	T	P	C
Theory						
	P	Elective IV	3	0	0	3
	P	Elective V	3	0	0	3
Practical						
NE0434	P	Project Work	0	0	17	8
		Total	**6**	**0**	**17**	**14**
		Total Contact Hours	**23**			

Summary Table

Semester	I	II	III	IV	V	VI	VII	VIII	Total	%
Total	22	24	26	27	25	21	17	14	176	100
G	3	1	3	3	5	2	0	0	17	9.7
B	13	13	4	4	0	0	0	0	34	19.2
E	6	7	3	0	6	3	0	0	25	14.1
P	0	3	16	20	14	16	17	14	100	56.8

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 176

LIST OF ELECTIVES

Code	Category	Course	L	T	P	C
NE0001	P	High Intensity Laser Plasma Interactions	3	0	0	3
NE0002	P	Reactor Safety	3	0	0	3
NE0003	P	Special Transducers and Instrumentation	3	0	0	3
NE0004	P	Medical Informatics	3	0	0	3
NE0005	P	Introduction to Rehabilitation Engineering	3	0	0	3
NE0006	P	Human Assist Devices	3	0	0	3
NE0007	P	Modeling of Physiological Systems	3	0	0	3
NE0008	P	Product Design, Management Techniques and Entrepreneurship	3	0	0	3
NE0009	P	Intellectual Property Rights, Innovation and Technology	3	0	0	3
NE0010	P	Engineering of Nuclear Power Systems	3	0	0	3
NE0011	P	Operations Research	3	0	0	3

NOTE:
All electives having odd numbers shall be offered only during odd semesters, others during even semesters.

SYLLABUS

SEMESTER – I

		L	T	P	C
LE 0101	**ENGLISH**	**1**	**0**	**2**	**2**
	Prerequisite				
	Nil				

PURPOSE

To provide an adequate mastery of communicative English Language training primarily - reading and writing skills, secondarily listening and speaking skills.

INSTRUCTIONAL OBJECTIVES

To provide language training to the engineering students which will enable them to understand and acquire knowledge in technical subjects.

LISTENING

Listening Practice – Hints on Listening – Listening Practice
Note Taking: Note Taking Strategies

SPEAKING

Definitions: Expressing Opinions (agreement / disagreement)-Offering Suggestions – Technical Definitions – Describing Objects – speaking practice.
Phonetics: Pronunciation-Phonetic Transcription-Stress-Intonation

READING

Comprehension: Skimming-scanning-close reading-Comprehension – Transferring Information – Exercise – An unseen passage should be given and questions may be asked in the form of True or False statements, MCQ, short answers.
Transcoding : Interpreting tables, flow charts, pie chart, bar diagram, tree diagram, graphs.

WRITING

Art of Writing: Writing Language – Rules for effective writing – Technical Essay Writing – Exercise
Report Writing: Technical Writing – Lab Report – Exercise
Letter Writing : Formal Letters – Letter to the Editor – Letter Inviting Dignitaries – Letter of Application Curriculum Vitae – Placing an Order.
Dialogue Writing

FOCUS ON AND COMMUNICATION AND "COMPUNICATION"

Communication : Basic Concepts – Process – Kinds – Routes – Forms – Factors – Barriers – Triangles Communication (Communicate through Computers – Power Point & Tele Conference).

INTERNAL ASSESSMENT

Based on the submission of Assignments and test performance of the students marks will be awarded.

TEXT BOOKS

1. Abraham Benjamin Samuel *"Practical Communication Communicative English LSRW2000"* – SRMEC – June 2006 Revised Edition.
2. Staff of the Department of Humanities and Social Science, Anna University, *"English for Engineers / Technologist,"* Vol.-I. Orient Longman, 1990.

REFERENCE BOOKS

1. Herbert. A. J. *"The structure of Technical English",* Orient Longman 1995.
2. Pickett and Laster, *"Technical English, Writing, Reading and Speaking"*, New York Harper and Row Publications, 1997.
3. "*Interactive course in phonetics and spoken English"* published by Acoustics Engineers (ACEN) 2002.
4. Munter, Mary, *"Business Communication Strategy and Skill"*, Prentice Hall Inc, New Jersey, 1987.

		L	T	P	C
MA 0101	**MATHEMATICS –I**	**3**	**2**	**0**	**4**
	Prerequisite				
	Nil				

PURPOSE

To impart analytical ability in solving mathematical problems as applied to the respective branches of Engineering.

INSTRUCTIONAL OBJECTIVES

At the end of the course, student should be able

1. To apply advanced matrix knowledge to Engineering problems.
2. To improve their ability in solving geometrical applications of differential calculus problems.
3. To equip themselves familiar with the functions of several variables.
4. To familiarize with the applications of differential equations.
5. To expose to the concept of three dimensional analytical geometry.

MATRICES

Characteristic equation – Eigen values and eigen vectors of a real matrix – Properties of eigen values – Caley-Hamilton theorem – Orthogonal reduction of a symmetric matrix to diagonal form – Orthogonal matrices – Reduction of quadratic form to canonical form by orthogonal transformations.

GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS

Curvature – Cartesian and polar coordinates – Circle of curvature – Involutes and Evolutes – Envelopes – Properties of envelopes.

FUNCTIONS OF SEVERAL VARIABLES

Function of two variables – Partial derivatives – Total differential – Taylor's expansion – Maxima and Minima – Constrained Maxima and Minima by Lagrangean Multiplier method – Jacobians

ORDINARY DIFFERENTIAL EQUATIONS

Simultaneous first order linear equations with constant coefficients – Linear equations of second order with constant and variable coefficients – Homogeneous equation of Euler type – Equations reducible to homogeneous form.

THREE DIMENSIONAL ANALYTICAL GEOMETRY

Direction cosines and ratios – Angle between two lines – Equation of a plane – Equation of a straight line – Co-planar lines – Shortest distance between skew lines – Sphere – Tangent plane – Plane section of a sphere – Orthogonal spheres.

TEXT BOOK

1. Grewal B.S, Higher Engg Maths, Khanna Publications, 38th Edition., Veerajan, T., *"Engineering Mathematics"*, Tata McGraw Hill Publishing Co., New Delhi,2000.
2. Dr.V.Ramamurthy & Dr. Sundarammal Kesavan, *"Engineering Mathematics"*, – Vol I & II Anuradha Publications, Revised Edition 2006.

REFERENCE BOOKS

1. Kreyszig.E, *"Advanced Engineering Mathematics"*, 8th edition, John Wiley & Sons. Singapore,2001.
2. Kandasamy P etal. *"Engineering Mathematics"*, Vol.I (4th revised edition), S.Chand &Co., New Delhi,2000.
3. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., *"Advanced Mathematics for Engineering students"*, Volume I (2nd edition), S.Viswanathan Printers and Publishers, 1992.
4. Venkataraman M.K., *"Engineering Mathematics"* – First Year (2nd edition), National Publishing Co., Chennai,2000.

		L	T	P	C
PH0101	**PHYSICS**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to develop scientific temper and analytical capability through learning physical concepts and their applications in engineering and technology. Comprehension of some basic physical concepts will enable the students to logically solve engineering problems.

INSTRUCTIONAL OBJECTIVES

At the end of the course, the student will be able to:

Understand the general scientific concepts required for technology,
Apply the concepts in solving engineering problems,
Explain scientifically the new developments in engineering and technology, and
Get familiarized with the concepts, theories, and models behind many technological applications.

PROPERTIES OF MATTER AND SOUND

Properties of Matter: Hooke's law – Twisting couple on a cylinder – Shafts – Torsion pendulum – Bending of beams – Bending moment – Uniform bending and non-uniform bending – I shape girder. **Sound:** Shock waves – Mach number (simple problems) – Ultrasonic production (magnetostriction and piezoelectric methods) and application – Acoustics of buildings – Sources and impacts of noise – Sound level meter – Control of noise pollution.

ELECTROMAGNETISM AND MICROWAVES

Electromagnetism: Divergence, curl and gradient – Maxwell's equations – Wave equation for electromagnetic waves – Propagation in free space – Poynting vector – Rectangular and circular wave guides. **Microwaves:** Properties and applications – Generation by magnetron and reflex klystron oscillator – Traveling wave tube – Biological effects.

OPTICS

Photometry: Principles and Lummer-Brodhun photometer. **Lasers:** Principles and characteristics – Types of lasers (CO_2, excimer, NdYAG, GaAs, free electron) – Holographic mass storage. **Optical Fiber:** Principles – Physical structure and types – Optical fiber communication. **Photo elasticity:** Theory and applications.

CRYSTAL PHYSICS AND CRYOGENICS

Crystal Physics: Crystal directions – Planes and Miller indices – Basic symmetry elements – Translational symmetry elements – Reciprocal lattice – Diamond and HCP crystal structure – Imperfections in crystals. **Cryogenics:** Methods of liquefaction of gases (cascade process, Linde's process, and adiabatic demagnetization process) – Measurement of cryogenic temperatures.

ENERGY PHYSICS

Introduction to non-conventional energy sources – Solar cells – Thermoelectric power generators – Thermionic power generator – Magneto hydrodynamic power generator – Fuel cells (H_2O_2) – Solid state batteries (Lithium) – Low voltage and high voltage nuclear cells – Thermocouple based nuclear cell – Ultra capacitors.

TEXT BOOKS

1. Arumugam, M., "*Engineering Physics*", 2nd edition, Anuradha Publishers, Kumbakonam, 2003.
2. Gaur and Gupta, "*Engineering Physics*", 7th edition, Dhandapani and Sons, New Delhi, 1997.
3. Thiruvadigal, J. D., Ponnusamy, S., Vasuhi, P. S. and Kumar, C., "*Physics for Technologists*", 5th edition, Vibrant Publication, Chennai, 2007.

REFERENCE BOOKS

1. Vasudeva, A. S., "*Modern Engineering Physics*", revised edition, S. Chand and Company Ltd., New Delhi, 2004.
2. Vasudevan, D. N., "*Fundamentals of Magnetism and Electricity*", 11th edition, S. Chand and Company Ltd., New Delhi, 1983.
3. Nair, K. P. R., "*Atoms, Molecules and Lasers*", Narosa Publishing House, New Delhi, 2006.
4. Pillai, S. O., "*Solid State Physics*",5th edition, New Age International (P) Ltd., New Delhi, 2004.
5. Khan, B. H., "*Non-Conventional Energy Resources*", Mechanical Engineering Series, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.

		L	T	P	C
CY0101	**CHEMISTRY**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.

INSTRUCTIONAL OBJECTIVES

The students should be conversant with

The role of applied chemistry in the field of engineering.
The knowledge of water quality parameters and the treatment of water.
The principles involved in corrosion and its inhibitions.
Important analytical techniques, instrumentation and the applications.
Knowledge with respect to the phase equlibria of different systems.

TECHNOLOGY OF WATER

Water quality parameters: Physical, Chemical & Biological - Hardness of water – estimation of hardness (EDTA method & O. Hehner"s method), Alkalinity – determination – disadvantages of using hard water in boilers: Scale, sludge formation – disadvantages – prevention – treatment: Internal conditioning – phosphate, calgon and carbonate conditioning methods – External: Zeolite, ion exchange methods - desalination – reverse osmosis and electrodialysis - domestic water treatment.

CORROSION AND ITS CONTROL

Corrosion: Basic concepts – principles, mechanism of chemical, electrochemical corrosion – Pilling Bedworth rule – galvanic corrosion – differential aeration corrosion - pitting corrosion - stress corrosion - factors influencing corrosion.

Corrosion control: cathodic protection – sacrificial anodic method – corrosion inhibitor. Protective coatings: surface preparation for metallic coatings - electro plating and electroless Plating - chemical conversion coatings – anodizing, phosphating & chromate coating.

PHASE EQUILIBRIA

Phase rule: Statement – explanation of the terms involved - one component system (water system only). Condensed phase rule - thermal analysis – two component systems: simple eutectic, Pb-Ag; Br, Cd - solid solution Cu-Ni and compound formation Mg-Zn - applications of eutectics.

POLYMERS AND REINFORCED PLASTICS

Classification of polymers – types of polymerization reactions – mechanism of addition polymerization: free radical, ionic and ziegler – Natta - effect of structure on the properties of polymers – strength, plastic deformation, plastics elasticity and physical nature –Preparation and properties of important resins:- Polyethylene, PVC, PMMA, Polyester, Teflon Bakelite, Epoxy resins, compounding of plastics, moulding methods - injection, extrusion, compression and calendaring - reinforced plastics – FRP – Carbon, Graphite, Glass– applications.

INSTRUMENTAL METHODS OF ANALYSIS

Basic principles, instrumentation of potentiometry, flame photometry – applications. Elementary theory – principle – instrumentation of UV – visible spectroscopy and atomic absorption spectroscopy and infrared spectroscopy.

TEXT BOOKS

1. Jain.P.C and Monika Jain, "*Engineering Chemistry*", Danpat Raj publishing company (P) Ltd, New Delhi – 2002.
2. Dara.S.S, "*Text book of Engineering Chemistry"*, S. Chand & Company Ltd, New Delhi 2003.
3. Willard H.A., Merit L.L and Dean J.A., "*Instrumental methods of analysis*" 6th Edition Van Nostrand, 1986.

REFERENCE BOOKS

1. Kuriacose J.C. and Rajaram J. "*Chemistry in Engineering and Technology"*, Volume II, Tata McGraw Hill p.b. Co., 1988.
2. Jeyalakshmi.R & Ramar. P, "*Engineering Chemistry*", 1st Edition, Devi Publications, Chennai 2006.
3. Kamaraj.P & Arthanareeswari. M, "*Applied Chemistry"*, 2nd Edition, Sudhandhira Publications, 2003.
4. Arivalagan. K, "*Engineering Chemistry*", 1st Edition, Mass publications, 2007.
5. P.Kamatchi, "*Applied Chemistry-I"*, Ponnuswamy publications, Chennai.
6. Dr. Helen P Kavitha , "*Engineering Chemistry* – I" ILA Publications, 2002

		L	T	P	C
GE 0101	**BASIC ENGINEERING – I**	**4**	**0**	**0**	**4**
	Prerequisite				
	Nil				

PART A - CIVIL ENGINEERING

PURPOSE

To get exposed to the glimpses of Civil Engineering topics that is essential for an Engineer.

INSTRUCTIONAL OBJECTIVES

To know about different materials and their properties.
Engineering aspects related to buildings.
To know about importance of surveying.
To know about the transportation systems.
To get exposed to the rudiments of engineering, related to Dams, Water Supply, Transportation system and Sewage Disposal.

BUILDING MATERIALS AND THEIR PROPERTIES

Introduction - Civil Engineering – Building Materials – Brick, Stone, Cement, Steel, Concrete, timber – Properties – Uses. Units – Stress, strain and three modulii of elasticity – factor of safety - Centre of Gravity and Moment of Inertia for rectangle and circular section – simple problems.

BUILDINGS AND THEIR COMPONENTS

Buildings – Classification - Components of buildings and their functions Foundations - functions – classification of foundations – Bearing capacity Floorings – functions - Types - Cement Concrete flooring – Mosaic flooring - Marble flooring Roofs - Types – Requirements – Madras Terrace roof. Tall structure – types of structural systems.

UTILITY AND SERVICES

Surveying - Objective – Principles – Classification – Instruments used for Surveying. Dams - Purpose – Selection of site – Classification – Gravity dam (cross-section details only) Transportation system - Classification – Roadway - components – classification of roads - Railway – Cross-section of permanent way-components parts and functions. Docks and Harbour – classification – Terminology Bridges –components of a bridge - types of bridges. Water supply - Sources - Standards of drinking water (BIS) – elementary treatment methods – RO System Sewage disposal – Septic tank – function and components.

TEXT BOOKS

1. Raju K.V.B., Ravichandran P.T., *"Basics of Civil Engineering"*, Ayyappa Publications, Chennai, 2000.
2. Ramesh Babu, "*Civil Engineering "*, VRB Publishers, Chennai, 2000.

REFERENCE BOOKS

1. Rangwala,S.C., "*Engineering Materials"*, Charotar Publishing House, Anand, 1980.
2. National Building Code of India, Part V, "*Building Materials"*, 2005
3. Surendra Singh, "*Building Materials"*, Vikas Publishing Company, New Delhi, 1996

PART B MECHANICAL ENGINEERING

PURPOSE
To familiarize the students with the basics of Mechanical Engineering.

INSTRUCTIONAL OBJECTIVES
To familiarize with
The basic machine elements
The Sources of Energy and Power Generation
The various manufacturing processes

MACHINE ELEMENTS
Springs: Helical and leaf springs – Springs in series and parallel. **Cams:** Types of cams and followers – Cam profile. **Power Transmission:** Gears (terminology, spur, helical and bevel gears, gear trains). Belt drives (types). Chain drives. **Simple Problems.**

ENERGY
Sources: Renewable and non-renewable (various types, characteristics, advantages/disadvantages). **Power Generation:** External and internal combustion engines - Hydro and nuclear power plants (layouts, element/component description, advantages, disadvantages, applications). **Simple Problems.**

MANUFACTURING PROCESSES
Sheet Metal Work: Introduction – Equipments – Tools and accessories – Various processes (applications, advantages / disadvantages). **Welding:** Types – Equipments – Tools and accessories – Techniques employed (applications, advantages / disadvantages (gas and arc welding only)) – Gas cutting – Brazing and soldering. **Lathe Practice:** Types - Description of main components – Cutting tools – Work holding devices – Basic operations. **Simple Problems**. **Drilling Practice:** Introduction – Types – Description – Tools. **Simple Problems**.

TEXT BOOKS

1. Kumar, T., Leenus Jesu Martin., and Murali, G., "*Basic Mechanical Engineering*", Suma Publications, Chennai, 2007.
2. Prabhu, T. J., Jai Ganesh, V., Jebaraj, S., "*Basic Mechanical Engineering*", Scitech Publications, Chennai, 2000.

REFERENCE BOOKS

1. Hajra Choudhary, S.K. and Hajra Choudhary, A. K., "*Elements of Manufacturing Technology*", Vols. I & II, Media Publishers, 1986.
2. Nag, P.K., "*Power Plant Engineering*", Tata McGraw-Hill, New Delhi, 2006.
3. Palanichamy, M.S., "*Basic Civil & Mechanical Engineering*", Tata McGraw-Hill , New Delhi 1991.
4. Nagpal G. R., "*Power Plant Engineering*", Khanna Publisher, Delhi,2004

		L	T	P	C
PD 0101	**PERSONALITY DEVELOPMENT - I**	**0**	**0**	**2**	**0**
	Prerequisite				
	Nil				

PURPOSE
The purpose of this course is to build confidence and inculcate various soft skills and to help students to identify and achieve their personal potential.

INSTRUCTIONAL OBJECTIVES
1. To guide thought process.
2. To groom student's attitude.
3. To develop communication skill.
4. To build confidence.

METHODOLOGY

The entire program is designed in such a way that every student will participate in the class room activities. The activities are planned to bring out the skills and talents of the students which they will be employing during various occasions in their real life.

1. Group activities + individual activities.
2. Collaborative learning.
3. Interactive sessions.
4. Ensure Participation
5. Empirical Learning

Self-analysis SWOT - Time management - Creative chain story telling

Vocabulary games I – Attitude - Interpersonal skills

Motivation I - Vocabulary games II - Article review

Team building exercise - Critical thinking - Event Management

Business situation - Leadership Qualities - Review

SCHEME OF INSTRUCTION

Marks allocated for regular participation in all oral activities in class

SCHEME OF EXAMINATION

Complete internal evaluation on a regular basis.

		L	T	P	C
GE0107	**NSS/NCC/NSO/YOGA**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

I. YOGA SYLLABUS

	PRACTICE	LECTURE
I	Meditation – Agnai, Asanas, Kiriyas, Bandas, Muthras	Benefits of Agnai Meditation
II	Meditation Santhi Physical Exercises (I & II)	Benefits of santhi Meditation
III	Kayakalpa Yoga Asanas, Kiriyas, Bandas, Muthras	Lecture & Practice
IV	Meditation Santhi Physical Exercises III & IV	Analysis of Thought
V	Meditation Thuriyam Kayakalpa Asanas, Kiriyas, Bandas, Muthras	Benefits of Thuriyam
VI	Meditation Thuriyam Kayakalpa Asanas, Kiriyas, Bandas, Muthras	Attitude
VII	Meditation Thuriyam Kayakalpa Asanas, Kiriyas, Bandas, Muthras	Importance of Arutkappy & Blessings
VIII	Meditation Santhi Kayakalpa Asanas, Kiriyas, Bandas, Muthras	Benefits of Blessings
		Hours = 30

TEXT BOOKS:

1. Vedatri Maharshi , *"Yoga for Modern Age"*
2. Vedatri Maharshi, *" Simplified Physical Exercises"*

NATIONAL SPORTS ORGANISATION (NSO)

Each student must select two of the following games and practice for two hours per week. An attendance of 80% is compulsory to earn the credits specified in the curriculum.

List of games:

Basket Ball
Football
Volley Ball
Ball Badminton
Cricket
Throw ball

NATIONAL CADET CORE (NCC)

Any student enrolling as a member of National Cadet Core (NCC) will have to attend sixteen parades out of twenty parades each of four periods over a span of an academic year.

Attending eight parades in first semester will qualify a student to earn the credits specified in the curriculum.

IV. NATIONAL SERVICE SCHEME (NSS)

A student enrolling as member of NSS will have to complete 60 hours of training / social service to be eligible to earn the credits specified in the curriculum.

		L	T	P	C
GE0105	**COMPUTER LITERACY**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

This Lab Course will enable the students to understand the basics of computer and to know the basics of MS-Office.

INSTRUCTIONAL OBJECTIVES

1. To learn the basics of computer.
2. To work on MS-Word, MS-Excel, MS-Power Point and MS-Access

EXPERIMENTS TO IMPLEMENT

Study experiment on evolution of computer programming languages.
Suggest some of the Network Topologies that can be incorporated in your campus. Justify your choice.
Experiments to demonstrate directory creation and file creation.
Create a document with all formatting effects.
Create a document with tables.
Create labels in MS word.
Create a document to send mails using mail merge option.
Create an Excel File to analyze the student's performance. Create a chart for the above data to depict it diagrammatically.
Create Excel sheet to use built-in-function.
Create Excel sheet to maintain employee information and use this data to send mails using mail merge.
Create a Power Point presentation for your personal profile with varying animation effects with timer.
Consider student information system which stores student personal data, mark information and non academic details.

* Use MS-Access to create Tables and execute SQL queries to do this following
* Display all student records.
* Display student details with respect to his identity.
* Delete some records from the table.
* Find total marks obtained by student in each list.

TEXT BOOK

1. "*Introduction to Information Technology*" ITL Education Solutions Ltd., Pearson 2nd Edition, 2006.

		L	T	P	C
PH 0103	**PHYSICS LABORATORY**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to develop scientific temper and analytical capability among the engineering students.

INSTRUCTIONAL OBJECTIVES

At the end of the course, the student will be able to:

Understand scientific concepts in measurement of different physical variables
Develop the skill in arranging and handling different measuring instruments
Get familiarized with the errors in various measurements and planning / suggesting how these contributions may be made of the same order so as to make the error in the final result small.

LIST OF EXPERIMENTS

Determination of Young's Modulus of the material – Uniform bending
Determination of Rigidity Modulus of the material – Torsion Pendulum
Determination of velocity of Ultrasonic waves in liquids
Determination of dispersive power of a prism using spectrometer
Determination of laser parameter – Divergence and wavelength for a given laser source – laser grating
Particle size determination using laser
Study of attenuation and propagation characteristics of optical fiber cable
Calibration of voltmeter using potentiometer.
Calibration of ammeter using potentiometer.
Construction and study of regulation properties of a given power supply using IC

REFERENCE BOOKS

1. Chattopadhyay, D., Rakshit, P. C. and Saha, B., "*An Advanced Course in Practical Physics*", 2nd edition, Books & Allied Ltd., Calcutta, 1990.
2. Chauhan and Singh, "*Advanced Practical Physics"*, revised edition, Pragati Prakashan, Meerut, 1985.
3. Thiruvadigal. J. D., Ponnusamy. S., Vasuhi. P. S. and Kumar. C, "*Hand Book of Practical Physics"*, 5th edition, Vibrant Publication, Chennai, 2007.

		L	T	P	C
CY 0103	**CHEMISTRY LABORATORY**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

An integrated laboratory course consists of experiments from applied chemistry and is designed to illustrate the underlying principles of measurement techniques, synthesis, dynamics and chemical transformation.

INSTRUCTIONAL OBJECTIVES

Students should be able to understand the basic concept and its applications.

LIST OF EXPERIMENTS

Preparation of standard solutions.
Estimation of total hardness, permanent and temporary hardness by EDTA method.
Conductometric titration – determination of strength of an acid.
Estimation of iron by potentiometer – titration.
Determination of molecular weight of polymer by viscosity average – method.
Determination of dissolved oxygen in a water sample by Winkler"s method
Determination of Na / K in water sample by Flame photometry.
Estimation of Copper in ore.
Estimation of nickel in steel.
Determination of total alkalinity and acidity of a water sample.

REFERENCE

1. Chemistry department manual, Edition, 2003.

		L	T	P	C
ME 0120	**WORKSHOP PRACTICE**	**0**	**0**	**4**	**2**
	Prerequisite				
	Nil				

PURPOSE

To provide the students with, hands on experience on different trades of engineering like fitting, carpentry, smithy, welding and sheet metal.

INSTRUCTIONAL OBJECTIVES

To familiarize with

The basics of tools and equipments used in fitting, carpentry, sheet metal, welding and smithy.

The production of simple models in the above trades.

LIST OF EXPERIMENTS

EMPHASIS TO BE LAID ON REAL LIFE APPLICATIONS WHEN FRAMING THE EXERCISES.

FITTING

Tools & Equipments – Practice in Filing and Drilling.
Making Vee Joints, Square, dovetail joints, Key Making.

CARPENTARY

Tools and Equipments- Planning practice. Making Half Lap, dovetail, Mortise & Tenon joints, a mini model of a single door window frame.

SHEET METAL

Tools and equipments - Fabrication of a small cabinet, Rectangular Hopper, etc.

WELDING

Tools and equipments - Arc welding of butt joint, Lap Joint, Tee Fillet. Demonstration of Gas welding, TIG & MIG.

SMITHY

Tools and Equipments –Making simple parts like hexagonal headed bolt, chisel.

TEXT BOOKS

1. Gopal, T.V., Kumar, T., and Murali, G., *"A first course on workshop practice – Theory, practice and work book"*, Suma Publications, 2005.

REFERENCE BOOKS

1. Kannaiah,P. & Narayanan,K.C. "*Manual on Workshop Practice"*, Scitech Publications, Chennai, 1999.
2. Venkatachalapathy, V.S. "*First year Engineering Workshop Practice"*, Ramalinga Publications, Madurai, 1999.

		L	T	P	C
ME 0130	**ENGINEERING GRAPHICS**	**1**	**0**	**4**	**3**
	Prerequisite				
	Nil				

(Only First Angle Projection is to be followed)

PURPOSE

To draw and interpret various projections of 1D, 2D and 3D objects.

To prepare and interpret the drawings of buildings.

INSTRUCTIONAL OBJECTIVES

To familiarize with

The construction of geometrical figures
The projection of 1D, 2D & 3D elements
Sectioning of solids and development of surfaces
Preparation and interpretation of building drawing

FUNDAMENTALS OF ENGINEERING GRAPHICS

Lettering, two dimensional geometrical constructions, conics, representation of three-dimensional objects – principles of projections – standard codes – projection of points.

PROJECTION OF LINES AND SOLIDS

Projection of straight lines, projection of solids – auxiliary projections

SECTIONS AND DEVELOPMENTS

Sections of solids and development of surfaces.

PICTORIAL PROJECTIONS

Conversion of projections: Orthographic projection, isometric projection of regular solids & combination of solids.

BUILDING DRAWING

Building Drawing – plan, elevation and section of single storied residential (or) office building with flat RCC roof and brick masonry walls having not more than 3 rooms (planning / designing is not expected in this course).

TEXT BOOKS

1. Jeyapoovan, T., *"Engineering Drawing and Graphics using AutoCAD 2000"*, Vikas Publishing house Pvt Ltd, NewDelhi, 2005.
2. Narayanan, K.L & Kannaiah, P., *"Engineering Graphics"*, Scitech Publications, Chennai, 1999.

REFERENCE BOOKS

1. Bhatt, N.D., *"Elementary Engineering Drawing (First Angle Projection)"*, Charotar Publishing Co., Anand, 1999.
2. Venugopal, K. *"Engineering Drawing & Graphics"*, New Age international Pvt. Ltd., 2001.
3. Natarajan, K.V. *"Engineering Drawing & Graphics"*, Private Publication, Chennai, 1990.
4. Shah, M.B. and Rana, B.C., *"Engineering Drawing"*, Pearson Education (Singapore) Pvt. Ltd., Delhi – 110 092, 2005.

II SEMESTER

		L	T	P	C
GE 0108	**VALUE EDUCATION**	**1**	**0**	**0**	**1**
	Prerequisite				
	Nil				

PURPOSE

To provide guiding principles and tools for the development of the whole person recognizing that the individual is comprised of Physical, Intellectual, Emotional and Spiritual dimensions.

INSTRUCTIONAL OBJECTIVES

To help individuals think about and reflect on different values.

To deepen understanding, motivation and responsibility with regard to making personal and social choices and the practical implications of expressing them in relation to themselves, others, the community and the world at large.

To inspire individuals to choose their own personal, social, moral and spiritual values and be aware of practical methods for developing and deepening

Value Education—Introduction – Definition of values – Why values? – Need for Inculcation of values – Object of Value Education – Sources of Values – Types

Values:

Personal values
Social values
Professional values
Moral and spiritual values
Behavioral (common) values

Personal values – Definition of person – Self confidence – Self discipline – Self Assessment – Self restraint – Self motivation – Determination – Ambition – Contentment – Humility and Simplicity - Sympathy and Compassion – Gratitude -Forgiveness – Honesty – Courtesy.

Social values – Definition of Society – Units of Society - Individual, family, different groups – Community – Social consciousness – Equality and Brotherhood – Dialogue – Tolerance – Sharing – Responsibility – Co-operation Freedom – Repentance and Magnanimity.

Professional values – Definition – Competence – Confidence – Devotion to duty –Efficiency – Accountability – Respect for learning /learned – Willingness to learn-Open and balanced mind – Team spirit – Professional Ethic – Willingness for Discussion – Aims – Effort – Avoidance of Procrastination and slothfulness –Alertness.

Behavioral values – Individual values and group values – Good manners at home and outside – Equality – Purity of thought, speech and action – Understanding the role of religion – Faith – Understanding the commonness of religions – respect for other faiths – unity in diversity – Living together – Tolerance – Non-violence – Truthfulness – Common aim – Unified effort towards peace – Patriotism.

REFERENCE BOOKS

1. Dr. S. Ignacimuthu S. J., *"Values for life"*, Better yourself Books, Bandra Mumbai-600 050 (1999).
2. *"Values(Collection of Essays)"*., Published by : Sri Ramakrishna Math., Chennai—4.,(1996)
3. Prof. R.P.Dhokalia., "*Eternal Human Values*", NCRT –Campus Sri Aurobindo Marg., New Delhi - 110 011.
4. Swami Vivekananda., "*Education*", Sri Ramakrishna Math., Chennai-4(1957)
5. "*Tirukural*" (English Translation by Dr.G.U.Pope).
6. "*The Bible*"
7. "*The Kuran*"
8. "*The Bagavath Geetha*"

		L	T	P	C
MA0102	**MATHEMATICS II**	**3**	**2**	**0**	**4**
	Prerequisite				
	MA0101				

(Common to all Branches of Engineering except BT, BP, BI, BME, FPE, & GE)

PURPOSE

To impart analytical ability in solving mathematical problems as applied to the respective branches of Engineering.

INSTRUCTIONAL OBJECTIVES

At the conclusion of the course, students should have understood Multiple Integrals , Laplace Transforms, Vector Calculus and Functions of a complex variable including contour integration and able to apply to all their Engineering problems.

MULTIPLE INTEGRALS

Double integration in Cartesian and polar coordinates – Change of order of integration – Area as a double integral – Triple integration in Cartesian coordinates.

LAPLACE TRANSFORMS

Transforms of simple functions – Basic operational properties – Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – periodic functions – Applications of

Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients only.

VECTOR CALCULUS

Gradient, divergence, curl – Solenoidal and irrotational fields – Vector identities (without proof) – Directional derivatives – Line, surface and volume integrals – Statements of Green's, Gauss divergence and Stroke's theorems only – Verification and applications to cubes and parallelopipeds only.

ANALYTIC FUNCTIONS

Definition of Analytic Function – Cauchy Riemann equations – Properties of analytic functions - Determination of harmonic conjugate – Milne-Thomson's method – Conformal mappings: 1/z, az az+b and bilinear transformation.

COMPLEX INTEGRATION

Line integral – Cauchy's integral theorem (without proof) – Cauchy's integral formulae (with proof) – application of Cauchy's integral formulae – Taylor's and Laurent's expansions (statements only) – Singularities – Poles and Residues – Cauchy's residue theorem (with proof) - Evaluation of line integrals.

TEXT BOOK

1. Grewal B.S, *"Higher Engg Math"s*, Khanna Publications, 38th Edition.
2. Veerajan, T., *"Engineering Mathematics"*, Tata McGraw Hill Publishing Co., New Delhi, 2000.
3. Dr.V.Ramamurthy & Dr. Sundarammal Kesavan, *"Engineering Mathematics – Vol I & II"*, Anuradha Publications, Revised Edition 2006.

REFERENCE BOOKS

1. Kreyszig.E, *"Advanced Engineering Mathematics"*, 8th edition, John Wiley & Sons. Singapore,2001.
2. Kandasamy P etal. *"Engineering Mathematics, Vol.I"* (4th revised edition), S.Chand &Co., New Delhi,2000.
3. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., *"Advanced Mathematics for Engineering students, Volume I"*, (2nd edition), S.Viswanathan Printers and Publishers, 1992.
4. Venkataraman M.K., *"Engineering Mathematics – First Year"*, (2nd edition), National Publishing Co., Chennai, 2000.

		L	T	P	C
PH 0102	**MATERIALS SCIENCE**	**2**	**0**	**2**	**3**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to develop comprehension of the rapidly changing technological scenario and the requisite expertise for appropriate selection of materials for specific engineering applications.

INSTRUCTIONAL OBJECTIVES

At the end of the course, the student will be able to:

1. Understand electrical properties of materials,
2. Understand the properties and applications of semi conducting materials,
3. Understand general properties and applications of magnetic and dielectric materials,
4. Understand the behavior of materials on exposure to light,
5. Understand general properties and application of modern engineering and bio materials, and
6. Get familiarized with the concepts of Nano Science and Technology.

ELECTRONIC AND PHOTONIC MATERIALS

Electronic materials: Importance of Classical and Quantum free electron theory of metals – Fermi energy and Fermi Dirac distribution function – Variation of Fermi level with temperature in intrinsic and extrinsic semiconductors – Hall effect – Dilute Magnetic Semiconductors (DMS) and their applications – High

temperature Superconductivity. Photonic materials: LED and LCD materials – Photo conducting materials – Nonlinear optical materials (elementary ideas) and their applications.

MAGNETIC, DIELECTRIC AND MODERN ENGINEERING MATERIALS

Magnetic materials: Ferrites and garnets – Magnetic bubbles and their applications – Giant Magneto Resistance (GMR) – Colossal Magneto Resistance (CMR).

Dielectric materials: Various polarization mechanisms in dielectrics (elementary ideas) and their frequency and temperature dependence – Dielectric loss – Piezo electric and ferro electric materials and their applications. **Modern engineering materials:** Shape memory alloys – Metallic glasses – Advanced ceramics and composites.

BIO MATERIALS

Classification of biomaterials – Comparison of properties of some common biomaterials – Effects of physiological fluid on the properties of biomaterials – Biological responses (extra and intra vascular system) – Metallic, Ceramic and Polymeric implant materials – Introduction to bio sensors and tissue engineering.

NANO MATERIALS AND NANOTECHNOLOGY

Basic concepts of Nano science and technology – Quantum wire – Quantum well – Quantum dot – Properties and technological advantages of Nano materials – Carbon Nanotubes and applications – Material processing by Sol – Gel method, Chemical Vapour deposition and Physical Vapour deposition – Microwave Synthesis of materials – Principles of SEM, TEM and AFM .

MECHANICAL PROPERTIES OF MATERIALS

Stress Strain diagram for different engineering materials – Engineering and true stress strain diagram – Ductile and brittle material – Tensile strength – Hardness – Impact strength – Fatigue – Creep – Fracture (Types and Ductile to brittle transition) – Factors affecting mechanical properties.

PRACTICALS

1. Band gap determination using Post office box.
2. Dielectric constant measurement.
3. Photoconductivity measurement.
4. Resistivity determination for a semiconductor wafer using Four probe method.
5. Determination of Hall coefficient and carrier type for a semiconductor material.
6. To trace the hysteresis loop for a magnetic material.
7. Magnetic susceptibility – Quincke's method.
8. Determination of thermal conductivity – Lee's Disc method
9. Visit to Nano Technology Laboratory (optional)

TEXT BOOKS

1. S.O. Kasap, *"Principles of Electronic Materials and Devices"*, Tata McGraw Hill Edition, New Delhi, 2002.
2. Van Vlack, L.H., *"Material Science for Engineers"*, 6th edition, .Addision Wesley, 1985.
3. Thiruvadigal, J. D., Ponnusamy, S. and Vasuhi.P. S., *"Materials Science"*, 5th edition, Vibrant Publications, Chennai, 2007.

REFERENCE BOOKS

1. Rolf E. Hummel, *"Electronic Properties of materials"*, Narosa Publishing House, New Delhi, 1994.
2. Raghavan.V., *"Materials Science & Engineering – A First Course"*, 5th edition, Prentice Hall of India, New Delhi,2005.
3. Khanna. O. P., *"A Text Book of Material Science & Metallurgy"*, Revised edition, Dhanpat Rai Publications, New Delhi,2006.
4. Sujata V. Bhat, *"Biomaterials"*, 2nd edition, Narosa Publishing House, New Delhi, 2006.
5. Mick Wilson, Kamali Kannangara, Michells Simmons and Burkhard Raguse, *"Nano Technology – Basic Science and Emerging Technologies"*, 1st edition, Overseas Press,New Delhi,2005.

		L	T	P	C
GE 0102	**BIOLOGY FOR ENGINEERS**	**2**	**0**	**0**	**2**
	Prerequisite				
	Nil				

PURPOSE

To provide a basic understanding of biological mechanisms from the perspective of engineers.

INSTRUCTIONAL OBJECTIVES

To familiarize the students with the basic organization of organisms and subsequent building to a living being. With this knowledge, the student will be then imparted with an understanding about the machinery of the cell functions that is ultimately responsible for various daily activities. Nervous and immune systems will be taught as examples of this signaling machinery.

FROM ATOMS TO ORGANISMS

The Cell: the Basic Unit of Life - Molecular Components of Cells - Expression of Genetic Information - Protein Structure and Function- Cell Metabolism - Cells Maintain Their Internal Environments - Cells Respond to Their External Environments - Cells Grow and Reproduce - Cells Differentiate

THE MOLECULAR DESIGN OF LIFE

Biochemistry and the Genomic Revolution- . DNA Illustrates the Relation between Form and Function-Biochemical Unity Underlies Biological Diversity-. Chemical Bonds in Biochemistry -. Biochemistry and Human Biology-. Protein Synthesis Requires the Translation of Nucleotide Sequences Into Amino Acid Sequences-.2. Aminoacyl-Transfer RNA Synthetases Read the Genetic Code- A Ribosome Is a Ribonucleoprotein Particle (70S) Made of a Small (30S) and a Large (50S) Subunit-Protein Factors Play Key Roles in Protein Synthesis-. Eukaryotic Protein Synthesis Differs from Prokaryotic Protein Synthesis Primarily in Translation Initiation

CATALYTIC STRATEGIES

Proteases: Facilitating a Difficult Reaction-. Making a Fast Reaction Faster: Carbonic Anhydrases-. Restriction Enzymes: Performing Highly Specific DNA-Cleavage Reactions- Nucleoside Monophosphate Kinases: Catalyzing Phosphoryl Group Exchange between Nucleotides Without Promoting Hydrolysis- metabolism-anabolism and catabolism-photosynthesis and carbon fixation- biological energy production.

MECHANOCHEMISTRY

How Protein Motors Convert Chemical Energy into Mechanical Work- Brief Description of ATP Synthase Structure- The F1 Motor: A Power Stroke-A Pure Power Stroke- Coupling and Coordination of Motors-Measures of Efficiency- F1-Motor of ATP synthase- The Bacterial Flagellar Motor- Motor Driven by H_ and Na_ Ion Flux- Proton Motive Force, Sodium-motive Force, Ion Flux- Molecular Motor Directionality- Chimeric Kinesin Motors- Backwards Myosins- Chimeric Myosin Motors- Bidirectional Dyneins?

SENSORY AND IMMUNO SYSTEMS

General Principles of Cell Signaling-Signaling via G-Protein-linked Cell-Surface Receptors-Signaling via Enzyme-linked Cell-Surface Receptors-Target-Cell Adaptation-The Logic of Intracellular Signaling: Lessons from Computer-based "Neural Networks"-The Cellular Basis of Immunity-The Functional Properties of Antibodies-The Fine Structure of Antibodies-The Generation of Antibody Diversity-T Cell Receptors and Subclasses-MHC Molecules and Antigen Presentation to T Cells- Cytotoxic T Cells-Helper T Cells and T Cell Activation-Selection of the T Cell Repertoire

TEXT BOOK

1. J.M.Berg, J.L.Tymosczko and L.Sryer. *"Biochemistry"*, W.H. Freeman Publications.
2. "*STUDENT COMPANION to accompany Biochemistry*", Fifth Edition -Richard I. Gumport
3. Frank H. Deis, Nancy Counts Gerber, Roger E. Koeppe, II, *"Molecular motors "*.

REFERENCE BOOKS:

1. Alberts, 2003, "*Molecular Biology of the cell*" Garland Science.
2. Lodish, 2004, *"Molecular cell biology"* FREEMAN.

		L	T	P	C
GE0104	**PRINCIPLES OF ENVIRONMENTAL SCIENCE**	**2**	**0**	**0**	**2**
	Prerequisite				
	Nil				

PURPOSE

The course provides the comprehensive knowledge in environmental science, environmental issues and the management.

INSTRUCTIONAL OBJECTIVES

The importance of environmental education, ecosystem and ethics.
Knowledge with respect to biodiversity and its conservation.
To create awareness on the various environmental pollution aspects and issues.
To educate the ways and means to protect the environment.
Important environmental issues and protection

ENVIRONMENT AND ECOSYSTEMS

Environmental education: definition - scope - objectives and importance. Concept of an ecosystem – types (terrestrial and aquatic ecosystems) – structure and function – ecological succession - food chains, food webs and ecological pyramids

BIODIVERSITY

Introduction: definition - genetic, species and ecosystem diversity - value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values - threats to biodiversity: habitat loss, poaching of wildlife - endangered and endemic species of India, Conservation of biodiversity: in-situ and ex-situ conservations.

POLLUTION AND WASTE MANAGEMENT

Air and water pollution – classification of pollutants and their effects – control measures of air pollution. Waste water treatment (general) – primary, secondary & tertiary stages.
Solid waste management: causes - effects of municipal waste, hazardous waste, bio medical waste - process of waste management.

CURRENT ENVIRONMENTAL ISSUES

Environmental ethics -issues and possible solutions- population explosion, climatic change, ozone layer depletion, global warming, acid rain and green house effect.
Sustainable development: definition, objectives and environmental dimensions of sustainable development-environmental audit for sustainable development.

ENVIRONMENTAL PROTECTION

National and international concern for environment: Important environmental protection acts in India – water, air (prevention and control of pollution) act, wild life conservation and forest act – functions of central and state pollution control boards - international effort – key initiatives of Rio declaration, Vienna convention, Kyoto protocol and Johannesburg summit.

TEXT BOOKS

1. Sharma.B.K. and Kaur, *"Environmental Chemistry"*, Goel Publishing House, Meerut, 1994.
2. De.A.K., *"Environmental Chemistry"*, New Age International, New Delhi, 1996.
3. Kurian Joseph & R. Nagendran, *"Essential of Environmental Studies"*, Pearson Education, 2004.

REFERENCE BOOKS

1. Dara S.S., *"A Text Book of Environmental Chemistry and pollution control"*, S.Chand & Company Ltd., New Delhi, 2004.
2. Jeyalakshmi.R, *"Principles of Environmental Science"*, 1st Edition, Devi Publications, , Chennai 2006.
3. Kamaraj.P & Arthanareeswari.M, *"Environmental Science – Challenges and Changes"*, 1st Edition, Sudhandhira Publications, 2007.
4. Arivalagan.K, Ramar.P & Kamatchi.P, *"Principles of Environmental Science"*, 1st Edition, Suji Publications, 2007.

		L	T	P	C
GE 0106	**BASIC ENGINEERING – II**	**4**	**0**	**0**	**4**
	Prerequisite				
	Nil				

PURPOSE

This course provides comprehensive idea about circuit analysis, working principles of machines and common measuring instruments. It also provides fundamentals of electronic devices, transducers and integrated circuits.

INSTRUCTIONAL OBJECTIVES

At the end of the course students will be able

To understand the basic concepts of magnetic circuits, AC & DC circuits.

To explain the working principle, construction, applications of DC & AC machines and measuring instruments.

To gain knowledge about the fundamentals of electric components, devices, transducers and integrated circuits.

PART A - ELECTRICAL ENGINEERING

ELECTRICAL MACHINES

Definition of mmf, flux and reluctance, leakage flux, fringing, magnetic materials and B-H relationship. Problems involving simple magnetic circuits, Faraday's laws, induced emfs and inductances, brief idea on Hysteresis and eddy currents. Working principle, construction and applications of DC machines and AC machines (1-phase transformers, 3-phase induction motors, single phase induction motors – split phase, capacitor start and capacitor start & run motors).

AC & DC CIRCUITS

Circuit parameters, Ohms law, Kirchhoff's law. Average and RMS values, concept of phasor representation. RLC series circuits and series resonance, RLC parallel circuits (includes simple problems in DC & AC circuits) Introduction to three phase systems – types of connections, relationship between line and phase values. (qualitative treatment only)

WIRING & LIGHTING

Types of wiring, wiring accessories, staircase & corridor wiring, Working and characteristics of incandescent, fluorescent, SV & MV lamps. Basic principles of earthing, simple layout of generation, transmission & distribution of power.

TEXT BOOKS

1. Muthusubramanian.R, Salivahanan.S, Muraleedharan.K.A, "*Basic Electrical, Electronics and Computer Engineering*", Tata McGraw - Hill, 1999.
2. Mehta V K , "*Principles of Electronics*", S Chand & Co,1980

REFERENCE BOOKS

1. Kothari D P and Nagrath I J , "*Basic Electrical Engineering* ", Tata McGraw Hill,1991
2. Mithal G K , "*Electronic Devices and Circuits*", Khanna Publications,1997

PART B - ELECTRONICS ENGINEERING

ELECTRONIC COMPONENTS AND DEVICES

Passive components: Resistors- Inductors and Capacitors and their types.

Semiconductor: Energy band diagram- Intrinsic and Extrinsic semiconductors- PN junction diodes and Zener diodes – characteristics.

Transistors: PNP and NPN transistors – theory of operation – Transistor configurations – characteristics – comparison.

Special semiconductor devices: FET – SCR – LED – V I characteristics – applications.

Rectifiers: Half wave and full wave rectifier – capacitive filter – wave forms – ripple factor – regulation characteristics.

TRANSDUCERS AND MEASURING INSTRUMENTS

Transducers: General features and classification of transducers, Resistive Transducers – Potentiometer, Unbonded strain gauge-Bonded strain gauge-Load cell, Inductive transducers – Differential output transducers – LVDT, Flow transducers, Temperature Transducers – Thermistors, Thermocouple and pyrometers.

Measuring Instruments: Basic principles and classification of instruments, Moving coil and Moving iron instruments, CRO – Principle of operation.

DIGITAL ELECTRONICS & LINEAR ICs

Digital Fundamentals: Number systems – Boolean Theorems – DeMorgan's Theorem - Logic gates – Implementation of Boolean Expression using Gates.

Integrated Circuits: IC fabrication – Monolithic Technique- Function of Operational Amplifier.

TEXT BOOKS

1. Muthusubramanian.R, Salivahanan.S, Muraleedharan.K.A, "*Basic Electrical, Electronics and Computer Engineering*", Tata McGraw - Hill, 1999.
2. Metha V.K, "*Principles of Electronics*", S. Chand & Co., 1980.
3. Kalsi H S, "*Electronics Instrumentation*", ISTE publication,1995

REFERENCE BOOKS

1. Kothari D. P and Nagrath IJ, "*Basic Electrical Engineering*", Tata McGraw- Hill, 1991.
2. Thomas L.Floyd "*Electronic devices*", Addison Wesley Longman (Singapore) Pvt . Ltd., 5th Edition.

NE0102	ELEMENTS OF NUCLEAR SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To introduce to the students the various basic concepts in nuclear science and the theory of nuclear reactors.

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make students familiar with the concepts of radioactivity, nuclear reactions, and reactor physics.

BASIC CONCEPTS IN NUCLEAR PHYSICS

Nuclear constituents – charge, mass, shape, and size of nucleus, Binding energy, packing fraction, nuclear magnetic moment, saturation and short range nuclear forces, Radioactivity – Laws of radioactive decay, half life, mean life, specific activity, Nuclear models – single particle shell model, evidence and limitations of shell model, liquid drop model : Introduction, assumptions, semi-empirical mass formula

MECHANISMS OF NUCLEAR DECAY

Law of radioactive decay, half life, mean life, specific activity, partial radioactive decay, successive disintegration, α decay: Barrier penetration, β decay: Fermi theory, selection rules, parity non-conservation, γ decay of excited states.

NUCLEAR DETECTORS AND ACCELERATORS

Types of detectors, Geiger-Mueller counter, Scintillation counter, classification of accelerators, Cyclotron, Betatron.

INTRODUCTION TO NUCLEAR ENGINEERING

Theories of Nuclear reactions, Conservation laws, Q-value equation, Nuclear fission, explanation on the basis of liquid drop model, energy available from fission, Nuclear chain reaction, Nuclear fusion.

NUCLEAR REACTORS

Nuclear Reactor – Basic principle, classification, constituent parts, Heterogeneous reactor, Swimming pool reactor, Breeder reactor, Heavy water cooled and moderated CANDU type reactors, Gas cooled reactors

TEXT BOOK

D.C.Tayal, Nuclear Physics, Himalayan Publication house, Bombay ,1980.

REFERENCE BOOKS

1. Irving Kaplan, "Nuclear Physics", Narosa Book Distributors, 2002.
2. R.D. Evans, *"The atomc Nucleus", McGraw-Hill,1955.*
3. D.C.Tayal, Nuclear Physics, Himalayan Publication house, Bombay ,1980.
4. J.H.Horlock ,"Combined Power Plants" ,Pergamon Press, 1992.

		L	T	P	C
PD 0102	**PERSONALITY DEVELOPMENT - II**	**0**	**0**	**2**	**0**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to build confidence and inculcate various soft skills and to help students to identify and achieve their personal potential

INSTRUCTIONAL OBJECTIVES

1. To guide thought process.
2. To groom student's attitude.
3. To develop communication skill.
4. To build confidence.

METHODOLOGY

The entire program is designed in such a way that every student will participate in the class room activities. The activities are planned to bring out the skills and talents of the students which they will be employing during various occasions in their real life.

1. Group activities + individual activities.
2. Collaborative learning.
3. Interactive sessions.
4. Ensure Participation.
5. Empirical Learning

Puzzles I - Poster design/Caption/Slogan writing (Social issues) - Bone of contention I – debate
Bone of contention II - Puzzle II - Survey and Reporting (favorite channel, music, food)
Interpretation of Visuals of I & II - Vocabulary games III
Book Review - Quiz I - Presentation Skills I
Presentation Skills II - Analytical Thinking - Review

EVALUATION

1. Activities assessed by both group and individual participation
2. Continuous assessment based on daily participation

SCHEME OF INSTRUCTION

Marks allocated for regular participation in all oral activities in class

SCHEME OF EXAMINATION

Complete internal evaluation on a regular Basis

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		L	T	P	C
CS0140	**COMPUTER PRACTICE**	**1**	**0**	**2**	**2**
	Prerequisite				
	Nil				

PURPOSE:
To introduce programming languages, C and C++ as tools to solve problems and to provide hands on training.

INSTRUCTIONAL OBJECTIVES:
After completing the course, the students should be able to
Understand the program development life cycle
Design algorithms to solve simple problems using computers
Convert algorithms into C and C++ programs and execute

PROGRAMMING FUNDAMENTALS
Computer Basics; Program Development Life Cycle: Flow Chart, Algorithm, Compilation and Execution; Introduction to C Language: program structure, variables, keywords, data types; Input / Output functions: scanf, printf; simple programs.

DECISION AND LOOP CONTROL STRUCTURE
Logical operators; Decision statements: if/else, switch/case statements; Loop control statements – for, while, do/while.

ARRAYS AND FUNCTIONS
Arrays:
Introduction to arrays; one dimensional arrays: declaration, reading and printing array elements, sorting and searching.
Functions:
Definition; declaration of functions; return statement; recursion.

INTRODUCTION TO OOP CONCEPTS
OOP concepts: data hiding, encapsulation, inheritance, overloading, polymorphism; classes and objects; constructor and destructor; simple program in C++.

INHERITANCE AND OVERLOADING
Inheritance – single, multiple, multilevel; Overloading – Function overloading, Operator overloading.

LIST OF EXERCISES

Note to the Instructors: Design exercise problems to demonstrate the use of C and C++ in the area of specialization.

1. Programs to demonstrate the use of scanf ( ) and printf( ) functions
2. Programs to evaluate arithmetic expressions
3. Programs using conditional statements
4. Programs using for, while , do…while
5. Programs on arrays
6. Programs to perform matrix addition and multiplication
7. Programs to implement functions
8. Programs to illustrate recursion
9. Program to create classes and objects using C++
10. Program to implement Constructor and Destructor in C++
11. Program to implement single inheritance in C++
12. Program to implement Function overloading in C++
13. Program to implement Operator overloading in C++

REFERENCE BOOKS
1. Computer Practice Laboratory Manual, SRM University.
2. Kanetkar P.Yashwant,"*Let us C*", BPB publications, 2002.

3. Ashok N.Kamthane, "*Programming with ANSI and Turbo C*", Pearson Education, 2006.
4. Herbert Schildt, "*The Complete Reference C++*", Tata McGraw Hill, 2001, 3rd Edition.
5. Robert Lafore, "*Object Oriented Programming in Microsoft C++*", The Waite Group, Galgotia Publications Pvt. Ltd., 2002.

		L	T	P	C
ME 0130	**ENGINEERING GRAPHICS**	**1**	**0**	**4**	**3**
	Prerequisite				
	Nil				

(Only First Angle Projection is to be followed)

PURPOSE

To draw and interpret various projections of 1D, 2D and 3D objects.
To prepare and interpret the drawings of buildings.

INSTRUCTIONAL OBJECTIVES

To familiarize with
The construction of geometrical figures
The projection of 1D, 2D & 3D elements
Sectioning of solids and development of surfaces
Preparation and interpretation of building drawing

FUNDAMENTALS OF ENGINEERING GRAPHICS

Lettering, two dimensional geometrical constructions, conics, representation of three-dimensional objects – principles of projections – standard codes – projection of points.

PROJECTION OF LINES AND SOLIDS

Projection of straight lines, projection of solids – auxiliary projections

SECTIONS AND DEVELOPMENTS

Sections of solids and development of surfaces.

PICTORIAL PROJECTIONS

Conversion of projections: Orthographic projection, isometric projection of regular solids & combination of solids.

BUILDING DRAWING

Building Drawing – plan, elevation and section of single storied residential (or) office building with flat RCC roof and brick masonry walls having not more than 3 rooms (planning / designing is not expected in this course).

TEXT BOOKS

1. Jeyapoovan, T., *"Engineering Drawing and Graphics using AutoCAD 2000"*, Vikas Publishing house Pvt Ltd, NewDelhi, 2005.
2. Narayanan, K.L & Kannaiah, P., *"Engineering Graphics"*, Scitech Publications, Chennai, 1999.

REFERENCE BOOKS

1. Bhatt, N.D., *"Elementary Engineering Drawing (First Angle Projection)"*, Charotar Publishing Co., Anand, 1999.
2. Venugopal, K. *"Engineering Drawing & Graphics"*, New Age international Pvt. Ltd., 2001.
3. Natarajan, K.V. *"Engineering Drawing & Graphics"*, Private Publication, Chennai, 1990.
4. Shah, M.B. and Rana, B.C., *"Engineering Drawing"*, Pearson Education (Singapore) Pvt. Ltd., Delhi – 110 092, 2005.

		L	T	P	C
ME 0120	**WORKSHOP PRACTICE**	**0**	**0**	**4**	**2**
	Prerequisite				
	Nil				

PURPOSE

To provide the students with, hands on experience on different trades of engineering like fitting, carpentry, smithy, welding and sheet metal.

INSTRUCTIONAL OBJECTIVES

To familiarize with

The basics of tools and equipments used in fitting, carpentry, sheet metal, welding and smithy.

The production of simple models in the above trades.

LIST OF EXPERIMENTS

EMPHASIS TO BE LAID ON REAL LIFE APPLICATIONS WHEN FRAMING THE EXERCISES.

FITTING

Tools & Equipments – Practice in Filing and Drilling.
Making Vee Joints, Square, dovetail joints, Key Making.

CARPENTARY

Tools and Equipments- Planning practice. Making Half Lap, dovetail, Mortise & Tenon joints, a mini model of a single door window frame.

SHEET METAL

Tools and equipments - Fabrication of a small cabinet, Rectangular Hopper, etc.

WELDING

Tools and equipments - Arc welding of butt joint, Lap Joint, Tee Fillet. Demonstration of Gas welding, TIG & MIG.

SMITHY

Tools and Equipments –Making simple parts like hexagonal headed bolt, chisel.

TEXT BOOKS

1. Gopal, T.V., Kumar, T., and Murali, G., *"A first course on workshop practice – Theory, practice and work book"*, Suma Publications, 2005.

REFERENCE BOOKS

1. Kannaiah,P. & Narayanan,K.C. "*Manual on Workshop Practice"*, Scitech Publications, Chennai, 1999.
2. Venkatachalapathy, V.S. "*First year Engineering Workshop Practice"*, Ramalinga Publications, Madurai, 1999.

SEMESTER III

		L	T	P	C
LE0201	**GERMAN LANGUAGE PHASE I**	**2**	**0**	**0**	**2**
	Prerequisite				
	Nil				

PURPOSE
Enabling the Engineering Students to one more Foreign Language, especially German, which is scientific and technical language. This may be useful in the field of employment opportunities as well as helping them to develop projects on browsing German websites.

INSTRUCTIONAL OBJECTIVES
Developing pronunciation so that they can read the text and e-mail during their employment, instructing them to write their own C V and developing a fundamental conversation with any German national

INTRODUCTION
German Language, Alphabets and Pronunciation.

THEMEN
Name, Land, Leute, Beruf, Familie geschwister, Einkaufen, Reisen, Zahlen, Haus, Freunden, Essen and Stadium, Fest, Zeit.

LISTENING
Listening to the cassette and pay special attention to the meaning and sounds. Listening Comprehension – Announcements / Airport / Station / General.

READING
Listening to the cassette and reading it allowed.
READING COMPRENSION BASICS / STATION / NEWS / NOTICE BOARDS.

GLOSSARY
Technical Words Lesson (1-5)
TEXT BOOK WITH CASSETTES

1. Grundkurs Deutsch
2. Momentmal (Max Mueller Bhavan – Goethe Institute, Germany).

SCHEME OF EVALUATION

Internal 50 = Listening – 10 Marks, Speaking – 20 Marks, Reading – 10 Marks and Writing = 10 Marks
External 50 – 3 hours final written exam

		L	T	P	C
LE0203	**JAPANESE LANGUAGE PHASE I**	**2**	**0**	**0**	**2**
	Prerequisite				
	Nil				

PURPOSE
1. In view of globalization, learning Foreign Language by Engineering graduates enhances their employment opportunities.
2. Get awareness of understanding of International culture.
3. Widening the Linguistic Skills of the Students.

INSTRUCTIONAL OBJECTIVES
To learn the scripts of Japanese Languages namely Hiragana, Katakana and Kanji, Vocabularies etc. To learn basic grammar and acquire basic communication skills. To understand Japanese culture.

Alphabets (Hiragana), Self Introduction, Greetings, Classroom expressions, Numbers,
Conversation.

Alphabets Hiragana (continued),Vocabularies.
Counters .Time expression. Conversation

Katakana and related vocabulary.
Kanjis –introduction. conversation.

Lesson-1 Watashiwa Nihonjin desu. Grammar,Marume &Sentence pattern.Marume.
Conversation.

TEXT BOOKS

1. Nihongo Shoho I main Text sold in India by the Japanese Language Teachers Association Pune.
2. Hiragana and Katakana Work Book published by AOTS Japan
3. Grammar and Kotoba (Work Book)
4. Japanese for Dummies.(Conversation) CD.

SCHEME OF EVALUATION

Internal 50 = Listening – 10 Marks, Speaking – 20 Marks, Reading – 10 Marks and Writing = 10 Marks
External 50 – 3 hours final written exam

		L	T	P	C
LE0205	**FRENCH LANGUAGE PHASE I**	**2**	**0**	**0**	**2**
	Prerequisite				
	Nil				

PURPOSE

1. As language skills are as valuable as technical skills knowledge of French enables the engineering graduates in career orientation.
2. As a second international global Lang after English there is a wider choice of job opportunities in the international employment market and also multinationals in India and an understanding of French culture thro language.

INSTRUCTIONAL OBJECTIVES

Characterized by the Roman script, grammar, vocabulary and colloquial expressions are taught which enables them to communicate effectively with any native speaker.

INTRODUCTION AND PRONUNCIATION

Introduction of the French Language, Alphabets and Pronunciation, Greetings (Wishing, Thanking and Bidding good bye), Introducing oneself & someone Presenter quelqu'un et se presenter - conversational French sentences based on the topics discussed above.

VOCABULARY

Numbers and Dates, Days, Months and Seasons, Time, Nouns, Professions and Nationalities. Conversational sentences on weather, time, and professions.

GRAMMAR

Basic Verbs (Avoir, Etre, Aller, Faire) – Conjugation – Present tense, Affirmative, Negative, Interrogative, Adjectives (Qualitative), Subject Pronouns and Disjunctive Pronouns.

CONVERSATION AND LISTENING

Conversational sentences on physical description and expressions with verbs like avoir, etre and faire

GRAMMAR

Prepositions (a, de,dans, en, sur,sous, pour….),Contracted Articles, Question Tag
(Qui, Quel, Ou, ……etc)

TEXT BOOK:

1. Panorama – Goyal Publishers
2. Apprenons le Francais I, Sarawathy publication.

SCHEME OF EVALUATION
Internal 50 = Listening – 10 Marks, Speaking – 20 Marks, Reading – 10 Marks and Writing = 10 Marks
External 50 – 3 hours final written exam

		L	T	P	C
MA0211	**MATHEMATICS – III**	**3**	**2**	**0**	**4**
	Prerequisite				
	MA0101,MA0102				

PURPOSE
To equip the students with the knowledge of slightly advanced topics of mathematics.

INSTRUCTIONAL OBJECTIVES
After the completion of the course, the students should be able to apply
1. The rudiments of Fourier series
2. The theory and problems of PDE
3. The applications of PDE to boundary value problems.
4. Fourier transforms and to their branches of engineering**.**

FOURIER SERIES
Dirichlet's conditions – General Fourier series – Half range Sine and Cosine series – Parseval's identity – Harmonic Analysis.

PARTIAL DIFFERENTIAL EQUATIONS
Formation – Solution of standard types of first order equations – Lagrange's equation – Linear homogeneous partial differential equations of second and higher order with constant coefficients - Classification of second order linear partial differential equations.

ONE DIMENSIONAL WAVE & HEAT EQUATION
Boundary and initial value problems - Transverse vibrations of elastic string with fixed ends – Fourier series solutions – One dimensional heat equation - Steady and transient states – problems.

TWO DIMENSIONAL HEAT EQUATION
Two dimensional heat equation – Steady state heat flow equation – Laplace Equation Cartesian form – Laplace equation in polar form – heat flow in circular plates including annulus - Fourier series solution.

FOURIER TRANSFORMS
Statement of Fourier integral theorem – Fourier transform pairs – Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

TEXT BOOK
1. Grewal B.S., "*Higher Engineering Mathematics*"36th edition, Khanna Publishers, 2002.

REFERENCE BOOKS
1. Kreyszig.E, "*Advanced Engineering Mathematics*", 8th edition, John Wiley & Sons, Singapore, 2000.
2. Kandasamy P etal. "*Engineering Mathematics*", Vol. II & Vol. III (4th revised edition), S.Chand & Co., New Delhi, 2000.
3. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., *"Advanced Mathematics for Engineering students*", Volume II & III (2nd edition), S.Viswanathan Printers and Publishers, 1992.
4. Venkataraman M.K., "*Engineering Mathematics*" – Vol.III – A & B (13th edition), National Publishing Co., Chennai, 1998.

NE0201	MECHANICS OF MATERIALS	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To introduce to the students, the various opportunities in the emerging field of nuclear Engineering and nuclear technologies.

INSTRUCTIONAL OBJECTIVES

The Objective of this course is to make students familiar with the important of mechanical properties and its applications.

STRESSES, PRINCIPLE STRESSES, STRAIN ENERGY

Basic definations: Stress-Strain-Shear-Poison's ratio- 1D Hook's law and constitutive equation for elastic behaviour-Examples of various stress states 2D and 3D multiaxial stress states -**Principal stresses:** Theory principle stresses-Calculations of Octahedral and maximum shear stress, Stress-Strain Temperature relations-Stress– Strain diagram for different engineering materials - **Strain Energy:** Strain energy Density-Stress concentration.

SHAFTS & DEFLECTION OF BEAMS

Introduction to Shafts- Plastic Deformation in circular Shafts - Thin-Walled Hollow shafts-**Deflection of Beams:** Introduction-Deformation of a beam under Transverse loading-Direct Determination of the elastic curve from the Load distribution-Method of Superposition-Application of Superposition to statically indeterminate Beams.

COLUMNS& ECCENTRIC LOADING

Introduction-Stability of Structures-Euler's Formula for Pin-ended columns-Extension of Euler's formula to columns with other end condition-**Eccentric loading:** The Secant formula Design of column under a centric load- Design of column under an Eccentric load.

ENERGY METHODS & BEAMS OF ELASTIC FOUNDATIONS

Introduction-Strain energy- Elastic energy for a shearing stresses - **Beams of Elastic foundations**-Introduction-Basic equations-Winkler foundation-Semi-Infinite Beams with concentrated End loads-Infinite beams with concentrated end loads.

FAILURE CRITERIA

Yield criteria for Ductile materials under plane stress-Fracture criteria for Brittle materials under plane stress-Introduction to fracture mechanics-Repeated loading: **Fatigue:** Introduction to Fatigue-Fatigue materials – Factors affecting mechanical properties.

TEXT BOOK

1. Bear FP, Johnston ER Jr, DeWolf JT. Mechanics of Materials, 4 ed., McGraw Hill, 2006.

REFERENCE BOOKS

1. Cook RD, Young WC, Advanced Mechanics of Materials, 2ed, Prentice Hall, 1999.
2. Gere JM and Timoshenko SP, Mechanics of Materials, 5ed, PWS Kent Publishing , Boston, 1997.
3. James M. Gere and Barry J. Goodno, Mechanics of materials 7 ed., Cenage learning, Toronoto, CA, \2009.

NE0203	NEUTRON PHYSICS	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the contemporary and the recent researches in nuclear engineering applications

INSTRUCTIONAL OBJECTIVES
This course is intended to provide the students with description of the computational methods for neutron physics research.

INTRODUCTION/REACTOR LAYOUT AND CLASSIFICATION

Chart of nuclides/neutron sources- Neutron reactions/Boltzman distribution/number density- Neutron cross-sections- Binding energy/liquid drop model/fission process- Tour of MIT research reactor- Burners, converters, breeders/neutron life cycle-Neutron life cycle- Criticality accidents/why is radiation dangerous- Neutron flux, reaction rates, current-One velocity model

CRITICALITY CONDITIONS AND KINEMATICS OF NEUTRON SCATTERING

Non-multiplying media- Multiplying media-Criticality conditions- Kinematics of neutron scattering- Group diffusion method- Solution of group equations

FLUX,GROUP THEORY AND MONTE CARLO METHODS

Energy dependence of flux- Group theory/four factor formula-Reactors of finite size- Reactors of multiple regions: One group- Reactors of multiple regions: Two group- Application of the two-group equations- Few group and multi-group approaches- Monte Carlo analysis

REACTOR OPERATION AND FEEDBACK

Subcritical multiplication and reactor startup- Reactor operation without feedback- Analytic solution of reactor kineticsDynamic period and inhour equation- Reactor operation with feedback effects- Achievement of feedback effects/Chernobyl

TMI

Shutdown margin/review of TMI

TEXT BOOK

1. Lamarsh, John. Introduction to Nuclear Engineering. 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 2001

REFERENCES

1. Henry, A. F. Nuclear Reactor Analysis. Cambridge, MA: MIT Press, 1975. ISBN: 9780262080811. Shultis, J., and R. Faw. Fundamentals of Nuclear Science and Engineering. New York, NY: Marcel Dekker, 2002.
2. He
3. witt, G., and J. Collier. Introduction to Nuclear Power. New York, NY: Taylor and Francis, 2000.

NE0205	MATERIALS FOR NUCLEAR APPLICATIONS	L	T	P	C
	Prerequisite	**3**	**0**	**0**	**3**
	Nil				

PURPOSE
To introduce to the students, the various opportunities in the emerging field of nuclear Engineering and nuclear technologies.

INSTRUCTIONAL OBJECTIVES
The objective of this course is to make students familiar with the important of nuclear environments, characterisation and materials selection for nuclear applications.

NUCLEAR MATERIAL
Structure of a power plant, 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, alluminium and its alloys-Coolant used in reactors radiation embrittlement- corrosion reactor materials-Mechanical properties of materials.

CHARACTERISTICS OF NUCLEAR MATERIALS
Radiation, Fission, reactor and reactor elements, characteristics of fission materials-Density – Melting point-Electrical and thermal conductivity-Fission cross section- Coolants- Cladding materials- Moderators-Heat exchanger-Arrestor.

APPLICATION OF RADIOISOTOPES
Nuclear systematics - naturally occurring radioactive isotopes and series - instrumental techniques for detection and measurement of radioactivity - radioactive methods for prospecting and assaying of mineral (radioactive and non-radioactive) deposits - applications of radioactivity and radon in prospecting for oil and hydrocarbon deposits - applications of radiometric studies to paleoseismology-Radioisotopes and applications in industry and medicine.

RADIATION APPLICATIONS
Radiotracing principle and techniques-Radiotraces applications to engineering processes-Radiogauging principles, techniques and applications- Radiation shielding- Environmental transport of radionuclides.

NUCLEAR REACTOR & APPLICATIONS
Thermal Parameter-sources and distribution of thermal loads in nuclear Power reactor- Conservation equation and their applications to nuclear power systems - Nuclear reactor materials and applications-Nuclear imaging-Nuclear waste management.

TEXT BOOK
1. Kopelman, Materials for nuclear reactors, McGraw Hill, 1970.

REFERENCE BOOKS
4. Kenneth Joy, Nuclear Power-Today and Tomorrow, Methven, 1961.
5. G.F. Knoll, Radiation detection and measurement, John Wiley &Sons, 3ed, London, 2000.
6. RE. Fand J.K.Shultis, Radiological Assessment, Prentice Hall, 1993.
7. J.J. Duderstadt and L.J. Hamilton, Nuclear Reactor Analysis, John Wiley, 1976

		L	T	P	C
NE0207	**NUCLEAR THERMO HYDRAULICS - I**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE
To introduce to the students, the various opportunities in the emerging field of nuclear technology.

INSTRUCTIONAL OBJECTIVES
The objective of this course is to make students familiar with the energy exchange processes due to temperature differences (Heat transfer) that are relevant to nuclear energy systems.

INTRODUCTION
Fundamental Concepts, Fluid Motion, Viscosity Hydrostatics and Manometry, Force on Submerged Surfaces.

SYSTEMS AND CONTROL VOLUMES
Mass, Momentum Balance, Angular Momentum and Energy Balance and Example, Application of Control Volume Balance to 1-D Systems: 1-D Mass, Momentum and Energy Balances, Application.

KINEMATICS
Momentum Equation, Incompressible In viscid flow: Pressure and Measurement**,** Energy and Bernoulli Equations Dimensional Analysis: Flow Similarity and Scaling Internal

LAMINAR FLOW
Laminar Pipe Flow, Flow in Pipes and Bends. Calculation of Head Lass - Friction Factor**:** Minor Losses and Non-circular Ducts**,** Solution of Pipe Flow problem**,** Flow Measurement Boundary Layer Introduction (2-D cases) - Fluid Drag.

TURBO MACHINERY ANALYSIS
Turbo machinery Analysis: Turbo machinery Performance, Pump One Dimensional Compressible Flow: Isentropic Flow, Flow with Friction Introduction to Two-Phase Flow, Applications in Nuclear Safety.

TEXT BOOK
1. Fox, Robert W. and McDonald, Alan T. Pritchard Philip J., "*Introduction to Fluid Mechanics*, "Sixth Edition, John Wiley, 2004.
2. Panton, Ronald L., "*Incompressible Flow*," John Wiley, 1984.

REFERENCE BOOKS
1. White, Frank M., "*Fluid Mechanics*," Third Edition, McGraw-Hill,1994.
2. Potter Merle C. and Wiggert David C., "*Mechanics of Fluids*," Second Edition, Prentice Hall,1997.
3. Bertin John, J., *Engineeing Fluid Mechanics*, Second Edition, Prentice Hall, 1987.
4. White, Frank M., "*Viscous Fluid Flow*," McGraw-Hill, Second Edition.
5. Schlichting, H., "*Boundary Layer Theory*," McGraw-Hill, 1960.

NE0209	THERMODYNAMICS	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE
To introduce to the students, the basic concepts and knowledge about thermodynamic laws and relations

INSTRUCTIONAL OBJECTIVES
The objective of this course is to make students familiar with the important concepts of thermodynamics applicable to nuclear engineering.

BASIC CONCEPTS OF THERMODYNAMICS
Macroscopic vs Microscopic aspects – Thermodynamic system and surrounding – Forms of energy– Properties of a system – State and equilibrium– Quasi static process– Zeroth law of Thermodynamics -Heat and work-Internal energy-Indicator Diagrams work done in Isothermal and adiabatic processes-First law of thermodynamics-significance and applications of first law of thermodynamics-Reversible and irreversible process-Carnot's theorem-Carnot's engine, efficiency

THERMODYNAMIC LAWS AND ENTROPY
-Second law of thermodynamics-Thermodynamic scale of temperature-Entropy concept- entropy changes in reversible and irreversible processes-Entropy of universe-Entropy-Temperature diagrams-Thermodynamic potentials -Clausius theorem – Clausius inequality – Entropy principle – Property diagrams involving entropy – Entropy change of Ideal gases – Entropy generation in a closed system – Entropy generation in an open system – Third law of Thermodynamics – Introduction to availability in non-flow and flow Process

THERMODYNAMIC RELATIONS
Maxwell's equations – Clapeyron equation – General relations for dh,du,ds,Cp and Cv – Joule Thomson coefficient.
Gas Mixtures – Dalton's law of partial pressures – P-v-T behaviour of gas mixtures– Property calculations..

HEAT AND MASS TRANSFER
Introduction- General Equation of Heat Conduction- 1-D and 2-D steady conduction –analytical approach-Unsteady conduction- Numerical approach to conduction problems-Introduction to convection: Conservation equations for mass-momentum and energy-Internal and external laminar forced convection- Natural convection-Effect of turbulence
on convective heat transfer- Heat Exchangers – basic principles and design- Introduction to Radiation- Spectral and directional nature of surface radiation- Kirchhoff's law and gray surface approximation

POWER GENERATION
Thermodynamic analysis of Conventional Power Plants- Advanced Power Cycles-Overview of Nuclear power plant-Radio activity- Cross sections- Fission process-reaction rates, diffusion theory- elastic scattering and slowing down-criticality calculations- critical heat flux- power reactors, nuclear safety.-Steam Turbine -

Superheater, reheater and Intercoolers in Gas-Turbine power plants- Hydro power plants - turbine characteristics.

TEXT BOOKS

1. H.B. Callen, Thermodynamics and an Introduction to thermostatistics, John Wiley,
1. Toronto, 1985
2. A. Bejan, Advanced Engineering thermodynamics, John Wiley, Toronto, 1988

REFERENCE BOOKS

1. Michael Moran, J., and Howard Shapiro, N., *Fundamentals of Engineering Thermodynamics*, 4th
2. Edition, John Wiley & Sons, New York, 2000.
3. Rayner Joel, *Basic Engineering Thermodynamics*, 5th Edition, Addison Wesley, New York, 1996.
4. Holman, J. P., *Thermodynamics*, 4th Edition Tata McGraw Hill, New Delhi, 1998.
5. Kothandaraman, C. P., and Domkundwar, S., *A Course in Thermal Engineering*, 5th Edition, Dhanpat
6. Rai & Sons, New Delhi, 1998.
7. F. P. Incropera and D. P. Dewitt, Fundamentals of Heat and Mass Transfer, 5th Edition,
8. John Wiley and Sons, 2004.
9. R. W. Haywood, Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991

		L	T	P	C
PD0201	**PERSONALITY DEVELOPMENT - III**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to build confidence and inculcate various soft skills and to help students to identify and achieve their personal potential.

INSTRUCTIONAL OBJECTIVES

1. To guide thought process.
2. To groom student's attitude.
3. To develop communication skill.
4. To build confidence.

METHODOLOGY

The entire program is designed in such a way that every student will participate in the class room activities. The activities are planned to bring out the skills and talents of the students which they will be employing during various occasions in their real life.

1. Group activities + individual activities.
2. Collaborative learning.
3. Interactive sessions.
4. Ensure Participation.
5. Empirical Learning

Goal Setting - Problem Solving - Emotional Quotient

Assertiveness - Stress Management - Quiz II

Lateral Thinking (Situational) - Team Work (Role Plays) Impromptu - Text Analysis

Business plan presentation I - Business plan presentation II - Chinese Whisper

Picture Perfect - Case Studies – Review

SCHEME OF INSTRUCTION

Marks allocated for regular participation in all oral activities in class

SCHEME OF EXAMINATION

Complete internal evaluation on a regular basis.

NE 0211	THERMODYNAMICS LAB	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

This laboratory class will teach the students to know about the fundamental laws of Thermo dynamics and its applications

INSTRUCTIONAL OBJECTIVES

1. To learn and understand the principles of thermal and mechanical energy. This includes the study of energy transformations and thermodynamic relationships applied to flow and non-flow processes in power and refrigeration cycles.
2. To provide the student the necessary analytical skills to solve and analyze a variety of energy related problems.

LIST OF EXPERIMENTS

1. Temperature sensor Caliberation
2. EES-Energy transfer
3. Calorimeter
4. EES first law of thermo dynamics
5. EES second law of thermo dynamics
6. EES – refrigeration cycle, internal combustion engine simulation
7. Refrigeration cycle
8. Energy balance experiment (1^{st} law Experiment)

REFERENCE

1. Laboratory manual

NE 0213	NUCLEAR THERMO-HYDRAULICS LAB-I	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

This course will acquaint students with various fluid flow and heat transfer phenomena seen in nuclear reactor systems and design.

INSTRUCTIONAL OBJECTIVES

1. Gain knowledge on working of Flow meters
2. Able to compare performance of various machines at different operating points.

LIST OF EXPERIMENTS

1. Basic Hydrostatic Pressure and Manometer Experiment
2. Reynolds Experiment
3. Flow Meters and DP Measurements
4. Flow around Bodies
5. Turbulence and Vortex Visualization in a Vertical Channel
6. Pipe Friction and Similarity Law
7. Drag Force on Spheres

REFERENCE

1. Laboratory manual

SEMESTER IV

		L	T	P	C
LE0202	**GERMAN LANGUAGE PHASE - II**	**2**	**0**	**0**	**2**
	Prerequisite				
	LE0201				

PURPOSE

Enabling the Engineering Students to one more Foreign Language, especially German, which is scientific and technical language. This may be useful in the field of employment opportunities as well as helping them to develop projects on browsing German websites.

INSTRUCTIONAL OBJECTIVES

Developing pronunciation so that they can read the text and e-mail during their employment, instructing them to write their own C V and developing a fundamental conversation with any German national.

SPEAKING;

Dialogue – Questioning / Basic queries / Conversational with practical exposure.

GRAMMATIK (WRITING)

Verben, Wortstellung, Nomen, Pronomen, Artikel, Nominitativ, Akkusativ, Dativ, Adjective, Prasens, Perfect and Neben Satze.

GLOSSARY

Technical words. Lesson (6-10)

TEXT BOOK WITH CASSETTES

A. Grundkurs Deutsch
B. Mo`ntmal

(Prescribed by Max Mueller Bhavan – Goethe Institute, Germany).

SCHEME OF EVALUATION

Internal 50 = Listening – 10 Marks, Speaking – 20 Marks, Reading – 10 Marks and Writing = 10 Marks
External 50 – 3 hours final written exam

		L	T	P	C
LE0204	**JAPANESE LANGUAGE PHASE II**	**2**	**0**	**0**	**2**
	Prerequisite				
	JAPANESE LANGUAGE PHASE I				

PURPOSE

In view of globalization, learning Foreign Language by Engineering graduates enhances their employment opportunities.
Get awareness of understanding of International culture.
Widening the Linguistic Skills of the Students.

INSTRUCTIONAL OBJECTIVES

To learn the scripts of Japanese Languages namely Hiragana, Katakana and Kanji, Vocabularies etc. To learn basic grammar and acquire basic communication skills. To understand Japanese culture.
Lesson 2-{Korewa Tsukue desu } – Grammar, Sentence pattern, Marume .
Conversation
Lesson 3 – [Kokoni denwa ga arimasu] - Grammar, Sentence pattern, Marume .Copnversation
Lesson 4– {Asokoni hito ga imasu} - Grammar, Sentence pattern, Marume .
Lesson 5– {Akairingo wa ikutsu arimasu ka}-Grammar, Sentence pattern, Marume . Conversation.
Lesson 6– {Barano hana wa ippon ikura desu ka}- Grammar, Sentence pattern.Marume.Conversation

TEXT BOOKS

1. Nihongo Shoho Imain Text sold in India by the Japanese Language Teachers Association Pune.
2. Hiragana and Katakana Work Book published by AOTS Japan
3. Grammar and Kotoba (Work Book)
4. Japanese for Dummies.(Conversation) CD.

SCHEME OF EVALUATION
Internal 50 = Listening – 10 Marks, Speaking – 20 Marks, Reading – 10 Marks and Writing = 10 Marks

		L	T	P	C
LE0206	**FRENCH LANGUAGE PHASE II**	**2**	**0**	**0**	**2**
	Prerequisite				
	LE0205				

PURPOSE

1. As language skills are as valuable as technical skills knowledge of French enables the engineering graduates in career orientation.
2. As a second international global Lang after English there is a wider choice of job opportunities in the international employment market and also multinationals in India and an understanding of French culture thro language.

INSTRUCTIONAL OBJECTIVES
Characterized by the Roman script, grammar, vocabulary and colloquial expressions are taught which enables them to communicate effectively with any native speaker

Sports (Ski, natation, tennis, Tour de France), Cuisine (French dishes),Cinema
(Review of a film) – Articles on these topics and group discussion will be followed.

GRAMMAR
Possessive Adjectives, Demonstrative Adjectives, Past tense – Passé Compose(Verbe Auxiliare:.Etre et Avoir)
Culture and Civilization French Monuments (Tres celebres), French History (Jeanne d' Arc, Louis XIV,
Prise de la Bastille), Culture and Civilisation (vin, fromage, mode, parfums)

Transport system, government and media in France – articles on these topics.

Comprehension and Grammar Comprehension passages and conversational sentences in
different situations (at the restaurant, at the super market)

TEXT BOOK:

1. Panorama – Goyal Publishers
2. Apprenons le Francais II, Sarawathy Publications

SCHEME OF EVALUATION

Internal 50 = Listening – 10 Marks, Speaking – 20 Marks, Reading – 10 Marks and Writing = 10 Marks
External 50 – 3 hours final written exam

		L	T	P	C
MA0232	**PROBABILITY AND RANDOM PROCESSES**	**3**	**2**	**0**	**4**
	Prerequisite				
	Nil				

PURPOSE
To introduce the students to the idea of probability and random process, an important mathematical tool in signal processing.

INSTRUCTIONAL OBJECTIVES
At the end of the course, the students should be fully equipped with the knowledge of

1. Probability and Random variables
2. 2 – D Random variables
3. The concepts of Random process
4. The Correlation Functions and
5. The applications of Fourier Transforms like Spectral Density and others.

PROBABILITY AND RANDOM VARIABLES:
Probability theory – Random Variables – Moments – Moment generating function – Binomial, Poisson, Geometric, Exponential, Normal distributions, functions of Random Variables, Chebyshev inequality.

TWO DIMENSIONAL RANDOM VARIABLES
Two dimensional Random Variables – Marginal and conditional distributions – Transformation of Random Variables – central limit theorem – simple problems.

RANDOM PROCESSES
Classification of Random processes – Stationarity – WSS and SSS processes – Poisson Random process – Pure Birth process – Renewal Process – Markov Chain and transition probabilities.

CORRELATION FUNCTIONS:
Autocorrelation function and its properties – Cross Correlation function and its properties – Linear System with Random inspects.

SPECTRAL DENSITY
Power spectral Density Function – Properties – System in the form of convolution – Unit Impulse Response of the System – Einstein – Weiner-Khinchine Relationship – Cross Power Density Spectrum – Properties.

TEXT BOOK
1 T. Veerarajan, "*Probability, Statistics and Random Processes*", Tata McGraw – Hill Publishing Company Limited, New Delhi, 2004.

REFERENCE BOOK
Trivedi K S, " *Probability and Statistics with reliability, Queueing and Computer Science Applications*",Prentice Hall of India,New Delhi, 1984

		L	T	P	C
NE0204	**NUCLEAR THERMAL HYDRAULICS - II**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE
To introduce to the students, the various opportunities in the emerging field of nuclear technology.

INSTRUCTIONAL OBJECTIVES
The objective of this course is to make students familiar with the energy exchange processes due to temperature differences (Heat transfer) that are relevant to nuclear energy systems.

INTRODUCTION
Physical Origins and Rate Equations Conduction -Convection -Radiation -Relationship to Thermodynamics-The Conservation of Energy Requirement Conservation of Energy for a Control Volume-The Surface Energy Balance Introduction to conduction, Conduction Rate Equation, Thermal Properties of Matter, Heat Diffusion Equation, Boundary and Initial Conditions.

ONE-DIMENSIONAL AND TWO-DIMENSIONAL, STEADY-STATE CONDITION
The Plane Wall -An Alternative Conduction Analysis -Radial Systems- Conduction with Thermal Energy Generation- Heat Transfer from Extended Surfaces- the Bio heat Equation. Alternative Approaches-The Method of Separation of Variables-The Conduction Shape Factor and the Dimensionless Conduction - Heat Rate Finite-Difference Equations- Solving the Finite-Difference Equations.

TRANSIENT CONDUCTION AND CONVECTION
The Lumped Capacitance Method-Validity of the Lumped Capacitance Method- General Lumped Capacitance Analysis- Spatial Effects-The Plane Wall with Convection- Radial Systems with Convection- The Semi-Infinite Solid
- Objects with Constant Surface Temperatures or Surface Heat Fluxes- Periodic Heating- Finite-Difference Methods

The Convection Boundary Layers- Local and Average Convection Coefficients- Laminar and Turbulent Flow- The Boundary Layer Equations.

INTERNAL - EXTERNAL FLOW AND CONVECTION
The Empirical Method-The Flat Plate in Parallel Flow- Methodology for a Convection Calculation-The Cylinder in Cross Flow- The Sphere. Hydrodynamic Considerations- Thermal Considerations- The Energy Balance- Laminar Flow in Circular Tubes: Thermal Analysis and Convection Correlations. Convection Mass Transfer. Physical Considerations-The Governing Equations- Similarity Considerations-Laminar Free Convection on a Vertical Surface-The Effects of Turbulence - Empirical Correlations.

BOILING AND CONDENSATION
Boiling and Condensation, Heat Exchanges**,** Radiation: Processes and Properties, Radiation Exchange between Surfaces, Diffusion Mass Transfer.

TEXT BOOK
1. F. P. Incropera, D. P. DeWitt, T. H. Bergman & A. S. Lavine "*Fundamentals of Heat and Mass Transfer* (6^{th} edition)," John Wiley & Sons (2007).

REFERENCE BOOKS
1. R. B. Bird, W. E. Stewart & E. N. Lightfoot "*Transport Phenomena* (Revised 2nd edition)," John Wiley & Sons (2007)
2. N. E. Todreas & M. S. Kazimi "*Nuclear Systems* I" Hemisphere Publishing (1990)

NE0206	CONTROLLED THERMO NUCLEAR FUSION	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE
To introduce to the students, the various opportunities in the emerging field of nuclear engineering.

INSTRUCTIONAL OBJECTIVES
The objective of this course is to make students familiar with the important concepts applicable to controlled thermonuclear fusion and its application in the field of power production.

NUCLEAR FUSION
Fusion power generation, concept of cross section, mean free path and collision frequency. Radiation losses. fusion reactor energy, system energy balance, plasma heating, Lawson criterion.

PLASMA PHYSICS
Nature of plasma, plasma charectristics, magnetic configuration and particle orbit, plasma as magneto hydrodynamic (MHD) fluid. MHD macroscopic eqillibrium and stabilities. MHD relaxation confinement

THERMONUCLEAR FUSION-I
Open magnetic confinement –magnetic and kinetic pressure, magnetic flux surfaces, magnetic mirrors, instabilities in mirror fields. Classical mirror confinement.

THERMONUCLEAR FUSION-II
Closed magnetic systems-Torroidal fields, Tokamak features, particle trapping.
Tokamaks-devices, equilibrium, beta limit of elongated plasma, impurity control, scrap- off layer and divertor, boot strap current.neoclassical tearing mode.

APPLICATION OF THERMONUCLEAR FUSION
Reversed field pinch(RFP) stellarator- configuration, relaxation, confinement, Oscillating field device, stellarator- helical field, stelarator devices, neoclassical diffusion in helical field, confinement of stellarator system.

TEXT BOOKS

1.Kenro Miyamoto , *"Plasma physics and controlled nuclear fusion"*, springer, 2005

REFERENCE BOOKS

1. Jeffrey P. Freidberg, *"Plasma physics and fusion energy"*, Cambridge University Press, 2007
2. A.A.Harms, *"Principles of fusion energy"*, world scientific,2000
3. K. Bockasten, "controlled thermonuclear fusion research", International Atomic Energy Agency, 1961

NE0208	DESIGN IN NUCLEAR ENGINEERING	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To introduce to the students, the various concepts in the design of nuclear reactors and power plants.

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make students familiar with the important concepts applicable in the design of nuclear
plants and reactors, their fundamental performance principles, concepts and modeling techniques.

REACTOR HEAT GENERATION

Energy release and deposition, Heat generation parameters, Neutron flux distributions and power profiles in reactor cores, Power peaking factors, Heat generation in the structure, Reactor shutdown heat generation

REACTOR HEAT REMOVAL

Heat transfer via thermal conduction, Thermal properties of fuel materials, Radial steady-state temperature distribution in fresh fuel and restructured fuel elements, Heat transfer via convection in single-phase coolants, Radial heat transfer from fuel element to coolant, Hydraulic flow in heated channels, heat transfer coefficients, Axial steady-state temperature distribution in fuel elements, Boiling heat transfer in nuclear reactors, Pressure drop through primary coolant loop, Heat removal and pumping power

NUCLEAR REACTOR DESIGN

Hot channel, hop spot factors, statistical methods, Overall hot channel factor, Applications of hot channel factors, Determination of reactor core characteristics (thermal – hydraulic analysis), Thermal design limits and safety margins, Figures of merit for core thermal performance

DESIGNS OF NUCLEAR POWER PLANTS

Pressurized Water reactors, Boiling water reactors, gas-cooled reactors, heavy water reactors, liquid metal-cooled fast reactors

TRANSIENT ANALYSIS (DYNAMICS AND SAFETY)

Temperature coefficients of reactivity, reactivity feedback, Loss-of-cooling accidents, Reactivity insertion accidents, Containment pressurization process, Response of a PWR pressurizer to load changes, Nuclear Power Plant control

TEXT BOOK

1. N. E. Todreas, M. S. Kazimi, , "Nuclear Systems I: Thermal Hydraulic Fundamentals" , Taylor & Francis, Edition II, 1993.

REFERENCE BOOKS

1. J. R. Lamarsh, A. J. Baratta, "*Introduction to Nuclear Engineering*", Prentice-Hall, 2001.
2. J. J. Duderstadt, L. J. Hamilton, "Nuclear Reactor Analysis", John Wiley & Sons, 1976.
3. Y. A. Cengel, R. H. Turner, "*Fundamentals of Thermal-Fluid Sciences*", McGraw-Hill, 2001.

NE0210	APPLIED RADIOCHEMISTRY	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE
To introduce to the students, the various opportunities involved in the field of Applied Radiochemistry

INSTRUCTIONAL OBJECTIVES
The objective of this course is to make the students familiar with the important concepts in the field of Applied Radiochemistry.

INTRODUCTION TO RADIOCHEMISTRY
Mass defect, binding energy, mean binding energy of stable nuclei. Disintegration theory-Nuclear stability and group displacement law. Synthesis of radioisotopes: ^{14}C, ^{3}H, ^{35}S, ^{36}Cl, ^{82}Br, ^{131}I, ^{32}P.Contribution of the discovery of artificial radioactivity in the field of heavy element chemistry.

DETECTION AND MEASUREMENT OF RADIOACTIVITY
Ionization chamber, Geiger- Muller,proportional, scintillation counters, Wilson cloud chamber, Health physics instrumentation-Film badges, Pocket ion chambers, portable counters and survey meters, Accelerators: Van de Graff and cyclotron.

ISOTOPE EFFECTS AND ISOTOPIC EXCHANGE REACTIONS
Isotope effect-Definition, physical and chemical isotope effects- Generalities of isotope effects- Isotopic exchange: basic concept, characteristics of isotopic exchange, mechanism of isotopic exchange-kinetics of homogenous and heterogeneous isotopic exchange reactions, self diffusion, and surface measurements.

INTERACTION OF RADIATION WITH MATTER
Primary radiation – Chemical Process, Direct interaction of radiation with matter, ionization, excitation, neutron impact. Basic reactions involving active species produced in the primary act, and Radiation dosimetry.

TRACERS
Selection of radioisotopes as tracer-Application of radioisotopes as tracersanalytical,-physico- chemical, medical, agriculture and industrial applications-Neutron activation analysis- Radiometric titrations and isotope dilution techniques-.Radiopharmaceutical, radioimmunoassay and radiation sterilization.

TEXT BOOK
1.G. Friedlander, J. W. Kennedy, E. S. Macias and J. M. Miller,"*Nuclear and Radiochemistry*" – A Wiley – Interscience Publication, John Wiley and Sons – III rd Edition.,1981.

REFERENCE BOOKS
1.K. Narayana Rao and H. J. Arnikar,"Artificial Radioactivity" – Tata McGraw Hill Publishing Company Ltd. New
Delhi,1986.
2. Haissionsky," *Nuclear Chemistry and its applications*"– Addison Wesley, 1964.

		L	T	P	C
NE0212	**ENGINEERING MECHANICS AND FLUID MECHANICS**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PART – A ENGINEERING MECHANICS

PURPOSE
To familiarise the students with the fundamentals of Engineering Mechanics.

INSTRUCTIONAL OBJECTIVES
The students will be able to understand the basics of
Principles governing static and dynamic equilibrium condition under action of forces.
Center of Gravity and Moment of Inertia.

The relationship between load and resistance offered by material through equilibrium compatibility and material property.

INTRODUCTION TO MECHANICS

Introduction to rigid body mechanics – Statics of particles – vectorial representation of forces – resolution and composition of forces – coplanar and space – equivalent system of forces – free body diagram- types of support and reactions – stable equilibrium – moments and couples – equilibrium in two – three dimensions – examples. Dynamics of particles – displacement, velocity, acceleration – relationship – relative and curvilinear motion - Newton's law -impulse and momentum (simple problems only).

PROPERTIES OF SURFACE AND SOLIDS

Determination of areas and volumes – first moment of area and the centroid of sections – rectangle, circle, triangle, T section, I section, Angle section, hollow sections by using standard formula – second and product moments of plane, area for rectangle, triangle, circle, T, I, Angle sections, hollow sections by standard formula – parallel and perpendicular axis theorem, polar moment of inertia – mass moment of inertia for rectangular, prism, sphere – (simple problems only).

MECHANICS OF DEFORMABLE BODIES

Force flow in different elements and systems- axial, flexure, shear and torsional modes – Axial forces – stress - strain – constitutive properties – isotrophy, orthotrophy, anisotrophy, homogenity, stress-strain curve for steel, concrete, plastics – creep – relationship between elastic properties – shear stress – bending stress (simple introduction) – torsional stress circular and non circular (theory only) – column – short and long column behaviour – buckling – behaviour under cyclic, ductile loads – Experimental methods for finding elastic constants – non destructive testing – joints – bolts and rivets – Principles of design only.

TEXT BOOK

1. Palaniswamy.M.S. and Nagan.S., *Engineering Mechanics – Statics and Dynamics*, Tata McGraw Hill, 2001.

REFERENCE BOOKS

1. Popov.E,, *Engineering Mechanics of solids* , PHI, New Delhi, 1997.
2. Srinath.L.S., *Advanced Mechanics of Solids* , Tata McGraw Hill Publishing Company, New Delhi, 1994.
3. Kazimi .S.M.A., *Solid Mechanics* , Tata McGraw Hill Publishing Company, New Delhi, 1991.

PART – B FLUID MECHANICS

PURPOSE

To learn fundamental concepts in the field of fluid mechanics.

INSTRUCTIONAL OBJECTIVES

1. To know the importance, application and inter-relationship of various properties of fluid.
2. To study theories those explain the behaviour and performance of fluid when the fluid is in motion.
3. To study theories those explain the behaviour and performance of fluid when the fluid is flowing through the pipe.

FLUID PROPERTIES

Importance and Application of fluid mechanics – Fluid properties – Density, Viscosity, Vapour Pressure, Bulk Modulus of Elasticity, Surface Tension, Capillarity – Pascal's Law – Law of Hydrostatics.

FLUID KINEMATICS

Velocity and Acceleration – Classification of Flow – Co-efficient of discharge-Continuity Equation – Streamline, Streakline, Pathline – Potential Function and Stream Function – Flow Net Analysis. Control Volume.

FLUID DYNAMICS AND FLOW THROUGH PIPES

Euler Equation – Bernoullie's Equation – Darcey's Equation – Momentum Principle – Free and Forced Vortex motion - Hagen-Poisuilli's – Laminar and Turbulent Flows – Reynold's Experiment – Moody Chart – Friction factor – Major and Minor Losses – Pipes in Series and Parallel- Centrifugal blower, Air compressor

TEXT BOOK

1. P.N.Modi and S.M.Seth, Hydraulics and Fluid Mechanics, Standard Book House, 2001.

REFERENCE BOOKS

1. R.K.Bansal, *Fluid Mechanics and Hydraulic Machines*, Laxmi Publications, 1992.
2. K.L.Kumar, *Engineering Fluid Mechanics*, Eurasia Publishing House, 2002.
3. K.Subramanya., *Theory and Applications of Fluid Mechanics*, Tata McGraw Hill Publishing Company, 1993.

		L	T	P	C
PD0202	**PERSONALITY DEVELOPMENT - IV**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to build confidence and inculcate various soft skills and to help students to identify and achieve their personal potential

INSTRUCTIONAL OBJECTIVES

1. To guide thought process.
2. To groom student's attitude.
3. To develop communication skill.
4. To build confidence.

METHODOLOGY

The entire program is designed in such a way that every student will participate in the class room activities. The activities are planned to bring out the skills and talents of the students which they will be employing during various occasions in their real life.

1. Group activities + individual activities.
2. Collaborative learning.
3. Interactive sessions.
4. Ensure Participation.
5. Empirical Learning

Motivation II - Interpretation of Visuals of I & II

Humor in real life - Body language - Collage and poster designing and slogan writing

Brain Teasers – JAM - Current News Update I

Current News Update II - Enactment (SKIT –I) - Enactment (SKIT – II)

Survey and Reporting (heroes, sports persons etc.) - Quiz III – Review

EVALUATION:

1. Activities assessed by both group and individual participation
2. Continuous assessment based on daily participation

SCHEME OF INSTRUCTION

Marks allocated for regular participation in all oral activities in class

SCHEME OF EXAMINATION

Complete internal evaluation on a regular Basis

NE 0214	NUCLEAR THERMO-HYDRAULICS LAB-II	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

This course will teach students various techniques of detecting and making measurements of nuclear or high energy radiation through hands-on radiation experiments.

INSTRUCTIONAL OBJECTIVES

1. Gain knowledge on working of Flow meters
2. Able to compare performance of two phase regimes

LIST OF EXPERIMENTS

1. Two-Phase Natural Circulation
2. Two-Phase Flow Regimes
3. Thermal Conduction
4. Natural and Forced Convection
5. Pool Boiling
6. Critical Flow and Phase Change (Blow down Expt.)

REFERENCE

1. Laboratory manual

NE0216	FLUID MECHANICS LAB	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

To enable the students to acquire knowledge of flow meters. Give student insight into working of various fluid machines and be able to compare performance of fluid machines under different working conditions.

INSTRUCTIONAL OBJECTIVES

Gain knowledge on working of centrifugal pumps, positive displacement pumps, hydraulic turbines centrifugal blowers and steam turbines.
Able to compare performance of various machines at different operating points.
To gain the knowledge of various flow meters and the concept of fluid mechanics.

LIST OF EXPERIMENTS

1. Determination of coefficient of discharge of orifice meter.
2. Determination of coefficient of discharge of venturi meter.
3. Major losses in pipe flow.
4. Verification of Bernoulli's theorem.
5. Minor losses – expansion and contraction losses in pipes.
6. Performance test centrifugal blower with different impellers.
7. Performance test on reciprocating air compressor.

REFERENCE

1. Laboratory manual

		L	T	P	C
NE0218	**COMPREHENSION -1**	**0**	**2**	**0**	**1**
	Prerequisite				
	Nil				

PURPOSE

To provide a complete review of Nuclear Science and Engineering topics covered in the first four semesters, so that a comprehensive understanding is achieved. It will also help students to face job interviews and competitive examinations**.**

INSTRUCTIONAL OBJECTIVES

1. To provide overview of all Nuclear Science and Engineering topics covered in the first four semesters.
2. To assess the overall knowledge level in the following topics of Nuclear Science and Engineering

COMPREHENSION

A. Review of the topics
B. Seminar/group discussion

Students shall have seminar/group discussion sessions on the topics listed under A above under the guidance of staff.

(Evaluation is based on an end semester examination)

SEMESTER V

		L	T	P	C
MB0301	**ENGINEERING ECONOMICS AND MANAGEMENT**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To provide engineering students with the management skills to enable them to assess, evaluate and take key management decisions by the application of management concepts.

INSTRUCTIONAL OBJECTIVES

At the end of the course, the students are expected to

1. Understand the various key concepts of micro economics.
2. Demonstrate the effect of time value of money and depreciation.
3. Apply the various project management techniques
4. Understand the various issues related to industrial safety.

Role and Importance of Economics for Engineers, Law of demand and supply, Break-even analysis, Pricing Policies.

Cost determination, Balance Sheet, Cost benefit analysis, Time Value of Money, Methods of Depreciation, Long Term and short term financing, Financial Institutions.

Management-Nature and functions, Project Management-Phases and Techniques, CPM, PERT, Human Aspects of Project Management-Issues and Problems, Managing-vs-leading a project.

Marketing Concepts, Marketing Mix, Product life cycle, Plant layout, Plant location, Material Handling, Productivity, Plant Maintenance and Industrial Safety.

Current Trends in financing, Role of Industrial Engineer and Applications of Industrial Engineering, Process of Project Management and the Future, Ethics and Project Management, E-Marketing-Ethical and legal issues.

TEXT BOOKS

1. R. Pannerselvam, "*Engineering Economics*", PHI, 2001.
2. O.P. Khanna, "*Industrial Engineering and Management*", Dhanpat Rai and sons, 1992.

REFERENCE BOOKS

1. Kotler, "*Marketing Management*", Pearson education, 12th edition.
2. Prasanna Chandra, "*Finance Sense for non-finance executives*", TMH.

NE0315	**MOLECULAR AND CELL BIOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To empower the students in the emerging field with the futuristic opportunities of Molecular and cell biology

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make the students familiar with the recent tasks and by themselves to know about cell systems

INTRODUCTION TO MOLECULAR BIOLOGY

Nature and function of genetic materials-DNA- structure and replication- RNA -types and DNA repair Protein synthesis- transcription, translation, genetic code evidence of triplet nature of the code.

GENETIC ENGINEERING

Gene regulation in prokaryotes-lac- operon -and tryp-operon as biosynthetic system, autoregulation and feed back inhibition. Genetic engineering - recombinant DNA, isolation of DNA- vector, restriction enzymes. Tranformation- screening for recombinants.

INTRODUCTION TO CELL BIOLOGY

Introduction - definition, scope, cell organization- Prokaryotic and Eukaryotic. Cell boundries, cell wall-gross layers ie middle lamella, Primary wall, secondary wall - structure, chemistry and functions of cell wall -pits (simple and bordered), Plasmodesmataplasma membrane- occurrence, structure. (light microscopic, electron microscopic and molecular) chemistry, function and origin.

COMPOSITION AND STRUCTURE OF DNA

Occurrence, structure, functions and origin of Endoplasmic reticulum, Golgi bodies, lysosomes, Ribosomes, perioxisomes, Mitochondria and Chioroplast. DNA autonomy of organelles.

NUCLEUS: ORGANISATION AND DIVISION

Nucleus, nuclear membrane, chromosomes, euchromatin, heterochromatin, giant chromosomes polytene and lampnrush. Cell cycle, cell division, mitosis and meiosis, cytokinesis.

TEXT BOOKS

1. Brown W.V and Bertke. E.M. 1974, A text book of Cytology C.V Mosley Co, St.Louis

REFERENCES BOOKS

1. Cohn, N.S. 1979. Elements of Cytology. Freeman Book Co.
2. De Robritis E.D.P and DeRobritis E.M.F jr. 1987 Cell and Molecular biology Lea and Febiger.
3. Verma P.S. and Agarwal VK, 1995 Cell Biology and Evolution.
4. Freifelder.D. Essentials of Molecular Bilogy. Joner and Bartlette Pub Inc. Boston.
5 Feifelder. D. Molecular Biology. Narosa.
6. Watson J.D et.al Molecular biology of the Gene The Benjamin / Cummings.
7. Freifelder, D. Microbial

NE0317	COMPUTERS IN REACTOR ANALYSIS	L	T	P	C
	Prerequiste	**3**	**0**	**0**	**3**
	Nil				

PURPOSE

To introduce to the students the basic computational methodsand modern numerical methods used in reactor analysis

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make the students comprehend the theory behind the modern numerical methods and acquire skill in application of various computational methods like MATLAB,FORTRAN and UNIX

MODERN NUMERICAL METHODS

Method of Bisection – Method of False Position – Fixed point iterative Method - Newton's Method- Numerical differentiation using Newton's divided, forward and backward interpolation polynomials – Numerical Integration by Trapezoidal rule, Simpson's 1/3 and 3/8 rules.

NEURAL COMPUTING IN ENGINEERING -I

Features of membership function- Standard forms and boundaries- Fuzzification- Membership value assignments – Intuition – Inference – Rank ordering - Fuzzy to crisp conversions- Lamda- cuts for Fuzzy sets- Lamda cuts for Fuzzy relations- Defuzzification methods.

NEURAL COMPUTING IN ENGINEERING -II

The Basic Neuron : Introduction – Modeling the single neuron, learning in simple neurons, the perception – a vertical perspective, the perception learning rule, proof, limitations of perceptions.

The Multilayer Perception : Introduction, altering the perception model, the new model, the new learning rule, the multi layer perception algorithm, the XOP problem reverted, visualizing network behavior, multi layer perceptions as classifiers, generalization, fault tolerance, learning difficulties, radial basis functions, applications.

UNIX

Overview of Unix-Unix documentation-files, directories –Accounts and processes –Redirections and pipes – Shells – Editing texts-Dot files – Regular expressions – X Windows

MATLAB

Familiarisation with MATLAB- control system tool box, MATLAB- SIMULINK tool box -Determination of step response for first order & second order system with unity feedback &calculations of control system specifications like time constant, % peak overshoot, settling time etc., from the response.-Simulation of step response & impulse response for type-0 , type-1 & type –2 system with unity feedback using MATLAB-Determination of root locus, BODE- Plot, NYQUIST- plot using MATLAB - control system toolbox for 2^{nd} order system & determination of different control system specifications from the plot.

TEXT BOOKS

1. P.D.Washerman, “Neural Computing : Theory & Practice”, Vax Northland Reinhold, 1989
2. Balagurusamy, E., Numerical Methods, Tata McGraw Hill Publications Company, New Delhi, 1999.

REFERENCE BOOKS

1. R.Beale and T.Jackson, “Neural Computing : An Introduction”, Adam Hilger, 1990.
2. Pas Y.H. “Adaptive Pattern Recognition and Neural Networks”, Addison Wesley, 1989.
3. Kandasamy, P. Thilagavathy, K. and Gunavathy, K., Numerical Methods, (Revised Edition), S. Chand and Company, New Delhi, 2003.
4. Sastry, S.S. Introductory Methods of Numerical Analysis, Third Edition, Printice Hall of India Pvt. Ltd., New Delhi, 1999.

NE0319	**NUCLEAR REACTOR THEORY I**	L	T	P	C
	Prerequisite	**3**	**0**	**0**	**3**
	Nil				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the contemporary and the recent researches in nuclear engineering applications.

INSTRUCTIONAL OBJECTIVES

This course is intended to provide the students with description of the computational methods for nuclear engineering applications. By the end of the course, the students will be able to perform analytical and numerical calculations necessary in nuclear system research and development .

INTRODUCTION

Course overview- Fundamental concepts- Nuclear energetics-Radioactivity-Binary nuclear reactions, neutron-nuclear reactions- Principles of nuclear reactors, nuclear power

FUNDAMENTALS OF NUCLEAR SYSTEMS

Characteristics of the fission reaction, neutron moderation, practical fission fuels-Reactor power, fuel burn up, and fuel consumption-Neutron chain-reacting systems-Homogeneous and heterogeneous cores, reflectors-Reactor kinetics and dynamics, reactivity feedback- Core composition changes during reactor operation, nuclear system lifetime

MATHEMATICAL DESCRIPTION OF PHYSICAL PHENOMENA: NEUTRON AND MODELLING METHODS

General considerations about reactor physics, engineering requirements- Description of the neutron distribution: fluxes, currents, and sources-Nuclear data, cross sections, and reaction rates- Basic scheme of nuclear system modeling methods-Deterministic modeling of nuclear systems-Neutron balance (conservation) equations

NUCLEAR DATA AND CROSS SECTION PROCESSING

Cross-section data- Evaluated nuclear data files-Introduction to the data formats and procedures of the ENDF-6 system- NJOY nuclear data processing system, multigroup cross section libraries

CORE COMPOSITION CHANGES DURING REACTOR OPERATION

Core composition changes-Nuclide production-destruction equations, adiabatic fuel depletion modeling-Equilibrium fuel cycle-Solution of the nuclide production-destruction equations-Reactivity effects of fuel composition changes

TEXT BOOK

1. W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, 2001

REFERENCE BOOKS

1. J. R. Lamarsh, Introduction to Nuclear Reactor Theory, Addison-Wesley Pub., 1966
2. J. R. Lamarsh, A. J. Baratta, Introduction to Nuclear Engineering, 3d ed.,

NE0321	**REACTOR THEORY AND KINETICS**	L	T	P	C
	Prerequisite	**3**	**0**	**0**	**3**
	Nil				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the contemporary and the recent researches in nuclear engineering applications

INSTRUCTIONAL OBJECTIVES

. The objective is to relate the fundamental physical principles, concepts and modeling techniques to analysis and design of nuclear reactors. It prepares to analyze nuclear reactors including aspects of performance, dynamics and safety and to either develop new designs or to assess existing or proposed designs based upon fundamental understanding of reactor physics.

INTRODUCTION

Course overview -Neutron nuclear reactions -.Neutron chain fission reactions - Classification of nuclear reactors

ONE-GROUP DIFFUSION THEORY, MULTIREGION REACTORS

One-dimensional two-region reactor - Reflected reactor; reflector savings- Numerical solutions of one-group diffusion problems

MULTIGROUP DIFFUSION THEORY

Multigroup diffusion theory - Analytical solutions of 2-group diffusion problems - Collapsing multigroup cross sections

REACTOR KINETICS AND DYNAMICS
General considerations about reactor dynamics, classification of time problems-Delayed neutrons-The transport equation with delayed neutrons- Reactor kinetics equations under diffusion approximation-Point reactor kinetics equations-Solution of the point kinetics equations, inhour equation, period-reactivity relations

POINT REACTOR KINETICS
Delayed fission neutrons - Point kinetics problems and their approximate
Solutions- Numerical solutions of point kinetics problems

TEXT BOOK

1. W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, 2001

REFERENCES

1. J. R. Lamarsh, Introduction to Nuclear Reactor Theory, Addison-Wesley Pub., 1966
2. J. R. Lamarsh, A. J. Baratta, Introduction to Nuclear Engineering, 3d ed., Prentice-Hall, 2001

		L	T	P	C
NE0323	**BIOLOGICAL EFFECTS OF RADIATION**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE
The purpose of this course is to expose the student to the use of ionizing radiation and its biological effects in the medical field.

INSTRUCTIONAL OBJECTIVES
The student will
1. Understand the use of ionizing radiation in medical and industrial applications.
2. Understand the biological effects of low and high doses of ionizing radiation.

ACTION OF RADIATION IN LIVING CELLS
Various theories related to radiation at cellular level. DNA and chromosomal damages.

SOMATIC APPLICATION OF RADIATION
Radio sensitivity protocols of different tissues of human. LD50/30 effective radiation on skin, Bone marrow, eye, endocrine glands, and basis of radio therapy.

GENETIC EFFECTS OF RADIATION
Threshold and linear dose, gene control hereditary diseases effect of dose.

EFFECT OF MICROWAVE AND RFWITH MATTERS
Effects of various human organs and systems. Wavelength in tissue, non thermal interaction. Standards of protection, national and international standards and precautions.

UV RADIATION
Classification of sources, measurement, photo medicine, UV radiation safety visible and infrared radiation.

TEXT BOOK
1. Glasser O., *Medical Physics,* Volume I, II, III, The year book publishers Inc, Chicago 1980.

REFERENCE BOOK
1. Moselly H., *Non ionizing Radiation, Adam-Hilgar*, Bristol 1988.

		L	T	P	C
PD0301	**PERSONALITY DEVELOPMENT - V**	**1**	**0**	**2**	**2**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to build confidence and inculcate various soft skills and to help students to identify and achieve their personal potential

INSTRUCTIONAL OBJECTIVES

At the end of the course the students will be able to

1. Acquire the important soft skills for employment
2. Take part in group discussions and job interviews confidently
3. Appear for placement aptitude tests confidently
4. Gain self confidence to face the placement process

METHODOLOGY

The entire program is designed in such a way that every student will participate in the class room activities. The activities are planned to bring out the skills and talents of the students which they will be employing during various occasions in their real life.

1. Group activities + individual activities.
2. Collaborative learning.
3. Interactive sessions.
4. Ensure Participation.
5. Empirical Learning

Syllogism - Binary Logic [cause & effect] - Assertive & Counter Argument - Simple Interest - Time & Work - Time & Distance

Upstream &Downstream Reasoning - Verbal Comprehension I - Verbal Comprehension II- Compound Interest Logarithms - Surds & Indices

Verbal Reasoning I - Verbal Reasoning II - Verbal Reasoning III – Percentage – Test – Averages

Deductive Reasoning I - Deductive Reasoning II - Language Usage I - Decimal Fractions - Profit & Loss – Probability

Language Usage II - Logic Games I - Logic Games II – Area - Pipes & Cisterns – Test

SCHEME OF INSTRUCTION

Marks allocated for regular participation in all oral activities in class

SCHEME OF EXAMINATION

Complete internal evaluation on a regular Basis

NE0325	**SIMULATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
	Prerequisite				
	Nil				

PURPOSE

To enable the students to acquire knowledge of simulation using advanced computer about the nuclear reactions

INSTRUCTIONAL OBJECTIVES

To provide experience to students in computer simulation of systems with emphasis on control systems, digital signal processing, and digital system design

To expose the students to the concepts of virtual instrumentation

LIST OF EXPERIMENTS

1. Study of first order and second order system responses-measurement of system parameters
2. Simulation of step and pulse response using MATLAB
3. Documentation using UNIX
4. 3D Assembly-level/High-level language program for FFT Computation using FORTRAN
5. Determination of root locus using MATLAB
6. Control system toolbox for 2nd order system
7. Determination of different control system specifications from the Nyquist plot

REFERENCE

1. Laboratory manual

NE 0327	NUCLEAR MEASUREMENT LAB-I	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

To enable the students to acquire knowledge Detector counting statistics and working principle of detectors

INSTRUCTIONAL OBJECTIVES

Able to compare performance of various detectors at different reactors
To gain the knowledge of alpha and gamma spectrometry

LIST OF EXPERIMENTS

1. G-M Counter characteristics, counting statistics.
2. Scintillation detectors and gamma spectrometry.
3. Multichannel analysis.
4. Semiconductor detectors for alpha and gamma spectrometry.
5. Coincidence measurements.
6. BF 3 counters.
7. Foil Activation.
8. Cadmium ratio measurements.
9. Neutron diffusion length and age measurements.

REFERENCE

1. Laboratory manual

		L	T	P	C
NE0329	**INDUSTRIAL TRAINING - I**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE
To expose the students to the industrial working environment and make them industry ready.

IMPLEMENTATION
A minimum of 2 weeks in-plant training has to be undergone by the student after 3rd semester but before 5th semester. A certificate from the company to the effect that the student has undergone the training successfully is to be produced by the student. The student is required to present a report on the observations and knowledge gained during the training, which will be evaluated by a panel of senior faculty members.

SEMESTER VI

NE0320	FUZZY APPROACHES IN ENGINEERING	L	T	P	C
	Prerequiste	**3**	**0**	**0**	**3**
	Nil				

PURPOSE

To introduce to the students the principles of Fuzzy logic and approaches and to lay emphasis on the fundamentals .

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make the students comprehend with the mathematical fundamentals of fuzzy logic theory and to emphasize its applications in engineering

INTRODUCTION TO FUZZY SETS

Crisp sets- Fuzzy sets- Operation and properties- Fuzzy relation- properties - Fuzzy tolerance and equivalence relations – value assignments.

FUZZY-CRISP CONVERSIONS

Features of membership function- Standard forms and boundaries- Fuzzification- Membership value assignments – Intuition – Inference – Rank ordering - Fuzzy to crisp conversions- Lamda- cuts for Fuzzy sets- Lamda cuts for Fuzzy relations- Defuzzification methods.

OPERATIONS ON FUZZY SETS AND FUZZY LOGIC

Fuzzy Arithmetic, numbers, vectors and the extension principle – Fuzzy numbers – Internal arithmetic - Fuzzy logic- Approximate reasoning- Fuzzy tautologies, contradictions, equivalence and logical proofs- Forms of implication operator- Max-Min Composition – Max Product Composition - other Composition operation.

FUZZY RULE BASED SYSTEM

Natural language- Linguistic hedges- Rule based systems- Canonical rule forms- Decomposition of compound rules- Likelihood and truth qualification- Aggregation of Fuzzy rules- Graphical techniques of inference- Fuzzy relational equations- Partitioning- Fuzzy association memories(FAM).

FUZZY CONTROL SYSTEM

Simple Fuzzy logic controller- General Fuzzy logic controller- Examples of Fuzzy control system design.
Classical Fuzzy control problem- Inverted pendulum – Fuzzy Logic with Motor control – Example of Fuzzy Logic in Motor drives – Non-Linear fuzzy control – Application of Fuzzy Logic in Industry.

TEXTBOOK

1. Timothy J. Ross ‘Fuzzy logic with Engineering Applications’ McGraw Hill.

REFERENCE BOOKS

1. Li-Xin Wang, ‘A Course in Fuzzy Systems and Control’, Prentice Hall PTR, 1997.
2. R.K. Yager, D.P.Filev, ‘Essentials of Fuzzy Modeling and Control’, John Wiley & Sons Inc, New York, 1994.
3. Klir G.J. and B.O.Yuan, ‘Fuzzy sets and Fuzzy Logic: Theory and Applications’, PHI, India, 1997.
4. Dimiter Driakov etal,’ An Introduction to Fuzzy Control’, Narosa Publication House, 1993.

NE0322		L	T	P	C
	NUCLEAR REACTOR THEORY II	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the contemporary and the recent researches in nuclear engineering applications

INSTRUCTIONAL OBJECTIVES

This course is intended to provide the students with description of the computational methods for nuclear engineering applications.

NEUTRON MODERATION
Neutron moderation in infinite homogeneous media- Moderation without absorption Moderation with infinitely massive absorber- Moderation with real materials Neutron moderation in finite homogeneous media- Continuous slowing down theory Moderation without absorption, fast non-leakage probability- Moderation with absorption, resonance-escape probability

MULTIGROUP METHOD
Problems posed by the solution of the Boltzmann equation, multigroup method- Multigroup diffusion method- Spectrum calculations and cross section averaging Numerical solution of the multigroup equations, multigroup iteration methods Zero-dimensional multigroup diffusion problem

PERTURBATION THEORY
Motivations for a perturbation theory- Adjoint problem-First-order perturbation theoryApplications of first-order perturbation theory

CORE COMPOSITION CHANGES DURING REACTOR OPERATION II
Core management, reload pattern optimization- Reactor properties over life – estimating core life, nuclear fuel management-Fission product buildup (fission product poisoning)

NUCLEAR REACTOR DESIGN PRINCIPLES AND APPLICATIONS OF THE INTRODUCED MODELING TECHNIQUES
Nuclear reactor analysis and design, neutronics and thermo hydraulics coupling- Computational analysis capabilities for Generation IV systems

TEXT BOOK

1. W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, 2001

REFERENCE BOOKS

1. J. J. Duderstadt, L. J. Hamilton, Nuclear Reactor Analysis, John Wiley & Sons, 1976
2. K. O. Ott, W. A. Bezella, Introductory Nuclear Reactor Statics, American

NE0324	NUCLEAR FUEL SYSTEM	L	T	P	C
	Prerequisite	**3**	**0**	**0**	**3**
	Nil				

PURPOSE
To introduce to the students, the various opportunities in the emerging field of Nuclear fuel system.

INTRODUCTION
Atomic structure-radioactivity - nuclear energy - condition for fission – transmutation - fission products – reactors - fuel supply - waste management-fuel cycle.

FUEL FABRICATION AND ISOTROPIC ENRICHMENT OF URANIUM
Introduction to fuel fabrication - design and consideration -uranium fortification – conversion – magnox – fuel – oxides - oxide fuel assembly - enrichment of uranium: gaseous diffusion - centrifuge enrichment - laser enrichment - re-enrichment of reprocessed uranium.

POWER REACTOR
Introduction - fission in nature; the fission process - natural fission -fundamentals of fission reactor: fission chain reaction, prerequisites for a reactor - choice of moderator - feed back mechanism - reactor control - decay heat - fission products and transuranics - reactors types.

WASTE TREATMENT
Introduction - waste types - liquid waste - solid waste - aerial effulent -disposal of fuel or wastes; waste categories – low - level waste - intermediate level waste - high level waste.

ENVIRONMENTAL RADIOACTIVITY AND SAFETY

Atmospheres - terrestrial environment - artificial radionuclide of special interest - risk assessment management-critical control - THORP.

TEXT BOOK

1.Peter. D. Wilsion, ***"****The nuclear fuel cycle from ore to waste"* oxford science publications, Oct 1996.

REFERENCE BOOKS

1. OECD Nuclear Energy Agency "Advanced nuclear fuel cycles and radioactive waste management" 2006.
2. F. Barker "management of radioactive wastes" 1998.
3. Donald R. Wily "the chemistry of nuclear fuel waste deposal" polytechnic international press, 2002.

		L	T	P	C
PD0302	**PERSONALITY DEVELOPMENT VI**	**1**	**0**	**2**	**2**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to build confidence and inculcate various soft skills and to help students to identify and achieve their personal potential

INSTRUCTIONAL OBJECTIVES

At the end of the course the students will be able to

1. Acquire the important soft skills for employment
2. Take part in group discussions and job interviews confidently
3. Appear for placement aptitude tests confidently
4. Gain self confidence to face the placement process

METHODOLOGY

The entire program is designed in such a way that every student will participate in the class room activities. The activities are planned to bring out the skills and talents of the students which they will be employing during various occasions in their real life.

1. Group activities + individual activities.
2. Collaborative learning.
3. Interactive sessions.
4. Ensure Participation.
5. Empirical Learning

Self Introduction - Narration - Current News Update – Numbers - Height & Distance - Square & Cube Roots

Current Tech Update - Verbal Aptitude Test I - GD –I - Odd man out series - Permutation & Combination - Problems on ages

GD –II - Resume Writing - Mock Interview I / reading comprehension - Problems on trains – Allegation of Mixtures - Test

Mock Interview II / reading comprehension - Mock Interview III/ reading comprehension - GD – III - Ratio & Proportion - Clocks - H.C.F & L.C.M

GD – IV - Verbal Aptitude Test II – Review – Partnership – Puzzles - Test

SCHEME OF INSTRUCTION

Marks allocated for regular participation in all oral activities in class

SCHEME OF EXAMINATION

Complete internal evaluation on a regular Basis

NE 0326	NUCLEAR MEASUREMENT LAB-II	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

To enable the students to acquire knowledge of Neutron reactors working principle and its counters

INSTRUCTIONAL OBJECTIVES

Able to compare performance of various kinetics
To gain the knowledge of oscilloscopes and pulsed detection electronics

LIST OF EXPERIMENTS

1. Oscilloscopes and Pulse-detection Electronics
2. Geiger-Müller Counters
3. Silicon Semiconductor Detectors
4. Stopping Power for Alpha Particles
5. Gamma-Ray Coincidences, Timing, and Compton Scattering Kinematics Measurements
6. Neutron Activation Analysis with HP-Ge Detectors
7. Neutron Detection
8. Natural Uranium-Light Water Subcritical Assembly
9. Neutron Flux Measurement

REFERENCE

1. Laboratory manual

NE0328	REACTOR LAB	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

To enable the students to acquire knowledge of reactor operation and its instrumentation

INSTRUCTIONAL OBJECTIVES

To gain the knowledge of various accessories used in the reactor
Activation and analysis of neutron data in reactor

LIST OF EXPERIMENTS

1. Reactor operation
2. Control rod calibration
3. Reactor power measurement
4. Neutron activation experiments
5. Thermal column and neutron beam port demonstration.
6. Application of reactor physics principals to operation
7. Neutron activation analysis
8. Instrumentation
9. Reactivity evaluation

REFERENCE

1. Laboratory manual

		L	T	P	C
NE0330	**COMPREHENSION – II**	**0**	**2**	**0**	**1**
	Prerequisite				
	NE0218				

PURPOSE

To provide a review of Nuclear Science and Engineering topics covered up to VI semester, so that a comprehensive understanding is achieved. It will also help students to face job interviews and competitive examinations**.**

INSTRUCTIONAL OBJECTIVES

1. To provide overview of all Nuclear Science and Engineering topics covered up to VI semester.
2. To assess the overall knowledge level in the following topics of Nuclear Science and Engineering.

COMPREHENSION

A. Review of the topics

B. Seminar/group discussion

Students shall have seminar/group discussion sessions on the topics listed under A above under the guidance of staff.

(Evaluation is based on an end semester examination).

		L	T	P	C
NE0332	**COMPUTER SKILLS**	**1**	**0**	**2**	**2**
	Prerequisite				
	Nil				

PURPOSE

To acquire extramural knowledge on the computer implementation of various engineering solutions.

IMPLEMENTATION

The students are expected to undergo at least two computer courses from a list of courses provided from time to time by the departments of engineering and technology. Resources for conducting the courses will be found from in-house talents and outside professionals with expertise in the particular course. Certification will be done by both the university and the bodies notified for the purpose. The students are required to obtain a minimum grade for gaining the required credit.

SEMESTER – VII

NE0431	APPLIED REACTOR ANALYSIS	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the contemporary and the recent researches in nuclear engineering applications

INSTRUCTIONAL OBJECTIVES

The objective is to relate the fundamental physical principles, concepts and modeling techniques to analysis and design of nuclear reactors. It prepares to analyze nuclear reactors including aspects of performance, dynamics and safety and to either develop new designs or to assess existing or proposed designs based upon fundamental understanding of reactor physics.

CONCEPT OF CRITICALITY; PRINCIPAL EIGENVALUE & FUNDAMENTAL MODE

Criticality -One-group diffusion theory, bare homogeneous reactor - Criticality search - size and composition effects

HETEROGENEOUS REACTORS

Homogenization of a fuel-moderator assembly -Core homogenization - Effective diffusion theory for control rods - Power peaking factors

TEMPERATURE COEFFICIENTS OF REACTIVITY

Temperature coefficients of reactivity -Perturbation theory evaluation - Reactivity feedback

CHANGES DUE TO DEPLETION & FISSION PRODUCT BUILDUP

Nuclide production-destruction equations -Reactivity effects of fuel composition changes -Samarium and xenon

NUCLEAR REACTOR ANALYSIS

Nuclear power reactors -Nuclear reactor analysis - Reactor physics and thermodynamics coupling

TEXT BOOK

1. W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, 2001

REFERENCE BOOKS

1. J. R. Lamarsh, Introduction to Nuclear Reactor Theory, Addison-Wesley Pub., 1966
2. J. R. Lamarsh, A. J. Baratta, Introduction to Nuclear Engineering, 3d ed., Prentice-Hall, 2001

NE0433	FAST REACTOR THEORY	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the contemporary and the recent researches in nuclear engineering applications

INSTRUCTIONAL OBJECTIVES

The objective is to relate the fundamental physical principles, concepts and modeling techniques to analysis and design of nuclear reactors. It prepares to analyze nuclear reactors including aspects of performance, dynamics

and safety and to either develop new designs or to assess existing or proposed designs based upon fundamental understanding of reactor physics.

SUSTAINABLE DEVELOPMENT AND FAST SPECTRUM SYSTEMS

Spent fuel - light water reactor, light water reactor MOX, fast reactor MOX Radiotoxicity of fission products-Advanced conditioning of minor actinides-Transmutation of minor actinides

PARTITIONING AND TRANSMUTATION SCIENCE AND ENGINEERING IN RADIOACTIVE WASTE MANAGEMENT

Aqueous and pyrochemical reprocessing technologies and recycling oftransuranic elements and fission products- Partitioning of minor actinides from aqueous reprocessing streams- Pyrochemical reprocessin Separation of long lived fission and activation products- Conditioning of separated minor actinides- Dual purpose conditioning for transmutation and disposal - inert matrix fuels-Global status of reprocessing

TRANSMUTATION

Physics of transmutation, transmutation efficiency-Transmutation strategies-Homogeneous recycling-Heterogeneous recycling and its potential limitations-Transmutation issues of long-lived fission product-Fuel concepts for transmutation-Transmutation potential of various nuclear systems including dedicated cores-Transmutation systems and safety

FAST REACTORS

Fast reactor principles-Design considerations: materials, neutronics, heat transfer, and systems-Fast reactors for actinide transmutation-Safety of fast reactors-Fast reactor fuels-Fast reactor structural materials-Commercialization of fast reactors-Fast reactor database-Code systems for fast reactor studies

HYBRID SYSTEMS

Hybrid system principles-Size of hybrid systems-Practical systems-Evaluation of hybrid systems-Accelerator driven systems – international trends in research and
Development-Fusion-driven systems

TEXT BOOK

1. W. M. Stacey, *Nuclear Reactor Physics*, John Wiley & Sons, 2001.

REFERENCE BOOKS

1. R. G. Cochran, N. Tsoulfanidis, *The Nuclear Fuel Cycle: Analysis and Management*, 2nded., American Nuclear Society, 1999
2. M. M. El-Wakil, Nuclear Heat Transport, American Nuclear Society, Revised edition, 1978, 1993.

NE 0435	RADIOLOGY MEASUREMENT LAB	L	T	P	C
		0	0	3	2
	Prerequisite				
	Nil				

PURPOSE

To enable the students to acquire knowledge of the construction and operation of general radiographic and fluoroscopic equipment, mammographic unit and dental radiographic equipment.

INSTRUCTIONAL OBJECTIVES

To be familiar with principles of radiographic imaging
To apply this knowledge to the production of radiograph and the assessment of image quality
To understand the construction, operation of imaging and processing equipment, radiation protection and quality control
Control and manipulate parameters associated with exposure and processing to produce a required image of esirable quality.

LIST OF EXPERIMENTS

1. Radioisotope applications
2. Biological effects of ionising radiation
3. X-Ray and related equipment
4. Image characteristics
5. Interaction of ionising radiation with matter
6. Detection of ionising radiation
7. Dosimetry
8. Dental Radiography
9. Mammography
10. Xeroradiography

REFERENCE

1. Laboratory manual

		L	T	P	C
NE0437	**INDUSTRIAL TRAINING - II**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

To expose the students to the industrial working environment and make them industry ready.

IMPLEMENTATION

A minimum of 2 weeks in-plant training has to be undergone by the student after 5^{th} semester but before 7^{th} semester. A certificate from the company to the effect that the student has undergone the training successfully is to be produced by the student. The student is required to preset a report on the observations and knowledge gained during the training, which will be evaluated by a panel of senior faculty members

SEMESTER VIII

NE0434	**PROJECT WORK**	**0**	**0**	**17**	**8**

ELECTIVES

		L	T	P	C
NE0001	**HIGH INTENSITY LASER PLASMA INTERACTIONS**	**0**	**0**	**2**	**1**
	Prerequisite				
	Nil				

PURPOSE

The topic of the course is the physics of the interaction of high intensity light fields with matter and their interactions.

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make thestudents familiar with the high intensity laser technology laser plasma physics, and their applications.

HIGH INTENSITY LASER TECHNOLOGY

Ultrashort pulse generation; amplification of femtosecond laser pulses, Ti:Sapphire technology and OPCPA amplifiers; pulse diagnostics; future PetaWatt and ExaWatt laser systems, Electrons in relativistic light fields; introduction into plasma physics; absorption processes; electron acceleration; bubble acceleration; ion acceleration mechanisms

LASER ACCELERATED PARTICLES AND APPLICATIONS

Monoenergetic electron acceleration with lasers, Bremsstrahlung generation and applications in nuclear physics; ion acceleration and applications in accelerator physics; medical applications, strong field quantumelectro-dynamics with intense laser fields

LASER PLASMA PHYSICS

Coulomb collisions and transport processes, Motion of charged particles in magnetic fields: plasma confinement schemes. MHD models: simple equilibrium and stability analysis, Two-fluid hydrodynamic plasma models: wave propagation in a magnetic field; Introduces kinetic theory; Vlasov plasma model: electron plasma waves and Landau damping.

PLASMA INTERACTIONS

Comprehensive theory of electromagnetic waves in magnetized plasma, Wave propagation in cold and hot plasmas; Energy flow, Absorption by Landau and cyclotron damping and by transit time magnetic pumping (TTMP); Wave propagation in inhomogenous plasma; WKB theory, mode conversion, connection formulae, and Budden tunneling; Applications to RF plasma heating, wave propagation in the ionosphere and laser-plasma interactions.

TEXT BOOK

1.K Thyagarajan and A. K. Ghatak, *Lasers: Theory and Applications*, Plenum Publishing Corporation, New York, 1981

2. H. Schwoerer, J. Magill & B. Beilitus, Lasers and Nuclei: Application of ultra high intensity lasers in Nuclear Science , Springer Publishers

REFERENCE BOOKS

1.Jung, Ralph Laser-Plasma Interaction with Ultra-Short Laser Pulses, VDM Verlag

2.Jaroszynski Dino a (Author), Bingham R a (Author), Jaroszynski, Dino A. (Editor) Laser-Plasma Interactions, Taylor & Francis Group

NE0002	REACTOR SAFETY	L	T	P	C
		3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To introduce to the students, the various opportunities in the emerging field of Nuclear Engineering.

INSTRUCTIONAL OBJECTIVES

The objective of this course is to make students familiar with the important concepts applicable to reactor safety methods, analysis and NRC rules and procedures.

OPERATIONAL FEATURES OF NUCLEAR REACTOR SYSTEM – RELVANCE OF SAFETY

Purpose, Scope, Relevant Legislation, Safety Analysis Objectives and requirements, Responsibility, Events to be Analyzed, Identifying Events, Scope of Events, Classification of Events, Acceptance Criteria , Normal Operation, Anticipated Operational Occurrences and Design Basis Accidents , Beyond Design Basis Accidents, Acceptance Criteria for AOOs and DBAs, Safety Analysis Methods and Assumptions, General, Analysis Method, Analysis Data, Analysis Assumptions, Conservatism in Analysis, Safety Analysis Documentation, Safety Analysis Review and Update, Review of Safety Analysis.

REACTOR CONTAINEMNT AND ENGINEERED SAFETY FEATURES

Engineered Safety Features, Containment, Passive Containment Cooling System, Containment Isolation System, Passive Core Cooling System, Main Control Room Emergency Habitability System, Fission Product Control

TRANSIENT ANALYSIS AND ACCIDENT ANALYSIS OF REPRESENTATIVE REACTOR TYPES

Reactor physics, Fuel, Fuel element temperatures, Gas pressure inside sheath, Fuel behavior in accidents, Over power, dry out, Low coolant flow, Loss of coolant, Heat transport system, Fuel channels

NRC REGULATIONS AND PROCEDURES

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 material

TYPICAL REACTOR SAFETY ANALYSES

Reactor Safety

Temperature Excursion/Temperature Runaway, Safe Design and Operating Guidelines, Stability Criteria, Catalyst Loading and Preparations, General Emergency Guidelines,

Troubleshooting

High Reactor Pressure Drop, Pressure Drop Buildup During Operating Cycle, Pressure Pulsing of the Reactor, Channeling, Flow Maldistribution, Temperature Maldistribution, Quench Efficiency, Low Initial Catalyst Activity, Loss of Catalyst Activity, Low Temperature Response

TEXT BOOK

J.J. Duderstadt & L.J. Hamilton, “Nuclear Reactor Analysis”, John Wiley and Sons, 1976.

REFERENCE BOOKS

1. J.R. Lamarsh, “Introduction to Nuclear Reactor Theory”, Addison-Wesley, 1966.
2. D.J. Bennet, “The Elements of Nuclear Power”, Longman Group Limited, 1972.
3. John R. Lamarsh, “Introduction to Nuclear Engineering”, Addison-Wesley Publishing Company, 1983, ISBN 0-201-14200-7.
4. Hand book of nuclear engineering, Cacuci, Dan Gabriel (Ed)
5. Nuclear Engineering , Glasstone & Sesoske

		L	T	P	C
NE0003	**SPECIAL TRANSDUCERS AND INSTRUMENTATION**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

The purpose of this course is to introduce the students to the use of special transducers in the field of biomedical instrumentation.

INSTRUCTIONAL OBJECTIVES

At the end of the course the student will be able to

1. The use of force, pressure and motion measurement in the biomedical field.
2. The use of flow, temperature and radiation measurement in the biomedical field.

BIO-SENSORS

Study of biological sensors in the human body and their basic mechanism action organization of nervous system- neuronal mechanism and circuit processing - Study of various corpuscles like pacinian - functions and modelling - Chemoreceptors, hot and cold receptors, barro receptors, sensors for smell, sound, vision, osmolality and taste.

FORCE, PRESSURE AND MOTION MEASUREMENT

Various transducers capable of measuring low pressure and force, its measuring system, external and catheter tip transducers, transducer to measure single movement and differential movement, velocity transducers, seismic pick-up, accelerometer, biomedical applications.

CHEMICAL AND OPTICAL TRANSDUCER

Bio sensors - Ion exchange membrane electrodes- oxygen electrodes- CO2 electrodes enzyme electrode - construction - ISFET for glucose, urea etc. Electrolytic sensors - optical sensor - fiber optic sensors. Ion sensor, cation and anion sensor, liquid and solid ion exchange membrane electrodes, enzyme electrodes, molecular electrode, photo acoustic sensor, PPG sensors, biomedical applications.

TEMPERATURE AND PRESSURE MEASUREMENT

Different Transduction principles - Temperature transducers - thermo resistive transducers, thermoelectric, chemical thermometry. Displacement transducers - potentiometer - resistive strain gauges - inductive displacement - capacitive displacement transducer. Pressure transducer - indirect method - measurement of blood pressure using sphygmomanometer -instrument based on Korotkoff sound, strain gauge and LVDT transducers, capacitive and piezo electric type, catheter tip transducers - measurement of intracranial pressure – cathetertip-implantabletype.

FLOW MEASUREMENT

Flow measurement transducer -Electro magnetic flow meters and ultrasonic blood flow meters - Fibre optic flow transducers & transducers for light . Transducer to measure a velocity, magnitude and direction flow, various methods of measuring the parameter, invivo and invitro type of measurements.

TEXT BOOKS:-

1. D L Wise , *Applied Bio Sensors* , Butterworth, London
2. R S C Cobbold, *Transducers for Biomedcial Instruments* , Prentice

REFERENCE BOOKS

1. Micheal R.New Man, David G. Flemminga, *Physical sensors for Biomedical Applications* , CRC Pressinc, Florida, 1980.
2. Earnest O.Doeblin, *Measurement System Application and Design* , McGraw Hill Newyork 1990.

		L	T	P	C
NE0004	**MEDICAL INFORMATICS**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To give comprehensive idea about multimedia applications in medical field to develop educational / training packages.

To understand the component of virtual reality and virtual reality applications in medicine

INSTRUCTIONAL OBJECTIVES

To study the methods utilized for data storage ,data retrieval and analysis

To study the concept of visual programming and to develop VB based medical information systems.

To expose to various applications of computer in medical field like neural network, fuzzy system and virtual reality.

Based on the above knowledge to develop packages for transmission of medical information and for training.

MEDICAL DATABASE IMPLEMENTATION

Medical data acquisition and database systems: PC based mutlichannel data acquisition system; storage, analysis and retrieval techniques.

VISUAL BASIC

Visual programming concepts; visual Basic environment, tools and controls; Dynamic data exchange; VB based Medical information System.

COMPUTERS IN SYSTEM DESIGN

Hospital Information System its design and functional characteristics; Principles and application of Artificial Intelligence, Pattern Recognition, Neural Network and Fuzzy Logic in Medicine.

MULTIMEDIA AND VIRTUAL REALITY APPLIED TO MEDICINE

Basic concepts of Multimedia; Design of Multimedia information systems; Components of virtual reality; Virtual reality applications in medicine.

COMPUTERS IN MEDICAL RESEARCH

Medical Informatics and its levels; Design and development of educational packages on medical sciences; Integrated design concepts; Interactive multimedia, Virtual and digital libraries, Internet and its applications.

TEXT BOOK

1. R.D.Lele, *Computer in Medicine* , Tata McGraw-Hill, New Delhi, 1997.

REFERENCE BOOKS

1. 1.Tay Vaughan, *Multimedia making it work*, Tata McGraw-Hill, New Delhi, 1997.
2. 2.Davis Chapman, *Teach Yourself Visual Basic 6 in 21 days* , New Delhi, 1997.
3. 3.Harold Sackman, *Biomedical Information Technology*, Academic Press, New York, 1997.
4. 4.Mary Brth Fecko, *Electronics Resources: Access and Issues* , Bowker and Saur, London, 1997

		L	T	P	C
NE0005	**INTRODUCTION TO REHABILITATION ENGINEERING**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To familiarize the students with the technology currently used to improve the quality of life of individuals with disabilities, and those recovering from trauma

INSTRUCTIONAL OBJECTIVES

On completion of the course the student will be able to

1. Explain the need for medical aids.
2. Devise new concepts for future development and applications
3. Have a understanding of the orthopedic prosthetics and orthotics in rehabilitation
4. Have a understanding of the sensory rehabilitation systems

litation Concepts, Engineering Concepts in Sensory Rehabilitation and Motor Rehabilitation, Engineering Concepts in Communication Disorders.

ORTHOPEDIC PROSTHETICS AND ORTHOTICS IN REHABILITATION

Fundamentals: Function, Structure and Cosmesis of Orthotic or Prosthetic device. Computer-Aided engineering in customized component design, Example- Intelligent prosthetic knee, hierarchically controlled Prosthetic Hand.

WHEELED MOBILITY: WHEELCHAIRS AND PERSONAL TRANSPORTATION

Categories of Wheelchairs, Wheelchair structure and Component design, Ergonomics of Wheelchair Propulsion, Power Wheelchair Electrical Systems. Personal Transportation for the Handicap: Vehicle Selection, Lift Mechanisms, Hand Controls, Wheelchair restraint Mechanisms.

SENSORY REHABILITATION SYSTEMS

Visual System: Visual Augmentation, Tactual Vision Substitution, Auditory Vision Substitution, Auditory System: Auditory Augmentation, Visual Auditory Substitution, Tactual Auditory Substitution. Tactual System: Tactual Augmentation, Tactual Substitution.

PRINCIPLES OF APPLICATION

Conceptual frameworks, Provision Process, Education and Quality Assurance, Specific Impairments and Related technologies, Future Developments.

TEXT BOOKS

1. Robinson C.J., *Rehabilitation Engineering Handbook of Electrical Engineering*, CRC Press, Bocaration 1993.
2. *The biomedical engineering handbook*, by joseph d. brozino

REFERENCE BOOK

1. Keswick. J., *What is Rehabilitation Engineering*, Annual Reviews of Rehabilitation-Springer-Verlag, New York, 1982.

		L	T	P	C
NE0006	**HUMAN ASSIST DEVICES**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE

To understand functioning and usage of electromechanical units which will restore normal functional ability of particular organ which is defective temporarily or permanently.

INSTRUCTIONAL OBJECTIVES

To study various mechanical techniques that will help failing heart.
To study the functioning of the unit which does the clearance of urea from the blood?
To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
To study the various orthodic devices and prosthetic devices to overcome orthopedic problems.
To understand electrical stimulation techniques used in clinical applications.

CARDIAC ASSIST DEVICES

Principle of External counter pulsation techniques, intra aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

HEMODIALYSERS
Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

HEARING AIDS
Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

ORTHOSTHETIC AND ORTHODIC DEVICES
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, Sensory assist devices.

STIMULATOR AND RESPIRATORY ASSIST DEVICES
Stimulation, Practical applications of Stimulation, bio-feedback, Ventilator, IPPB unit, Nebulizer, Humidifier.

TEXT BOOKS
1. Levine S.N. (ed), *Advances in Bio-medical engineering and Medical physics , Vol. I, II, IV,* inter university publications, New York, 1968 (Unit I, IV, V).

REFERENCE BOOKS
1. Kopff W.J, *Artificial Organs* , John Wiley and sons, New York, 1976. (Unit II).
2. Albert M.Cook and Webster J.G, *Therapeutic Medical Devices* , Prentice Hall Inc., New Jersey, 1982 (Unit III).

		L	T	P	C
NE0007	**MODELLING OF PHYSIOLOGICAL SYSTEMS**	**3**	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE
To understand basic ideas related to modelling and different modelling techniques of certain physiological systems like respiratory system, thermal regulation system and lung model.

INSTRUCTIONAL OBJECTIVES

At the end of this course students are ,
1. Able to model any physiological system.
2. Gain thorough knowledge of modelling of thermal regulation system, Respiratory system
3. Pharmacokinetic modeling

Physiological processes and principles of their control flow, gas exchange ultra filtration , biochemical reactions, pneumatic transport, digestion, energy utilization and waste disposal, linear and non linear control systems, principles of open loop and feedback systems techniques for system response characterization – Pupillary control system ,characterization of physiological feed back system.

Modeling of human thermal regulatory system: Parameters involved, control system model etc. biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystems of human body like skin core, etc. and systems like within body, body environment etc.

Respiratory system: Modeling oxygen uptake by RBC and pulmonary capillaries, mass balancing by lungs, gas transport mechanism of lungs, oxygen and carbon dioxide transport in blood and tissues. Lung Model.

Ultra Filtration system Transport through cells and tubules, diffusion, facilitated diffusion and active transports, methods of waste removal, counter current model of urine formation in nephron, moellir Henle's loop.

Modeling body dynamics: Principles of mechanical modeling of bone, tissues etc., and modeling stress were propagation in bones, hills, model of muscle mechanisms current trends: Pharmacokinetic modeling with illustrated example like drug diffusion, computer aided modeling etc.

TEXT BOOKS:

1. *Advanced Methods of Physiological System Modeling* by V.Z. Marmarelis
2. *Applied mathematical model in Human Physiology*, by Johnny T. Ottesen, Mette S. Olufsen, Jesper K. Larsen

REFERENCE BOOKS:

1. *Physiological basis of Ventilatory Support*, By John. J. Marini, Arthur S. Slutsky
2. *Pharmacokinetic and Pharmacodynamic Data Analysis: Concepts and Applications***,** By Daniel (Weiner, Johan Gabrielsson

NE0008	Product Design, Management Techniques and Entrepreneurship	L	T	P	C
	Prerequisite	**3**	**0**	**0**	**3**
	NIL				

PURPOSE

The ultimate aim of this course is to have deeper understanding of the Nanotechnology.

INSTRUCTIONAL OBJECTIVES

To understand the basic concepts involve in this technology and to explore their limitations.

PRODUCT DESIGN

Concept Generation-Product Architecture-Industrial Design Process-Management of Industrial Process and assessing the qualityof insutrial design-Establishing the product specification

PRODUCT DEVELOPMENT

Criteria of selection of product-Product development-Process design of manufacture-Estimate the manufacturing cost-Reduce the support cost-Prototyping-Economics of project development projects-Elements of economic analysis financial models selective analysis and influence of the quantitative factors

MANAGEMENT TECHNIQUES

Technology management-Scientific management-Development of management thought-principals of management functions of management-Planning Organization-Directing staffing and controlling management by objective-SWOT analysis-Enterprise resource planning and supply chain management

ENTREPRENEURIAL COMPETENCE AND ENVIRONMENT

Concept of entrepreneurship - Entrepreneurship as a career personality – Characteristics of a successful entrepreneur - Knowledge and skill required for an entrepreneur - Business environment entrepreneurship development training - Centre and state Govt policies and regulations-International business

MANAGEMENT OF SMALL BUSINESS

Prefeasibility study - Ownership - Budgeting-Project Profile preparation - Feasilbility report preparation evaluation criteria market and channel selection product launching monitoring and evaluation of business effective management of small business

TEXT BOOKS :

(1) Karal, T Ulrich Steven, D Eppinger, " Product Design and Development", McGraw –Hill International , editions ,2003

REFERENCES BOOKS :

(1) S. Rosenthal " Effective Product Design and Development", Irwin,1992
(2) H.Koontz and H Weihrich," Essentials of management" , McGraw Hill Publishing company, Singapore International Edition,1980
(3) J.J Massie," essentials of Management" Prentice Hall of India Pvt Ltd,1985
(4) Hisrich," Entrepreneurship" Tata McGraw Hill, New Delhi,2001

		L	T	P	C
NE0009	**Intellectual Property Rights, Innovation and Technology**	**3**	**0**	**0**	**3**
	Prerequisite				
	NIL				

PURPOSE
The ultimate aim of this course is to have deeper understanding of the Nanotechnology.

INSTRUCTIONAL OBJECTIVES
To understand the basic concepts involve in this technology and to explore their limitations.

IP LAW BASICS
Introduction-Background and Concepts-Brief History of Institutions-Investing in Knowledge-Market Failures in Knowledge-IP, Public Sponsorship & Prize-IP Law Basics-Means of IP Protection-Patents-Copyrights - IP and Antitrust.

DESIGN OF IP
Optimal Design of IP-Scarce Ideas vs. Non-scarce ideas-Policy Levers in IP Design-Breadth- Length-Required Inventive Steps-Optimal Size of Reward and Structure-Entry Cost Regime- Horizontal Competition Regime-Economic Effects of Exemptions.

PROTECTING CUMULATIVE INNOVATIONS
Protecting Cumulative Innovations-Three Types of Cumulativeness-Basic v. Applied Research- Research Tool-Quality Ladders-Policy Levers and Prospecting-Battle Over Stem Cell Patents and WARF-Open Source (OS)-Incentive for OS

LICENSING AND JOINT VENTURE
Licensing, Joint Ventures and Competition Policy-Licensing-Licensing vs. Product Sale-Licensing for Productive Efficiency-New Product Innovation vs. Cost Reduction Innovation-Mergers-Ex Ante: R&D Joint Ventures-Ex Post: Patent Pool-Collective Rights Management Organization

LITIGATION AND ENFORCEMENT
Litigation and Enforcement-Remedies for Infringement-How they matter- Enforcement of IP by Technical Means-Limited Sharing of Copyrighted Works-Technology Transfer, Diffusion, and Adoption-Networks and Network Effects-Concepts and Issues-Direct vs. Indirect Network –Effects-Physical Networks-Business Strategies-System Competition vs. Standard Competition

TEXTBOOKS:
(1) Innovation and Incentives, Suzanne Scotchmer, MIT Press 2004.

REFERENCE BOOKS:
(1) Industrial Organization: Contemporary Theory & Practice, 3e, L. Pepall, D.J. Richards, and G. Norman, South-Western 2005.

NE0010	**ENGINEERING OF NUCLEAR POWER SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Prerequisite				
	Nil				

PURPOSE
To introduce to the students,the various opportunities involved in the field of Nuclear Power Systems
INSTRUCTIONAL OBJECTIVES
The objective of this course is to make the students familiar with the important concepts of Thermal hydraulics, reactor kinetics process instrumentation and control.

INTRODUCTION TO NUCLEAR POWER SYSTEMS
Thermal parameters - definitions and uses-Sources and distribution of thermal loads in nuclear power reactors-Conservation equations and their applications to nuclear power systems: power conversion cycles.

STRUCTURAL MECHANICS
Fundamentals of structural mechanics-Explanation of concepts invovled in structural mechanics-Applications to nuclear systems

NUCLEAR REACTORS
Types of reactor-Heat generation in fuel elements and temperature distributions. Heat removal, Reactor coolants. Single phase and two phase heat transfer. Boiling and flow regimes. Heat transfer and fluid flow correlations

REACTOR KINETICS
Introduction to control theory- Point reactor kinetics with introduction to feedback Effects- Non-linear effects.- Shielding-Introduction to reactor reliability and safety analysis- Radioactive waste disposal.

PROCESS INSTRUMENTATION AND CONTROL
Basic concepts, sensing and transmission/receiving of temperature, flow, liquid level, pressure, force, viscosity, humidity-Nuclear Materials: fabrication and properties of metallic fuels, ceramic fuels, applications.

TEXT BOOK
1. John Lamarsh , "*Introduction to Nuclear Engineering*", Addison Wesley Publishing Company, Edition II,1983.

REFERENCE BOOKS
1. Cecil Dudley,Gregg King, "*Nuclear Power Systems : An Introductory Text*" , Macmillan,1964.
2. Geoffrey F.Hewitt,John G Collier,"*Introduction to Nuclear Power*"II Edition,2000.

NE0011	OPERATIONS RESEARCH	L	T	P	C
	Prerequisite	**3**	**0**	**0**	**3**
	NIL				

PURPOSE
To introduce managerial skill for budding engineers

INSTRUCTIONAL OBJECTIVES
1. To equip the students with scheduling and network analysis
2. To make the students aware of replacement policy and game theory
3. To introduce the topic of inventory control
4. To make students aware of the problems of linear programming

RESOURCE SCHEDULING AND NETWORK ANALYSIS
Problem of sequencing – Sequencing n jobs through 2 machines and 3 machines, 2 jobs through m machines. PERT and CPM –Critical path calculation – Probability and cost consideration.

REPLACEMENT AND GAME THEORY
Replacement Models – Replacement of items that deteriorate with time – Equipment that fails suddenly. Two person zero sum games – Pure strategies and saddle point – Mixed strategies – 2 x n and m x 2 games – Method of dominance – Numerical and graphical solutions.

INVENTORY CONTROL
Inventory models – Deterministic models – Economic ordering quantity, Reorder level, optimum cost – Instantaneous and Non-instantaneous receipt of goods with or without shortages.

LINEAR PROGRAMMING
Introduction to Linear Programming – Formulation of the problem – Graphical method – Simplex method – Artificial variable techniques - Primal-dual problems – Dual Simplex method.

ADVANCED LINEAR PROGRAMMING PROBLEMS
Integer programming problem - Cutting plane algorithm – Transportation models - Vogel's Approximation method – MODI method – Unbalanced transportation problem – Degeneracy in transportation models – Assignment models – Traveling salesman problem-Dynamic Programming problem.

TEXT BOOK

1. Kanti Swarup, Gupta P.K., and Man Mohan, "O*perations Research*" Sultan Chand & Sons, 1994.

REFERENCE BOOKS

1. Gupta P.K., and Hira D.S., "*Operations Research*", S.Chand & Sons, 2000.
2. Sundaresan.V, Ganapathy Subramanian.K.S. and Ganesan.K, "*Resource Management Techniques*", A.R. Publications,2002
3. Taha H.A., "*Operations Research – An introduction*", 7th edition, PHI, 2002.
4. Sharma S.D., "*Operations Research*", Kedarnath Ramnath & Co., Meerut,1994.
5. Billy B. Gillet, "*Introduction to Operations Research* "– TMH Publishing Co.
6. Gupta P.K., and Manmohan, "*Operations Research and Quantitative Analysis"* – S.Chand & Co., New Delhi.
7. Hamblin S., and Stevens Jr., "*Operations Research*", Mc Graw Hill Co.
8. Taha H.A., "*Operations Research – An introduction*", 8th edition, Taha H.A., "*Operations Research – An introduction*", 7th edition, PHI, 2002.