JHARKHAND UNIVERSITY OF TECHNOLOGY

Ranchi, Jharkhand, India

B.TECH. 7th & 8th Semester Structure

With effect from

ACADEMIC YEAR 2018-19

Mechanical Engineering

Semester -VII

Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	MEC701	Automation in Manufacturing	3	0	0	3
2	PEC-III		3	0	0	3
3	PEC-IV		3	0	0	3
4	OEC III		3	0	0	3
5	OEC IV		3	0	0	3
6	ME701P	Lab VII (RAC)	0	0	2	1
7	ME702D	Project-I	0	0	4	2
8	ME703I	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-III (Anyone)**	**Code**	**Professional Elective-IV (Any one)**
MEP702	Refrigeration and Air Conditioning	MEP705	Power Plant Engineering
MEP703	Cryogenics	MEP706	Finite Element Analysis
MEP704	Gas Dynamics	MEP707	Tool Design

Code	**Open Elective-III (Any one)**	**Code**	**Open Elective-IV(Any one)**
MEO708	Mechanical Vibrations	MEO713	Rapid Prototyping
MEO709	Convective Heat Transfer	MEO714	Industrial Automation
MEO710	Micro and Nano Manufacturing	MEO715	Technology management
MEO711	Energy Systems and Management	MEO716	Computer Aided Manufacturing
MEO712	Condition Monitoring	MEO717	Maintenance Engineering & management

Semester -VIII

Branch: Mechanical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1	ME801D	Project-II			16	08
					Total Credit	08

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Electrical Engineering

Semester -VII

Branch: Electrical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ELC701	Protection of Power Apparatus Sy	3	0	0	3
2	PEC-III	**Professional Elective-III**	3	0	0	3
3	PEC-IV	**Professional Elective-IV**	3	0	0	3
4	OEC III	**Open Elective-III**	3	0	0	3
5	OEC VI	**Open Elective-IV**	3	0	0	3
6	EL701P	Power System Protection	0	0	2	1
7	EL702D	Project Part - I	0	0	4	2
8	EL703I	Internship Assessment	0	0	2	2
Total credits						20

Code	**Professional Elective-III (Any one)**	**Code**	**Professional Elective-IV (Any one)**
ELP702	Electrical Drives and Control	ELP706	High Power Converters
ELP703	Utilization of Electrical Power	ELP707	HVDC Transmission and FACTS
ELP704	Power System Dynamics and Control	ELP708	Smart Grid Technology
ELP705	Power Quality	ELP709	Electrical and Hybrid Vehicles

Code	**Open Elective-III (Any one)**	**Code**	**Open Elective-IV(Any one)**
ELO710	Soft Optimization Techniques	ELO713	Digital Signal Processing
ELO711	Illumination Technology	ELO714	Energy Storage Systems
ELO712	Process Instrumentation and Control	ELO715	Electrical machine and Power Systems*

* Not for EE Students

Semester -VIII

Branch: Electrical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1	EL801D	Project-II			16	08
					Total Credits	08

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Electrical & Electronics Engineering

Semester -VII

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ELC701	Protection of Power Apparatus Sy	3	0	0	3
2	PEC-III	Professional Elective-III	3	0	0	3
3	PEC-IV	Professional Elective-IV	3	0	0	3
4	OEC III	Open Elective-III	3	0	0	3
5	OEC IV	Open Elective-IV	3	0	0	3
6	EL701P	Power System Protection and	0	0	2	1
7	EE702D	Project Part - I	0	0	4	2
8	EE703I	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-III (Any one)**	**Code**	**Professional Elective-IV (Any one)**
ELP702	Electrical Drives and Control	EEP704	Antennae & Wave Propagation
ELP703	Utilization of Electrical Power	ELP708	Smart Grid Technology
ELP705	Power Quality	ELP709	Electrical and Hybrid Vehicles
ELP707	HVDC Transmission and FACTS		

Code	**Open Elective-III (Any one)**	**Code**	**Open Elective-IV(Any one)**
ELO710	Soft Optimization Techniques	ELO713	Digital Signal Processing
ELO711	Illumination Technology	ELO714	Energy Storage Systems
ELO712	Process Instrumentation and Control	ELO715	Electrical machine and Power Systems

* Not for EEE Students

Semester -VIII

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	L	T	P	Credits
1	EE801D	Project-II			16	08
					Total Credits	08

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Production Engineering

Semester -VII

Branch: Production Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	PEC701	Production Planning and Control	3	0	0	3
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC III	**Open Elective -III**	3	0	0	3
5	OEC IV	**Open Elective -IV**	3	0	0	3
6	PE701P	Optimization Lab	0	0	2	1
7	PE702D	Project-I	0	0	4	2
8	PE703I	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-III (Any one)**	**Code**	**Professional Elective-IV (Any one)**
PEP702	Statistical Quality Control	PEP705	Tool Design
PEP703	Total Quality Management	PEP706	Advance Casting and Welding
PEP704	Quality and Reliability Engineering	PEP707	Material Deformation Process

Code	**Open Elective-III (Any one)**	**Code**	**Open Elective-IV(Any one)**
PEO708	Supply Chain Management	PEO713	Finite Element Method
PEO709	Enterprises Resource Planning	PEO714	Modern Optimization Technique
PEO710	Management Information System	PEO715	Mechatronics
PEO711	Marketing Management	PEO716	Project Engineering
PEO712	Intelligent Manufacturing Systems		

Semester -VIII

Branch: Production Engineering

S.N.	Code	Course Title	L	T	P	Credits
1	PE801D	Project-II			16	08
					Total Credit	08

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Metallurgical Engineering

Semester -VII

Branch: Metallurgical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	MLC701	Foundry Technology	3	0	0	3
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC III	**Open Elective -III**	3	0	0	3
5	OEC IV	**Open Elective -IV**	3	0	0	3
6	ML701P	Foundry Lab.	0	0	2	1
7	ML702D	Project-I	0	0	4	2
8	ML703I	Internship Assessment	0	0	2	2
Total credits						20

Code	Professional Elective-III (Any one)	Code	Professional Elective-IV (Any one)
MLP702	Advances in Steel Making	MLP707	Principles of Management
MLP703	Non Destructive Testing	MLP708	Alloys Steels and High Temperature Alloys
MLP704	Light Metal Alloys Steels	MLP709	High Temperature Materials
MLP705	Special Steels and Cast Irons	MLP710	Computer applications in materials and Engineering
MLP706	Non Metallic Materials	MLP711	Physical Chemistry of Iron and Steel Making

Code	Open Elective-III (Any one)	Code	Open Elective-IV(Any one)
MLO712	Composite Materials	MLO715	Nano Materials
MLO713	Advanced Engineering Materials	MLO716	Nanostructured Materials
MLO714	Emerging Materials		

Semester -VIII

Branch: Metallurgical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	ML801D	Project-II			16	08
					Total Credit	08

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Civil Engineering

Semester -VII

Branch: Civil Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CEC701	Advanced Steel Design	3	0	0	3
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC III	**Open Elective -III**	3	0	0	3
5	OEC IV	**Open Elective -IV**	3	0	0	3
6	CE701P	Advance Steel Str . DETAILING	0	0	2	1
7	CE702D	Project-I	0	0	4	2
8	CE703I	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-III (Any one)	Code	Professional Elective-IV (Any one)
CEP702	Hydraulic Structures	CEP707	Construction Planning And Management
CEP703	Composite Materials	CEP708	Industrial waste treatment
CEP704	Prestressed Concrete	CEP709	Sustainable Construction Methods
CEP705	Ground Water Hydrology	CEP710	Elements of fluivial hydraulics
CEP706	Earthquake Engineering	CEP711	Railway Engineering

Code	Open Elective-III (Any one)	Code	Open Elective-IV(Any one)
CEO712	Reliability Engineering	CEO717	Basics of computational hydraulics
CEO713	Geographical Information System	CEO718	Urban Hydrology and Hydraulics
CEO714	Quality Control and Management	CEO719	Intelligent Transportation Systems
CEO715	Repairs & Rehabilitation of Structure	CEO720	Structural geology
CEO716	Engineering Economics and Accounts	CEO721	Environmental Health and Safety Management

Semester -VIII

Branch: Civil Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CE801D	Project-II			16	08
					Total Credit	08

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Electronics & Communication Engineering

Semester -VII

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ECC701	Optical Fiber Communication	3	0	0	3
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC III	**Open Elective -III**	3	0	0	3
5	OEC IV	**Open Elective -IV**	3	0	0	3
6	EC701P	Optical Fiber Communication	0	0	2	1
7	EC702D	Project-I	0	0	4	2
8	EC703I	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-III (Any one)**	**Code**	**Professional Elective-IV Any one)**
ECP702	Mobile Communication	ECP705	Antenna & Wave Propagation
ECP703	Satellite Communication	ECP706	RF IC Design
ECP704	Nanotechnology and Applications	ECP707	Real Time Embedded System

Code	**Open Elective-III (Any one)**	**Code**	**Open Elective-IV(Any one)**
ECO708	Soft Computing Technique	ECO711	Low Power VLSI Circuits
ECO709	VLSI Design *	ECO712	Biomedical Instrumentation
ECO710	5G Communication	ECO713	MEMs Technology
		ECO714	Smart Antenna

* Not for ECE Students

Semester -VIII

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	EC801D	Project-II			16	08
					Total Credit	08

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Mining Engineering

JHARKHAND UNIVERSITY OF TECHNOLOGY, RANCHI

MINING ENGINEERING
B.Tech, Semester VII (Fourth year]
Course Structure

Sl. No.	Course Code	Course Title	Hours per week			Credit
			L	T	P	
THEORY						
1.	MNC701	Mine Legislation and Safety Engineering	3	0	0	3
2.	**Professional Elective – III (Any One of the Following)**					
I.	MNP702	Applied Rock Mechanics	3	0	0	3
II.	MNP703	Numerical Methods in Geo-mechanics	3	0	0	3
III.	MNP704	Geo- Statistics	3	0	0	3
IV.	MNP705	Instrumentation in Rock Mechanics	3	0	0	3
3.	**Professional Elective – IV (Any One of the Following)**					
I.	MNP706	Mine Planning & Design	3	0	0	3
II.	MNP707	Mine Closure	3	0	0	3
III.	MNP708	Mine Reclamation & Rehabilitation	3	0	0	3
IV.	MNP709	Sustainable Mining Practices	3	0	0	3
4.	**Open Elective – III (Any One of the Following) ***					
I.	MNO710	Mine Economics & Resource Management	3	0	0	3
II.	MNO711	Mine Management	3	0	0	3
5.	**Open Elective – IV (Any One of the Following) ***					
I.	MNO712	Remote Sensing & GIS	3	0	0	3
II.	MNO713	Socio Economic Impacts of Opencast Mines	3	0	0	3
III.	MNO714	Sustainable Energy Resources	3	0	0	3
IV.	MNO715	Opencast Mining Machinery	3	0	0	3
V.	MNO716	Mine Disaster & Prevention Management	3	0	0	3
PRACTICALS						
1.	MN701P	Mine Planning & Design Lab	0	0	2	1
2.	MN702D	Project - I	0	0	4	2
3.	MN703I	Internship/ Tour and Training/ Industrial Training	0	0	3	2
					Total Credits	**20**

* Number of subjects may be change subject to availability of other department

12/12/2022 12.12.2022 12.12.2022

Semester -VIII

Branch: Mining Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	MN801D	Project-II			16	08
					Total Credit	08

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Computer Science & Engineering

Semester -VII

Branch: Computer Science & Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CSC701	Artificial Intelligence	3	0	0	3
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC III	**Open Elective -III**	3	0	0	3
5	OEC IV	**Open Elective -IV**	3	0	0	3
6	CS701P	Artificial Intelligence Lab.	0	0	2	1
7	CS702D	Project-I	0	0	4	2
8	CS703I	Internship Assessment II	0	0	2	2
					Total credits	20

Code	Professional Elective-III (Any one)	Code	Professional Elective- IV(Any one)
CSP702	Machine Learning	ITP705	Data Mining and Data Warehousing.
CSP703	Multimedia and Applications	ITP706	Information Security.
CSP704	Human Computer Interaction	CSP707	Computer Vision

Code	Open Elective-III (Any one)	Code	Open Elective-IV(Any one)
ITO708	Software Engineering	ITO711	Information Security
CSO709	Values and Ethics in Profession.	CSO712	Cryptography
CSO710	*Data Mining	ITO713	Knowledge Domain Development

* Not for CSE Students

Semester -VIII

Branch: Computer Science & Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CS801D	Project-II			16	08
					Total Credit	08

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Information Technology

Semester -VII

Branch: Information Technology

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CSC701	Artificial Intelligence	3	0	0	3
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC III	**Open Elective -III**	3	0	0	3
5	OEC IV	**Open Elective -IV**	3	0	0	3
6	IT701P	Artificial Intelligence Lab.	0	0	2	1
7	IT702D	Project-I	0	0	4	2
8	IT703I	Internship Assessment II	0	0	2	2
					Total credits	20

Code	**Professional Elective-III(Any one)**	**Code**	**Professional Elective-IV (Any one)**
CSP702	Machine Learning	ITP705	Data Mining and Data Warehousing.
CSP703	Multimedia and Applications	ITP706	Information Security.
CSP704	Human Computer Interaction	CSP707	Computer Vision

Code	**Open Elective-III (Any one)**	**Code**	**Open Elective-IV(Any one)**
ITO708	Software Engineering	ITO711	Information Security
CSO709	Values and Ethics in Profession.	CSO712	Cryptography
CSO710	*Data Mining	ITO713	Knowledge Domain Development

* Not for IT Students

Semester -VIII

Branch: Information Technology

S.N.	Code	Course Title	L	T	P	Credits
1.	IT801D	Project-II			16	08
					Total Credit	08

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Chemical Engineering

CHEMICAL ENGINEERING

Course Structure

SEMESTER VII

S. No.	Subject Code	Subject	L	T	P	Cr.
		Theory				
1.	CHC701	Chemical Plant Management	3	1	0	3
2.	CHP702 CHP703 CHP704 CHP705	1. Computer Aided Design 2. Process Modeling and Simulation 3. Fluid Dynamics 4. Computational Fluid Dynamics	3	0	0	3
3.	CHP706 CHP707 CHP708	1. Chemical Process & Operational Safety 2. Energy Conservation Methodology 3. Interfacial Engineering	3	0	0	3
4.	CHO709 CHO710 CHO711 CHO712	1. Polymer Science & Technology 2. Mineral Beneficiation 3. Fuel Cell Technology 4. Food Process Technology	3	0	0	3
5.	CHO713 CHO714 CHO715	1. Bio Chemical Engineering 2. Petrochemical Technology 3. Petroleum Refining Engineering	3	0	0	3
Total						**15**
		Practical				
1.	CH701P	Petroleum Refining Engineering Lab	0	0	2	1
2.	CH702D	Project – 1	0	0	4	2
3.	CH703I	Internship	0	0	2	2
Total						5
Grand Total Credits			**15 + 5**			**20**

***Open Electives can be opted from other Departments**

CHEMICAL ENGINEERING

Course Structure

SEMESTER VIII

S. No.	Subject Code	Subject	L	T	P	Cr.
1.	CH801D	Project – II	0	0	16	8
Total						**8**

Mechanical Engineering			
MEC701	**Automation in Manufacturing**	**L**	**T**
		3	**0**

Course Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.
3. To understand the basics of product design and the role of manufacturing automation

DETAILED SYLLABUS

Module 1

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers. **(10)**

Module 2

NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing. **(6)**

Module 3

Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control. **(10)**

Module 4

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies Introduction to Modeling and Simulation. **(6)**

Module 5

Product design, process route modeling, Optimization techniques, Case studies & industrial applications, Autonomous vehicles. **(10)**

Course Outcomes:

Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations.

Text Books:

i. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.
ii. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson.

Mechanical Engineering			
MEP702	**Refrigeration and Air Conditioning**	**L**	**T**
		3	**0**

Objectives:
1. To familiarize with the terminology associated with refrigeration systems and air conditioning 2. To understand basic refrigeration processes
3. To understand the basics of psychrometry and practice of applied psychrometrics
4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

DETAILED SYLLABUS

Module 1
Classification of refrigeration systems: Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics - Ozone depletion and global warming issues - System components. **(10)**
Module 2
Compressors, Condensers, Expansion devices and Evaporators -Performance matching of components of refrigeration systems. **(8)**
Module 3
Advanced sorption refrigeration systems and their components. **(4)**
Module 4
Review of Psychrometry and Air-conditioning processes - Comfort air conditioning and Cooling load calculations. **(8)**
Module 5
Applications of AC systems - Concept of enthalpy potential – Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils. **(10)**

Course Outcomes:
A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

Text Books:

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill,1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

Mechanical Engineering			
MEP703	**Cryogenics**	**L**	**T**
		3	**0**

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

1. Understand principles of cryogenic systems.
2. Understand air and helium liquefaction processes.
3. Classify cascade refrigeration systems.
4. Understand principles of ultra-low temperature systems and their applications.
5. Evaluate storage systems used in cryogenic applications.

DETAILED SYLLABUS

Module 1

Introduction: Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems. **(5)**

Module 2

Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual-pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle. **(10)**

Module 3

Ultra-low-temperature refrigerators: Definition and Fundamentals regarding ultra-low-temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages. **(10)**

Module 4

Storage and Handling of Cryogenic Refrigerants: Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on. **(10)**

Module 5

Applications: Broad Applications of Cryogenic Refrigerants in various engineering systems. **(5)**

Text Books:

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008.

Mechanical Engineering			
MEP704	**Gas Dynamics**	**L**	**T**
		3	**0**

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

1. Solve flow equations for quasi one dimensional flow through variable area ducts.
2. Analyze the flow through constant area ducts with friction and heat transfer.
3. Analyze flows with normal and oblique shocks.
4. Solve flow problems with supersonic velocities using shock-expansion theory.
5. Solve linearized velocity potential equation for multi-dimensional flows.

DETAILED SYLLABUS

Module 1

Introduction: Review of basic fluid dynamic and thermodynamic principles, Conservation equations for inviscid lows. **(10)**

Module 2

One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional flow Nozzle.

(10)

Module 4

Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat addition (Rayleigh flow), Method of characteristics (application to one-dimensional unsteady isentropic flow). **(10)**

Module 5

Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles. **(10)**

Text Books:

1. Anderson, J.D Jr., Modern Compressible Flows, Tata McGraw Hill, 2012.
2. Yahya, S.M., Fundamentals of Compressible Flow, New age International Pub., 2013.
3. Zucrow, M., Gas Dynamics, Wiley India, 2013.

Mechanical Engineering			
MEP705	**Power Plant Engineering**	**L**	**T**
		3	**0**

Objectives:
To provide an overview of power plants and the associated energy conversion issues.

DETAILED SYLLABUS

Module 1
Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems. **(10)**

Module 2
Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems. **(8)**

Module 3
Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. **(10)**

Module 4
Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems Energy.
(5)

Module 5
Economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants. **(10)**

Course Outcomes:
Upon completion of the course, the students can understand the principles of operation for different power plants and their economics.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Mechanical Engineering			
MEP706	**Finite Element Analysis**	**L**	**T**
		3	**0**

Objectives:

1. To illustrate the principle of mathematical modeling of engineering problems
2. To introduce the basics and application of Finite Element Method

DETAILED SYLLABUS

Module1

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method. **(10)**

Module2

One dimensional second order equation, discretization, linear and higher order elements,derivation of shape functions, Stiffness matrix and force vectors, assembly of elementalmatrices, solution of problems from solid mechanics and heat transfer, longitudinal vibrationand mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

(12)

Module3

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors. **(6)**

Module 4

Application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Planestresses and plane strain problems, body forces and thermal loads, plate and shell elements. **(8)**

Module 5

Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software. **(6)**

Course Outcomes:

Upon completion of the course, students will understand the FEM formulation and itsapplication to simple structural and thermal problems

Text Books:

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann,2004.
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.

Mechanical Engineering			
MEP707	**Tool Design**	**L**	**T**
		3	**0**

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

1. Interpret the geometrical and dimensional details of a production drawing.
2. Understand principles of locating and clamping systems.
3. Design jigs and fixtures for conventional and NC machining
4. Select and design progressive, compound or combination dies for press working operations
5. Design single point and multipoint cutting tools

DETAILED SYLLABUS

Module 1

Basic principles of tool design: Tool design – An overview, Introduction to Jigs and fixtures.

Work holding devices: Basic principle of six point location, Locating methods and devices, Principle of clamping and Types of clamps. (10)

Module 2

Design of jigs: Type of Drill bushes, Classification of drill jigs, Design of drill jigs. (3)

Design of fixtures: Design of milling fixtures, Design of turning fixtures (3)

Module 3

Introduction of press tool design: Introduction to Die cutting operations, Introduction to press and classifications, Die set assembly with components, Introduction to Centre of pressure, Examples of centre of pressure, Design of piercing die, Design of blanking die, Progressive, Compound and Combination dies . (10)

Module 4

Design of cutting tools: Introduction to cutting tools, Design of single point tool, Design of drill bit, Design of milling cutter (4)

Module 5

Brief introduction of NC machines work holding devices: Tool design for NC machines- An introduction, Fixture design for NC Machine, Cutting tools for NC Machine, Tool holding methods for NC Machine, ATC and APC for NC Machine, Tool presetting for NC Machine. (10)

Text Books:

1. F.W.Wilson.F.W. "Fundamentals of Tool Design”, ASME, PHI, New Delhi, 2010

2. Donaldson.C, G.H.Lecain and V.C.Goold “Tool Design”, TMH, New Delhi, 2010

Mechanical Engineering			
MEO708	**Mechanical Vibrations**	**L**	**T**
		3	**0**

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

1. Understand the causes and effects of vibration in mechanical systems.
2. Develop schematic models for physical systems and formulate governing equations of motion.
3. Understand the role of damping, stiffness and inertia in mechanical systems
4. Analyze rotating and reciprocating systems and compute critical speeds.
5. Analyze and design machine supporting structures, vibration isolators and absorbers.

DETAILED SYLLABUS

Module 1

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models. (6)

Module 2

SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert’s method, Energy method, (4)

Module 3

Free Vibration:: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. (5)

Module 4

Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration. (6)

Module 5

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion.

Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers. (10)

Module 6

Multi degree of freedom systems: Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.

(6)

Module 7

Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method. (4)

Text Books:

1. L. Meirovich, Elements of Vibration analysis, 2nd Ed. Tata Mc-Grawhill 2007
2. Reference Books:
3. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education 2011
4. W.T., Thompson, Theory of Vibration. CBS Publishers
5. Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

Mechanical Engineering			
MEO709	**Convective Heat Transfer**	**L**	**T**
		3	**0**

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

1. Understand principles of forced and free convection heat transfer processes.
2. Formulate and solve convective heat transfer problems.
3. Estimate heat dissipation from heat transfer devices.
4. Evaluate energy requirements for operating a flow system with heat transfer.
5. Understand current challenges in the field of convective heat transfer.

DETAILED SYLLABUS

Module 1
Introduction: Course structure, Basics of Thermodynamics, Fluid mechanics and Heat transfer
Fundamental Principles: Continuity, momentum and energy equations, Reynolds transport theorem, Second law of TD, Rules of Scale analysis, Concept of Heat line visualization. (8)

Module 2
Laminar forced convection: External flows: Boundary layer concept, velocity and thermal boundary layer, Governing equations, Similarity solutions, various wall heating conditions, Flow over sphere, wedge and stagnation flow. (8)

Module 3
Laminar forced convection: Internal flows: Fully developed laminar flow: Constant heat flux, Constant wall temperature, developing length. (4)
External Natural convection: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Boundary layer equations, Scale analysis, Low and high Prandtl number fluids, vertical walls, horizontal walls, sphere. (6)

Module 4
Internal Natural Convection: Natural convection in enclosures: isothermal and constant heat flux side walls, triangular enclosures, heated from below, inclined enclosures, annular space between horizontal cylinders. (8)

Module 5
Turbulent boundary layer flow: Boundary layer equations, mixing length model, flow over single cylinder, cross flow over array of cylinders, Natural convection along vertical walls, Turbulent duct flow. (6)

Text Books:

1. Bejan, A., Convection Heat Transfer, John Willey and Sons, New York, 2001.
2. Louis, C. Burmeister, Convective Heat Transfer, John Willey and Sons, New York, 2003.

3. Kays, W.M. and Crawford, M. E., Convective Heat and Mass Transfer, McGraw Hill, New York, 2001.

Mechanical Engineering			
MEO710	**Micro and Nano Manufacturing**	**L**	**T**
		3	**0**

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

1. Understand manufacturing considerations at the micro and nano scale.
2. Understand design-and-analysis methods and tools used for micro and nano manufacturing
3. Select manufacturing methods, techniques and process parameters for material processing quality
4. Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products

DETAILED SYLLABUS

Module 1

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches,, challenges in Nanotechnology.

Nanomaterials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC). (11)

Module 2

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). (9)

Module 3

Spectroscopic characterizations: Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy.

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). (10)

Module 4

Thermal Characterization of Nanomaterials: DTA, TGA, DSC (Principle and Applications), Determination of thermo physical parameters.

Microfabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding. MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining. (6)

Module 5

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.

MEMS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems. (4)

Text Books:

1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York, 1994. 5. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall , 2002.
5. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture,” McGraw- Hill, 2008.

Mechanical Engineering			
MEO711	**Energy Systems and Management**	**L**	**T**
		3	**0**

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

1. Understand principles of energy management and its influence on environment.
2. Comprehend methods of energy production for improved utilization.
3. Improve the performance of thermal systems using of energy management principles
4. Analyze the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
5. Evaluate energy projects on the basis of economic and financial criteria.

DETAILED SYLLABUS

Module 1

Introduction to Thermodynamics, Fluid Flow and Heat Transfer

Heat transfer media: Water, steam, Thermal fluids, Air-water vapour mixtures. (8)

Module 2

Heat transfer equipment: Heat exchangers, Steam plant

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energystorage systems (10)

Module 3

Energy conversion systems: Furnaces, turbines

Heat recovery systems: Incinerators, regenerators and boilers

Energy Management: Principles of Energy Management, Energy demand estimation, Organising and Managing Energy Management Programs, Energy pricing. (10)

Module 4

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. (8)

Module 5

Economic Analysis: Scope, Characterization of an Investment Project, Case studies. (5)

Text Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007.

Mechanical Engineering			
MEO712	**Condition Monitoring**	**L**	**T**
		3	**0**

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

1. Understand and apply maintenance schemes in industries.
2. Monitor condition of rotating machinery using signature, temperature and corrosion analysis.
3. Apply oil analysis technique to diagnose the wear debris.
4. Understand modern technologies for effective plant maintenance.

DETAILED SYLLABUS

Module 1

Introduction: Failures – System, component and services failures – classification and its causes, Maintenance Schemes – objectives – types and economic benefits, break down, preventive and predictive monitoring. (8)

Module 2

Vibration Monitoring – causes and effects of vibration, review of mechanical vibration concepts – free and forced vibrations, vibration signature of active systems – measurement of amplitude, frequency and phase. (5)

Module 3

Vibration monitoring equipment– vibration sensors (contact and non-contact type) –factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels. (6)

Module 4

Contaminant analysis: Contaminants in used lubricating oils – monitoring techniques (wear debris) – SOAP technique, Ferrography, X-ray spectrometry, Particle classification.

Temperature Monitoring – Various techniques – thermograph, pyrometers, indicating paint and NDT methods. (11)

Module 5

Special Techniques: Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non-destructive techniques, Structural health monitoring weldments for surface and subsurface cracks. (10)

Text Books:

1. Rao J. S., Vibration Condition Monitoring, Narosa Publishing House, 2/e 2000.
2. Isermann R., Fault Diagnosis Application, Springer-Verlag Berlin, 2011.
3. Allan Davis, Hand book of Condition Monitoring, Chapman and Hall, 2000.
4. Choudary K K., Instrumentation, Measurement and Analysis, Tata McGraw Hill.
5. Collacott, R. A., Mechanical Faults Diagnosis, Chapman and Hall, London, 1990

Mechanical Engineering			
MEO713	**Rapid Prototyping**	**L**	**T**
		3	**0**

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

1. Identify suitable time compression techniques for rapid product development.
2. Model complex engineering products and develop process plans for rapid production.
3. Analyse and select a rapid manufacturing technology for a given component.
4. Identify the errors during generation of STL files and minimize them.
5. Optimize FDM process parameters to improve the quality of the parts.

DETAILED SYLLABUS

Module 1

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. (5)

Module 2

RP Software: Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

Photopolymerization RP Processes: Stereolithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photopolymerization Processes. (9)

Module 3

Powder Bed Fusion RP Processes: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.

Extrusion-Based RP Systems: Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes. (6)

Module 4

Printing RP Processes: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes.

Sheet Lamination RP Processes: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. (6)

Module 5

Beam Deposition RP Processes: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks.
Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. (6)

Module 6

Reverse Engineering: Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.
Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.
RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. (6)

Text Books:

1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
2. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. RafiqNoorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

Mechanical Engineering			
MEO714	Industrial Automation	L	T
		3	0

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

1. Enumerate principles, strategies and advantages of industrial automation.
2. Select level of automation and calculate manpower requirement.
3. Design material handling and material storage systems for an automated factory.
4. Automate shop floor controls and part/device identification methods.
5. Study the effect of automation by simulation and experimentation.

DETAILED SYLLABUS

Module 1

Principles and Strategies of Automation-Power to Accomplish the Automated Process, program of Instruction, Control System, Advanced automation Functions-safety Monitoring, maintenance and repair Diagnostics, error Detection and Recovery, levels of automations-Five levels of automation and control in manufacturing. (10)

Module 2

Material Handling systems and Design-Introduction to Material Handling, Material Transport Equipment, analysis of Material Transport Systems, Storage systems-Storage System Performance and Location Strategies, Conventional Storage Methods and Equipment. (10)

Module 3

Automation Storage Systems, Engineering Analysis of Storage Systems.

Automatic identification methods-Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies. (6)

Module 4

Industrial control systems-Process Industries Vs Discrete Manufacturing Industries, Levels of Automation in the two industries, Variables and Parameters in the two industries.

Continuous Vs Discrete control- Continuous Control System, Discrete Control System.

Computer process control and its forms- Control Requirements, Capabilities of Computer Control, and Forms of Computer process Control. (10)

Module 5

Control system components-Sensors, Actuators, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Input/output Devices for Discrete Data. (4)

Text Books:

1. Groover, M.P., Automation production Systems and Computer Integrated Manufacturing, Pearson Education, 2003.
2. Krishna Kant, Computer Based Industrial Control, Prentice Hall of India, New Delhi, 2000.
3. Tiess Chiu Chang and Richard A.W., An Introduction to Automated Process planning Systems, Tata McGraw-Hill Publishing company, New Delhi, 2000.

Mechanical Engineering			
MEO715	**Technology Management**	**L**	**T**
		3	**0**

Objectives: In the Management of Technology programme the students learn to explore andunderstand technology as a corporate resource - a resource that allows a firm to keep many differentballs in the air. It shows how firms can use technology to design and develop products and servicesthat maximize customer satisfaction on the one hand, while maximizing corporate productivity,profitability and competitiveness on the other.

Outcomes: The programme addresses challenging questions most companies face such as:

1. What technologies do we need and when?
2. Do we procure the technology we need with our own research capabilities, in collaborationwith outside parties, or by acquiring it or licensing it from others?
3. How can we use the abundant technological opportunities to affect our mission, objectives and strategies?

DETAILED SYLLABUS

Module 1: Introduction to Technology Management

Definition, Concept of creativity, Components, Features, Classification of Technology, Concept andNature of Technology Management, Drivers of MOT, Significance and Scope of MOT, Role ofChief Technology Officer, Responding to Technology challenges. (8)

Module-2: The Role of Technology in the Creation of Wealth

The creation of wealth, Long-wave cycle, Evolution of production technology, Critical Factors inManaging Technology: The creativity factor, Types of innovation, Technology, price relationship,Managing change. (6)

Module 3: Management of Technology

The New Paradigms Essential issues in technology management, Project planning and management,Management paradigm and the technology factor. (4)

Module-4: Technology Life Cycles

S-curve of technological progress, Multiple generation technologies ,Diffusion of technology (2)

Module-5: The Process of Technological Innovation

Innovation and creative transformation in the knowledge age: critical trajectories, Case-Xerox, Amodel for technological innovation in biomedical devices. (5)

Module-6: Strategic planning

Competitiveness, Business Strategy and Technology Strategy, Technology Planning. TheAcquisition and Exploitation of Technology: Acquisition of technology. Exploitation of technology,Stages of technology development, Technology Transfer (6)

Module-7: Technology Diffusion

Concept of Diffusion, Integrated Diffusion Strategy, Influencing factors, Innovation adoption, Diffusion strategies, Community effects and network externalities, Distribut ion of Adopters,Crossing the Chasm, Market dynamics.Technology Absorption and Deployment, Technology Absorption, Influencing factors, Deploymentstrategies, Corporate Venturing, Benefits and Drawbacks of Corporate Venturing, Spin-offCompanies. (9)

Text Book:

1. Management of Technology by Tarek Khalil.
2. Rastogi P.N: “Management of Technology and Innovation”, Sage Publications, New Delhi, 2009.
3. Scott Shane: “Technology Strategy for Managers and Entrepreneurs”, Pearson Education, New Delhi, 2009.
4. CSG Krishnamacharyulu, Lalitha Ramakrishnan, “Management of Technology”, Himalaya, Publishing House Private Limited, New Delhi, 2008.

Mechanical Engineering			
MEO716	**Computer Aided Manufacturing**	**L**	**T**
		3	**0**

Objectives

1. This course introduces students with computer assisted modern manufacturing technologies.
2. The objective of this course is to make students learn the important theoretical concepts, and the state-of-the-art technological developments in the area of modern manufacturing.
3. Various topics to be covered are basics of automation, NC programming (Manual and APT),
4. concepts of group technology, Flexible Manufacturing system, CIM and robotics.

Outcomes: Student will be able to:

1. Understand the current status of CAM systems in industry.
2. Learn the concepts of group technology, automation, FMS and CIM.
3. To write manual part programs using G and M codes for lathe and milling m/c.
4. To write APT part programs milling m/c.

DETAILED SYLLABUS

Module 1

Automation: Definition of Automation, Need for Automation, building block of automationtechnology, Types of automation systems, Automation strategies, levels of automation, types of control system, Advantages, Disadvantages and applications of Automation.

(8)

Module 2

NC, CNC and Adaptive control: Introduction, history, components of NC machines, classificationof NC machines, input media for NC machines, microprocessor based CNC systems, block diagramof a typical CNC system, features of CNC, advantages of CNC, direct numeric control (DNC) and itsadvantages, Adaptive control and its types. (10)

Module 3

Part programming: Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and latheusing G and M codes, various canned cycles, Computer aided part programming: Introduction toAPT language, simple problems on APT programming. (10)

Module 4

Group Technology: Introduction, part families, part classification and coding, production flow analysis, composite part concept, machine cell design, benefits of GT. (4)

Module 5

FMS and CIM: Concept and definition of Flexible Manufacturing System (FMS), components ofFMS, FMS workstations, Automated material handling and storage systems, Automated storage andretrieval system and Industrial robots, FMS layout and benefits, Introduction and concept ofComputer Integrated manufacturing (CIM) through CIM wheel. (8)

Text books:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
2. Kundra, Rao and Tiwari., Computer Aided manufacturing, Tata McGraw Hill Publishers.

Reference books:

1. Steve Krar, Arthur Gill, “CNC technology and programming”, McGraw-Hill, 1990
2. James Madison, “CNC machining hand book”, Industrial Press Inc., 1996
3. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.
4. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall.

Mechanical Engineering			
MEO717	Maintenance Engineering & Management	L	T
		3	0

Objectives:

1. To keep asset in productivity and availability state based on requirement level of reliability and effectiveness.
2. To spend optimal maintenance cost in relation to achieve the availability and effectiveness of equipments.
3. To prevent or reduce the likelihood or frequency of failures of engineering components and systems.
4. To increase the quality, quantity of the product with minimal cost and increase the productivity of the plant.
5. To identify and correct the causes of failures that does occur in engineering system.

Outcomes: Student will be able to:

1. Maintenance management skill
2. Need of safety devices
3. Increase the productivity of the plant at minimal cost
4. Failure analysis of plant machineries
5. Concept of tribology, conditioning monitoring
6. Concept of maintainability and availability of mechanical components and systems.

DETAILED SYLLABUS

Module 1

Introduction: Fundamentals of Maintenance Engineering, Maintenance engineering its importance in material &energy conservation, Inventory control, Productivity, Safety, Pollution control, Safety Regulations,Pollution problems, Human reliability. (8)

Module 2

Maintenance Management: Types of maintenance strategies, Planned and unplanned maintenance, Breakdown, Preventive &Predictive maintenance their comparison, Computer aided maintenance, Maintenance scheduling,Spare part management, Inventory control, TPM. (8)

Module 3

Tribology In Maintenance: Friction wear and lubrication, Friction & wear mechanisms, Prevention of wear, Types of lubricationmechanisms, Lubrication processes. Lubricants types, General and special purpose, Additives,Testing of lubricants, Degradation of lubricants, Seal & packing. (8)

Module 4

Machine Health Monitoring: Condition based maintenance, Signature analysis, Oil analysis, NDT, Vibration, Noise and thermalsignatures, On line & off line techniques, Instrumentation &

equipment used in machine healthmonitoring. Instrumentation in maintenance, Signal processing, Data acquisition and analysis,Application of intelligent systems, Data base design.

(8)

Module 5

Reliability, Availability & Maintainability (RAM) Analysis: Introduction to RAM failure mechanism, Failure data analysis, Failure distribution, Reliability ofrepairable and non-repairable systems, Improvement in reliability, Reliability testing, Reliabilityprediction, Utilization factor, System reliability by Monte Carlo Simulation Technique. (8)

Text Books:

1. Krishnan Gopal and Banerji S. K., Maintenance & Spare parts Management, PHI
2. Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI
3. Shrivastava S.K., Industrial Maintenance Management, S. Chand Publications.
4. Rao C. N. R., Handbook of Condition Monitoring,.
5. Banga and Sharma, Industrial Engineering & Management Science, Khanna Publishers.

Reference Books:

1. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Hand Book, Mc-Graw Hill, 7th edition.
2. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Standard Hand Book, Mc-Graw Hill, 6th edition

Refrigeration and Air conditioning Lab

Semester - VII

List of Experiment

1) To study the basic components of simple vapour refrigeration cycle.
2) To study various components of room air conditioning system, apparatus, windows conditioning trainer.
3) To study vapour absorption refrigeration system.
4) To study ice plant.
5) To study vehicle air conditioning system
6) To study of cascade refrigeration system for producing low temperature.
7) To study different psychrometric processes.
8) Design of air conditioning system and load calculation for residential and commercial building.

ELECTRICAL ENGINEERIG

Electrical Engineering			
ELC701	**Protection of Power Apparatus and System**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1: **Analyze** the need of power system protection and **classify** the different types of relay and their operating principle.
CO2: **Distinguish** the difference between the distribution line protection and transmission line protection.
CO3: **Explain** the protection of generator, busbar and transformer and its limitations.
CO4**: Select** the different kind of circuit breaker based on their application.
CO5: **Choose** different type of protective devices against overvoltage as well as for earthing purpose.

CO-PO Mapping Matrix:

Enter correlation levels 1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2								1
CO2	3	2		2								1
CO3	2	1		2								1
CO4	3	3		3								1
CO5	3	3		2	3							1
Avg.	**2.8**	**2.4**		**2.2**	**3**							**1**

DETAILED SYLLABUS

Module – I **(5 Lectures)**

Basic concept & components of power system protection, types of relays-their operating principles, characteristics and their uses, Introduction to static relays and its advantages over electromagnetic relays.

Module – II **(8 Lectures)**

Protection of Alternators: Protection of generators against Stator faults, Rotor faults, and abnormal Conditions. Restricted earth fault and Inter-turn fault Protection. Numerical problems on % winding unprotected.

Module-- III **(8 Lectures)**

Protection of transformers: Percentage Differential Protection, Numerical Problem on Design of CT's Ratio, Buchholz relay Protection.

Module – IV **(8 Lectures)**

Protection of Lines: Over Current, Carrier Current and Three - zone distance relay protection using Impedance relays. Translay relay. Protection of Bus bars –differential Protection.

Module – V **(8 Lectures)**

Theory of arc interruption, types of circuit breakers – air, air-blast, minimum oil, vacuum & SF6, resistance switching, current chopping, auto-reclosing, circuit breaker ratings.

Protection against lightning over voltages - valve type and zinc - oxide lighting arresters,

Module – VI **(5 Lectures)**

Grounded and ungrounded neutral systems, methods of neutral grounding: solid, resistance, reactance, resonant grounding.

Text Books

[1]. Badri Ram, D. Vishwakarma, "Power System Protection and Switchgear", McGraw Hill, 2nd Edition.
[2]. Y.G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", PHI, 2nd Edition
[3]. BhuvaneshOza, Nirmal-Kumar Nair, Rashesh Mehta, Vijay Makwana, "Power System Protection & Switchgear, McGraw Hill, 1st Edition.

Reference Books

[1]. Stanley H. Horowitz, Arun G. Phadke, James K. Niemira, "Power System Relaying", Wiley, 4th Edition.
[2]. R. van C. Warrington, "Protective Relays Their Theory and Practice", Springer, 1st Edition.

Electrical Engineering			
ELP702	**Electrical Drives and Control**	**L**	**T**
		3	**0**

Course Outcomes: After successful completion of the course students will be able to:

COs-POs Mapping:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low)   2. Moderate (Medium)   3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1								1
CO2	3	3	1	1								1
CO3	3	3	2	1								1
CO4	3	3	3	1								1
CO5	3	3	3	1								1
Avg.	**3**	**3**	**2.25**	**1**								**1**

DETAILED SYLLABUS

Module – I: Introduction to Electrical Drives (9 Lectures)

Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Multi quadrant operation of drives. Load equalization.

Module – II: Starting and Braking of Electrical Drives (9 Lectures)

Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.

Module – III: Solid State Speed Control of DC Motor (7 Lectures)

Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. DC chopper drives.

Module – IV: Solid State Speed Control of Induction Motor (7 Lectures)

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications, Static Scherbius drive, Static Kramer drive.

Module-V: Synchronous Motor Drive (10 Lectures)

Synchronous motor V/f control, Cycloconverter control, self-controlled synchronous motor drive. Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

Text Books

[1]. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.

[2]. Electric Drives, Vedam Subrahmanyam, TMH

[3]. A first course on Electrical Drives, S.K. Pillai, New Age International Publication.

Reference Books

[1]. Electric motor drives, R. Krishnan, PHI

[2]. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.

[3]. Electric Motor & Drives. Austin Hughes, Newnes.

Electrical Engineering			
ELP703	**Utilization of Electrical Power**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Classify electric** drives and their specific application in industry.
CO2	**Explain** the operation of electric traction, energy consumption and it's advantages.
CO3	**Make use of** electric heating based on induction principle.
CO4	**List** different light sources and illumination parameters.
CO5	**Demonstrate** electrolytic process and **design** motor control circuit.

CO's-PO's Mapping Matrix:
Enter correlation levels 1, 2 or 3 as defined below

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3							1
CO2	3	2	2				2					1
CO3	3	2	2		2							1
CO4	3	2	2									1
CO5	3	2	2	2	2							1
Avg.	**3**	**2**	**2**	**2**	**2.33**		**2**					**1**

DETAILED SYLLABUS

Module I: Industrial Drives **(12 Lectures)**

Characteristics of electrical motors and their particular application for industrial drives. Motor enclosures, bearing, transmission of drives, choice of motor, motor used for lifts, cranes and general purpose machines, typical application in sugar, textile, paper and steel industries. Motors used in mining operations, rating of electric motors, calculation of size load equation of flywheels electric breaking; plugging, dynamic and regenerative breaking, breaking current, torque, speed time curves (number of revolutions made before stop)

Module II: Electrical Traction **(10 Lectures)**

General features and systems of track electrification, Tractive effort calculation of traction motors, traction motor control (series-parallel control).

Track equipment and collection gear, train movement, speed-time curve, Specific Energy Consumption (SEC) and factors affecting it.

Module III: Electric Heating **(5 Lectures)**

Introduction – Classification of methods of electric heating – Requirements of a good heating material – Design of heating element – Temperature control of resistance furnace – Electric arc furnace – Induction heating.

Module IV: Welding and Illumination **(13 Lectures)**

Dielectric heating – Electric welding – Resistance welding – Electric arc welding. Sources of light, incandescent and fluorescent lamps, Lighting Fittings, reflection factor illumination, calculation, solid angle, candle power, units of light and illumination, power curves, M. H. C. P and M. S. C. P. Illumination level and its measurement coefficient of utilization, waste light factor, illumination calculations for building and playgrounds, flood lighting, industrial lighting, Street lighting.

Module V **(2 Lectures**)

Electrolytic process and motor control circuit

Text Books:

[1]. "A first course on Electric Drives", S.K.Pillai, Wiley Eastern Ltd.

[2]. "Utilization of Electrical Energy", (S.I. Units), E.Open Shaw Taylor and V.V.L.Rao, Orient Long man.

[3]. "Generation, Distribution and Utilization of Electrical Energy", C.L. Wadhwa; Wiley Eastern Ltd.

Electrical Engineering			
ELP704	**Power System Dynamics and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course student will be able to:

COs	CO Description
CO1	**Outline** basic concepts of synchronous machine and its modeling
CO2	**Model** excitation systems, prime-mover, transmission line and load
CO3	**Apply** the concept of equal area criteria and critical clearing angle to transient stability of the machine.
CO4	**Explain** various methods for transient stability improvement
CO5	**Classify** voltage stability and outline its modeling requirements

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										1
CO2	2	2										1
CO3	2	2	2									1
CO4	2	1	1									1
CO5	2	2										1
Avg.	**2**	**1.6**	**1.5**									1

DETAILED SYLLABUS

Module I **(12 Lectures)**

A review of synchronous machine (cylindrical rotor and salient pole), Equations, Phasor diagrams under steady state and transient condition.

Meaning of stability in power system, explanation of steady state and transient stability, development of swing equations for a multi machine system; assumptions generally made for solution of swing equation.

Module II **(10 Lectures)**

Synchronous machine modeling: sub- transient model , two axis model , one axis (flux decay) model , classical model .

Excitation systems modeling: DC excitation, AC excitation and static excitation. Prime mover and energy supply systems modeling. Transmission line modeling, load modeling.

Module III **(10 Lectures)**

Equal area criterion for a two machine system without and including transmission losses; pre-determined swing curves; application of equal area criteria to understand the effect of various factors on transient stability limit. equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine.

Module IV **(5 Lectures)**

Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing, electric braking, voltage regulators, fast governor action, high speed excitation system.

Module V **(5 Lectures)**

Classification of voltage stability, modeling requirement s of voltage stability analysis: static and dynamic, sensitivity analysis, modal analysis, voltage collapse, prevention of voltage collapse.

Text Books:

[1]. P. Kundur, 'Power System Stability and Control', McGraw Hill Inc, New York, 1995.
[2]. Edward Wilson Kimbark, "Power System Stability, Volumes I, II, III," Wiley-IEEE Press, 1995.

Reference Books:

[1]. K.R.Padiyar, "Power System Dynamics, Stability & Control", 2nd Edition, B.S. Publications, Hyderabad, 2002.
[2]. P.Sauer&M.A.Pai, "Power System Dynamics & Stability", Prentice Hall, 1997.

Electrical Engineering			
ELP705	**Power Quality**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various power quality issues.
CO2	Evaluate the power quality indices used in industrial power system.
CO3	Understand various mitigation techniques for compensating devices to improve the power quality.
CO4	Simulate the compensating devices to improve the power quality

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

DETAILED SYLLABUS

Module - I: Overview of Power Quality (10 Lectures)
Classification of power quality issues, characterization of electric power quality, power acceptability curves – power quality problems: poor load power factor, non linear and unbalanced loads, dc offset in loads, notching in load voltage, disturbance in supply voltage, flicker, transient phenomenon, voltage fluctuations, sags/swells, voltage unbalance, power quality indices, distortion index, C-message index, IT product, IEEE guides and recommended practices.

Module- II: Measurement and Analysis Methods (8 Lectures)
Voltage, current, power and energy measurements, power factor measurement and definitions, time domain methods, Instantaneous Reactive Power Theory, Synchronous Frame Theory, Synchronous Detection Method, instantaneous symmetrical components, Instantaneous real and reactive powers

Module- III: Harmonics & Voltage Fluctuations (8 Lectures)
Sources and effect of harmonics and inter harmonics, voltage fluctuations, flicker and impulses, flicker calculations, effect of voltage fluctuations and impulses, occurrence and causes of voltage unbalance, standardization, decomposition into symmetrical components.

Module IV: Power Quality Improvement-I **(8 Lectures)**
Utility- Customer interface, harmonic filter: passive, active and hybrid filter, compensation using shunt devices-DSTATCOM, voltage regulation using DSTATCOM, principle, working and construction, algorithms for control of DSTATCOM, some case study examples.

Module V: Power Quality Improvement-II **(8 Lectures)**
Series compensation, protecting sensitive loads using DVR, principle, working construction and control schemes for DVR, hybrid devices –UPQC, principle, working and construction, some case study examples.

Text /reference Books:

[1]. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer, 2009

[2]. Power Quality: VAR Compensation in Power Systems R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2008

[3]. Understanding Power Quality Problems: Voltage Sags and Interruptions, Math H.J. Bollen, Wiley India Pvt Ltd, 2011.

[4]. Power Quality: Mitigation Technologies in a Distributed Environment,A Moreno Munoz, Springer India Private Limited 2007.

[5]. Power System Quality Assessment J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011.

Electrical Engineering			
ELP706	**High Power Converters**	**L**	**T**
		3	**0**

Prerequisite: Power Electronics

Course Outcomes:

After successful completion of course, the students will be able to:

COs	Description
CO 1	**Analyze** controlled rectifier circuits.
CO 2	**Explain** in basic operation and compare the performance of various power semiconductor devices and switching circuits.
CO3	**Design** and **analyze** power converter circuits and learn to select suitable power electronic devices and assessing the requirements of applications field.
CO 4	**Illustrate** the operation of line-commutated rectifiers–6 pulse and multi-pulse configurations.
CO 5	**Explain** the operation of PWM rectifiers–operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low)   2. Moderate (Medium)   3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	1							
CO2	1	3	1	2								
CO3	1	1	2	2	1							
CO4	2	2		1	2							
CO5	2	1	2	1	2							
Avg.	**1.8**	**1.6**	**1.5**	**1.6**	**1.5**							

DETAILED SYLLBUS

Module I: Diode rectifiers with passive filtering (6 Lectures)

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.

Module II: Thyristor rectifiers with passive filtering (6 Lectures)

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module III: Multi-Pulse converter (8 Lectures)

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module IV: Single-phase AC-DC single-switch boost converter (6 Lectures)
Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module V: AC-DC bidirectional boost converter (6 Lectures)
Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Module VI: Isolated single-phase AC-DC flyback converter (10 Lectures)
DC-DC flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure

Text / References Books:

[1]. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
[2]. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", Addison-Wesley, 1991.
[3]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
[4]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
[5]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2001

Electrical Engineering			
ELP707	**HVDC Transmission and Facts**	**L**	**T**
		3	**0**

Prerequisite: Power Electronics, Power System-II

Course Outcome:-

After successful completion of the course, the students will be able to:

COs	CO Description
CO1	**Compare** HVDC and EHVAC transmission systems
CO2	**Analyze** converter configurations used in HVDC and evaluate the performance metrics.
CO3	U**nderstand** controllers for controlling the power flow through a dc link and compute filter Parameters
CO4	**Apply** impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems with FACTS controller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	2	3	-	-	2	1	2	2	-	-	-	2
CO2	1	2	-	1	2	2	2	-	-	-	2	-
CO3	-	3	-	2	2	-	-	-	-	-	-	2
CO4	-	3	-	3	3	2	1	-	-	-	-	-
Avg.	**1.5**	**2.75**	**-**	**2**	**2.25**	**1.67**	**1.67**	**2**	**-**	**-**	**2**	**2**

DETAILED SYLLABUS

Module I: HVDC Power Transmission Technology **(4 Lectures)**

Evolution of HVDC transmission, Comparison of HVDC & HVAC system, Economics of power transmission, Technical performance, Reliability, Applications of HVDC transmission, Types of HVDC transmission links, Components of Converter station, Planning for HVDC transmission, Operating problems in HVDC system.

Module II: Analysis of HVDC converter **(7 Lectures)**

Introduction, Types of converters, Line commutated converter, Analysis of Line commutated converter, Choice of converter configuration for any pulse number, Analysis of voltage source converter, Basic 2-level Graetz bridge converter, 3 level voltage source converter, Converter charts.

Module III: HVDC System control **(7 Lectures)**

Principles of HVDC control links, Converter control characteristics, Control schemes & control comparisons, Firing angle control, current & Extinction angle control, Energization & de-energization of bridges, Starting & stopping of DC links, power control. Effects of Harmonics, sources of harmonic generation, Types of filters–Design examples

Module- IV: Flexible AC Transmission Systems (FACTS) **(5 Lectures)**

FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters.

Module V: Static Shunt Compensators (8 Lectures)

Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics.

Module VI: Static Series Compensators (6 Lectures)

Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control.

Module VII: Combined Compensators (5 Lectures)

Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Text Books:

[1]. K. R. Padiyar, “HVDC Power Transmission Systems”, New Age International Publishers, 2011

[2]. J. Arrillaga, “High Voltage Direct Current Transmission”, Peter Peregrinus Ltd., 1983.

[3]. Narain G.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.

[4]. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

Reference Book:

[1]. E. W. Kimbark, “Direct Current Transmission”, Vol.1, Wiley Inter science, 1971.

Electrical Engineering			
ELP708	**Smart Grid Technology**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** features of Smart Grid in the context of Indian Grid
CO2	**Assess** the role of automation in Transmission/Distribution
CO3	**Apply** Evolutionary Algorithms for the Smart Grid/Distribution Generation.
CO4	**Understand** operation and importance of PMUs, PDCs, WAMS, Voltage and Frequency control in Micro Grids

CO's- PO's Mapping:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	2	2	-	1	-	-	-	-	-	-
CO2	3	2	2	2	-	2	-	-	1	-	-	-
CO3	3	2	2	2	-	2	-	-	2	-	-	-
CO4	3	2	2	2	-	2	-	-	1	-	-	-
Avg.	**3**	**2**	**2**	**2**		**1.75**			**1**			

DETAILED SYLLABUS

Module I: **(5 Lectures)**

Introduction to Smart Grid, Architecture of Smart Grid System, Standards for Smart Grid System, Elements and Technologies of Smart Grid System.

Module II **(14 Lectures)**

Communication Technologies for Power System: Fiber Optical Networks, WAN base on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee. Information System for Control Centers (ICCS): ICCS Configuration, ICCS communication Network, ICCS Time Synchronization. E-Commerce of Electricity, GIS, GPS.

Module III **(8 Lectures)**

Integration, Control and Operation of Distributed Generation: Distributed Generation Technologies and its benefits, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid.

Module IV: **(12 Lectures)**

Monitoring the smart grid: Load dispatch centers, wide-area monitoring system (WAMS), Phasor Measurement Unit(PMU), ;Smart sensors/telemetry, advanced metering infrastructure

(AMI);smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing. Concept of Islanding.

Module V: **(3 Lectures)**

Micro grid: Integration of distributed energy sources; concept, operation, control and protection of Micro.

Text/Reference Books:

[1]. Smart power grids by A Keyhani, M Marwali.

[2]. Computer Relaying for Power Systems by Arun Phadke

[3]. Microgrids Architecture and control by Nikos Hatziargyriou

[4]. Renewable Energy Systems by Fang Lin Luo, Hong Ye

[5]. Voltage-sourced converters in power systems_ modeling, control, and applications by Amirnaser Yazdani, Reza Iravani"grid. Hybrid Power Systems: Integration of conventional and non-conventional energy sources.

Electrical Engineering			
ELP709	**Electrical and Hybrid Vehicles**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Demonstrate** the drive train and propulsion unit of hybrid vehicles and their performance
CO2	**Identify** the different possible ways of energy storage.
CO3	**Generalize** the different strategies related to energy management system.
CO4	**Design** the hybrid electric vehicle and battery electric vehicle.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	2	3	3	-	-	-	1	3
CO2	-	2	3	1	3	-	2	1	-	-	-	-
CO3	2	3	-	2	2	-	2	1	-	-	3	1
CO4	3	1	3	3	2	1	2	-	-	-	1	3
Total	**2.67**	**2**	**3**	**1.75**	**2.25**	**2**	**2.25**	**1**	**-**	**-**	**1.67**	**2.33**

DETAILED SYLLABUS

Module I: Introduction to Hybrid Electric Vehicles and Conventional Vehicles (3 Lectures)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Module II: Hybrid Electric Drive-trains (6 Lectures)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module III: Electric Propulsion Unit (9 Lectures)

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module IV: Energy Storage **(6 Lectures)**

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Electrical overlay harness and communications.

Module V: Sizing the Drive System **(5 Lectures)**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

Module VI Energy Management Strategies **(13 Lectures)**

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Rule and optimization based energy management strategies (EMS).

Case studies-Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

[1]. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, , John Wiley & Sons, 2011.
[2]. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

Reference Books:

[1]. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
[2]. T. Denton , “Electric and Hybrid Vehicles”, Routledge, 2016.

Electrical Engineering			
ELO710	**Soft Optimization Techniques**	**L**	**T**
		3	**0**

Pre-requisite: None

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	Descriptions
CO1	**Understand** the concepts of population based optimization techniques.
CO2	**Evaluate** the importance of parameters in heuristic optimization techniques.
CO3	**Apply** for the solution of multi-objective optimization.

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	-	-	-	-	-	2
CO2	3	3	2	1	2	-	-	1	-	-	-	2
CO3	3	3	2	1	2	-	-	1	-	-	3	2
Avg.	**3**	**3**	**2**	**1**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Genetic Algorithm and Particle Swarm Optimization (12 Lectures)

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Module II: Ant Colony Optimization and Artificial Bee Colony Algorithms (10 Lectures)

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models- Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Module III: Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm (10 Lectures)

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation-Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Module IV: Multi Objective Optimization **(4 Lectures)**
Application to multi-modal function optimization.Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Module V: Evolutionary Computing **(6 Lectures)**
Evolutionary Computing, Simulated Annealing, Random Search, Downhill Simplex Search.

Text Books/Reference:

[1]. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation,Springer International Publishing, Switzerland, 2015.

[2]. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley &
Sons, 2001.

[3]. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series in Evolutionary Computation, 2001.

[4]. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natural to Artificial Systems, Oxford university Press, 1999.

[5]. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2007.

[6]. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimization and Intelligence: Advances and Applications, Information science reference, IGI Global, 2010.

[7]. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

Electrical Engineering			
ELO711	**Illumination Technology**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students should be able to:

COs	CO Description
CO1	**Evaluate** the characteristics of illumination sources/devices.
CO2	**Understand** and determine the performance of various lighting systems.
CO3	**Design** of lighting controls and management.
CO4	**Understand** the standards of lighting systems and commissioning.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	1	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	1	-	-	-	2
CO3	3	3	2	1	1	-	-	1	-	-	3	2
CO4	3	3	2	1	1	-		1	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Ballast based Systems **(6 Lectures)**
Introduction - Magnetic and Electronic Ballast – Dimming Electronic Ballast for Fluorescent lamps - Lamp Ballast interactions – Electronic Ballast for HID Lamps - Pulse start metal halide system, Compact Fluorescent lamp.

Module II: Solid State Lamps **(13 Lectures)**
Introduction - Review of Light sources - white light generation techniques- Characterization of LEDs for illumination application. Power LEDs- High brightness LEDs- Electrical and optical properties – LED driver considerations.

Power management topologies- Thermal management considerations- Heat sink design- photometry and colorimetry - color issues of white LEDs- Dimming of LED sources -Designing usable lamp from white LEDs,- Luminaire design steps-SSL test standards. Dimming control scheme - Lighting controls for LED lamps.

Module III: Lighting Controls & Management **(8 Lectures)**
Introduction to lighting control – lighting control strategies - Energy Management strategies – Switching Control – sensor technology - occupancy sensors – PIR – Ultrasonic – location, coverage area & mounting configuration – special features –

Module IV: Applications of Sensors **(3 Lectures)**

Application. Photo sensors – spectral sensitivity – Photo sensor based control algorithms – Daylight-artificial light integrated schemes.

Module V: Commissioning of lighting controls **(10 Lectures)**

NASHRAE / IESNA standards & energy codes – international energy conservation code – compliance with controls Lighting Control Applications: Commercial lighting – stage and entertainment lighting – Architectural lighting – Residential Lighting Energy Management and building control systems.

Text Books/Reference:

[1]. Arturas Zukauskus, Michael S. Shur and Remis Gaska, "Introduction to solid state lighting", Wiley- Interscience, 2002.

[2]. E. Fred Schubert, "Light Emitting Diodes" (2nd edition), Cambridge University Press, 2006.

[3]. Craig DiLouie, Advanced Lighting Controls: Energy Saving Productivity, Technology & Applications, Fairmont Press, Inc., 2006.

[4]. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 1989.

[5]. Steve Winder, "Power Supplies for LED Driving" Newnens Publication, 2008.

[6]. Robert S Simpson, Lighting Control: Technology and Applications, Focal Press, 2003.

[7]. IES Lighting Handbook, 10th Edition IESNA, 2011.

Electrical Engineering			
ELO712	**Process Instrumentation and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	-	-	-	-	2
CO3	3	3	2	1	1	-	-	-	-	-	-	2
CO4	3	3	2	1	1	-		-	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

MODULE I: Introduction **(7 Lectures)**

Special Characteristics of process systems: Large time constants, Interaction, Multistaging, Pure Lag; Control loops for simple systems: Dynamics and stability.

MODULE II: **(10 Lectures)**

Generation of control actions in electronic pneumatic controller. Tuning of controllers Zeigler Nichols and other techniques. Different control techniques and interaction of process parameters e.g. Feed forward,cascade, ratio, Override controls. Batch and continuous process controls. Multi variable control. Feed forward control schemes.

MODULE III: **(8 Lectures)**

Control valves, Valve positioners, Relief and safety valves, Relays,Volume boosters, Pneumatic transmitters for process variables.Various process schemes/ Unit operations and their control schemese.g. distillation columns , absorbers, Heat exchangers, Furnaces,Reactors, Mineral processing industries pH and blending processes.

MODULE IV: **(12 Lectures)**

Measurement, control and transmission of signals of process parameters like flow, pressure, level and temperature.

MODULE V: **(5 Lectures)**
Computer control of processes: Direct Digital Control, Supervisory Control and advanced control strategies.

Text/Reference Books:

[1]. Stephananopoulos G- Chemical Process control- An Introduction to theory and practice, PHI,1990
[2]. Luyben W L – Simulation and control for chemical engineers,1989, 2nd Edition, McGraw Hill,1989.

Electrical Engineering			
ELO713	**Digital Signal Processing**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Understand** the concepts of different discrete transforms.
CO3	**Analyze** systems in complex frequency domain.
CO4	**Design** of different types of filters.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Discrete-Time Signals (04 Lectures)

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp &complex exponentials, arithmetic operations on sequences..

Module II: LTI Systems (06 Lectures)

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non recursive systems.

Module III: Discrete Fourier Transform (10 Lectures)

Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation,DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Module IV: Discrete Time Fourier Transform **(05 Lectures)**

Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain**.**

Module V: Fast Fourier Transforms **(04 Lectures)**

Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module VI: Z- Transforms **(08 Lectures)**

Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Perseval's relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

ModuleVII: Filter Design **(5 Lectures)**

Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.

Text Books:

[1]. Digital Signal Processing-A computer based approach, S. Mitra, TMH
[2]. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI
[3]. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.
[4]. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Leasrning.

Reference Books

[1]. Digital Signal Processing, Chen, OUP
[2]. Digital Signal Processing, Johnson, PHI
[3]. Digital Signal Processing using MATLAB, Ingle, Vikas.

Electrical Engineering			
ELO714	**Energy Storage Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of this course, students will be able to:

CO's	CO Descriptions
CO1	analyze the characteristics of energy from various sources and need for storage
CO2	classify various types of energy storage and various devices used for the purpose
CO3	Identify various real time applications

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1							2
CO2	3	3	3	2	1							2
CO3	3	3	3	2	1							2
CO4	3	3	3	3	1							2
CO5	3	3	3	2	1							2
Avg.	**3**	**3**	**3**	**2**	**1**							**2**

DETAILED SYLLABUS

Module I: Electrical Energy Storage Technologies (08 Lectures)

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Module II: Needs for Electrical Energy Storage (08 Lectures)

Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

Module III: Features of Energy Storage Systems (08 Lectures)

Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES),Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2),Synthetic natural gas (SNG).

Module IV: Types of Electrical Energy Storage systems (06 Lectures)

Electrical storage systems, Double-layer capacitors (DLC) ,Superconducting magnetic energy storage (SMES),Thermal storage systems ,Standards for EES, Technical comparison of EES technologies.

Module V: Applications (10 Lectures)

Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers),New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems ,Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA–aggregation of many dispersed batteries.

Text Books:

[1]. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

[2]. The Electrical Energy Storage by IEC Market Strategy Board.

Reference Book:

[1]. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

Electrical Engineering			
ELO715	**Electrical Machines and Power Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of transformers, auto transformers, asynchronous and synchronous machines.
CO2	**Evaluate** performance characteristics of induction machine and synchronous machines.
CO3	**Analyze** the effects of excitation and mechanical input on the operation of synchronous machine.
CO4	**Understand** different elements and supply systems of power systems.
CO5	**Determine** the parameters of transmission lines

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1	1	1					1
CO2	3	1	3	2	2							1
CO3	3	2	3	2	2							1
CO4	3	3	3	3	3		1					1
CO5	3	2	3	2	2							1
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Transformers (8 Lectures)

Constructional features, types, Special constructional features – cruciform and multiple stepped cores, cooling methodology, conservators, breather, Buchholz relay, voltage, current and impedance relationships, equivalent circuits and phasor diagrams at no load and full load conditions,voltage regulation, losses and efficiency, all day efficiency, auto transformer and equivalent circuit, parallel operation and load sharing.

Module II: Asynchronous Machines (8 Lectures)

General constructional features of poly phase asynchronous motors, concept of rotating magnetic field, principle of operation, phasor diagram, Equivalent circuit, torque and power equations, torque-slip characteristics, losses and efficiency.

Module III: Synchronous Machines (9 Lectures)

General constructional features, armature winding, emf equation, effect of distribution and pitch factor,flux and mmf relationship, phasor diagram, non-salient pole machine, equivalent circuit, determination of equivalent circuit parameters by open and short circuit tests, voltage regulation using synchronous impedance method, power angle characteristics.

Module IV: Introduction to Power Systems **(9 Lectures)**

Single line diagram of power system, brief description of power system elements, synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator. Supply System: different kinds of supply system and their comparison, choice of transmission voltage.
Transmission Lines: configurations, types of conductors, resistance of line, skin effect.

Module V: Transmission Lines **(8 Lectures)**

Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit ,transmission lines, representation and performance of short, medium and long transmission lines, Ferranti effect,surge impedance loading.

Text/Reference Books:

[1]. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, ‘Electric Machinery’, Tata McGraw Hill, 2006.
[2]. M.G. Say, ‘Performance and Design of Alternating Current Machines’, CBS Publishers, New Delhi, 2008 Nagrath I. J and Kothari D.P. ‘Electric Machines’, Tata McGraw Hill Publishing company Ltd, 2010.
[3]. Power System Analysis, J. Grainger and W.D. Stevenson, TMH, 2006.
[4]. Electrical Power Systems,C. L.Wadhwa, New age international Ltd. Third Edition,2010
[5]. Electric Power Generation, Transmission&Distribution,S.N.Singh, PHI Learning.

B. Tech 7^{th} Semester (EE/EEE)

EL701P	**Power System Protection Laboratory**	**P**	**Credit**
		3	**1**

List of Experiments

Atleast 10 experiments should be performed from the following list of experiments.

1. To determine the operating current of a definite time over current relay.
2. To plot characteristics of an electromagnetic Inverse Definite Minimum Time (IDMT) relay.
3. To study the definite time relay testing kit and to compute its operating voltage.
4. To perform the Merz price/ differential protection for the transformer.
5. To perform the over voltage protection using transformer protection simulator.
6. To perform the over current protection using transformer protection simulator.
7. To determine the earth fault current of a 3-phase AC generator with 25% of its rated voltage.
8. To study operating mechanism of Vacuum Circuit Breaker (VCB) & Minimum Oil Circuit Breaker (MOCB).
9. To study the parallel feeder protection scheme.
10. To study the protection scheme of a synchronous Generator/Alternator.
11. To plot the operating characteristics of Numerical differential relay for protecting 3-phase transformer protection.
12. To study the protection scheme of induction motor using Numerical relay.
13. To study the High rupturing capacity (HRC) fuse & tripping of bi-metallic thermal overload protection and its characteristics.
14. To study the relay coordination in radial distribution system.
15. To study the working principle of impedance relay and its effect during faults in a transmission line.

Electrical & Electronics Engineering

Electrical & Electronics Engineering			
ELC701	**Protection of Power Apparatus and System**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1: **Analyze** the need of power system protection and **classify** the different types of relay and their operating principle.
CO2: **Distinguish** the difference between the distribution line protection and transmission line protection.
CO3: **Explain** the protection of generator, busbar and transformer and its limitations.
CO4**: Select** the different kind of circuit breaker based on their application.
CO5: **Choose** different type of protective devices against overvoltage as well as for earthing purpose.

CO-PO Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2								1
CO2	3	2		2								1
CO3	2	1		2								1
CO4	3	3		3								1
CO5	3	3		2	3							1
Avg.	**2.8**	**2.4**		**2.2**	**3**							**1**

DETAILED SYLLABUS

Module – I **(5 Lectures)**

Basic concept & components of power system protection, types of relays-their operating principles, characteristics and their uses, Introduction to static relays and its advantages over electromagnetic relays.

Module – II **(8 Lectures)**

Protection of Alternators: Protection of generators against Stator faults, Rotor faults, and abnormal Conditions. Restricted earth fault and Inter-turn fault Protection. Numerical problems on % winding unprotected.

Module III **(8 Lectures)**

Protection of transformers: Percentage Differential Protection, Numerical Problem on Design of CT's Ratio, Buchholz relay Protection.

Module – IV **(8 Lectures)**

Protection of Lines: Over Current, Carrier Current and Three - zone distance relay protection using Impedance relays. Translay relay. Protection of Bus bars –differential Protection.

Module – V **(8 Lectures)**

Theory of arc interruption, types of circuit breakers – air, air-blast, minimum oil, vacuum & SF6, resistance switching, current chopping, auto-reclosing, circuit breaker ratings.

Protection against lightning over voltages - valve type and zinc - oxide lighting arresters,

Module – VI **(5 Lectures)**

Grounded and ungrounded neutral systems, methods of neutral grounding: solid, resistance, reactance, resonant grounding.

Text Books

1. Badri Ram, D. Vishwakarma, "Power System Protection and Switchgear", McGraw Hill, 2nd Edition.
2. Y.G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", PHI, 2nd Edition
3. BhuvaneshOza, Nirmal-Kumar Nair, Rashesh Mehta, Vijay Makwana, "Power System Protection & Switchgear, McGraw Hill, 1st Edition.

Reference Books

1. Stanley H. Horowitz, Arun G. Phadke, James K. Niemira, "Power System Relaying", Wiley, 4th Edition.
2. R. van C. Warrington, "Protective Relays Their Theory and Practice", Springer, 1st Edition.

Electrical & Electronics Engineering			
ELP702	**Electrical Drives and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1: **Classify electric** drives and their specific application in industry.
CO2: **Explain** the operation of electric traction, energy consumption and it's advantages.
CO3: **Make use of** electric heating based on induction principle.
CO4: **List** different light sources and illumination parameters.
CO5: **Demonstrate** electrolytic process and **design** motor control circuit.

COs-POs Mapping:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1								1
CO2	3	3	1	1								1
CO3	3	3	2	1								1
CO4	3	3	3	1								1
CO5	3	3	3	1								1
Avg.	**3**	**3**	**2.25**	**1**								**1**

DETAILED SYLLABUS

Module – I: Introduction to Electrical Drives **(9 Lectures)**

Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Multi quadrant operation of drives. Load equalization.

Module – II: Starting and Braking of Electrical Drives **(9 Lectures)**

Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.

Module – III: Solid State Speed Control of DC Motor **(7 Lectures)**

Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. DC chopper drives.

Module – IV: Solid State Speed Control of Induction Motor **(7 Lectures)**

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications, Static Scherbius drive, Static Kramer drive.

Module-V: Synchronous Motor Drive **(10 Lectures)**

Synchronous motor V/f control, Cycloconverter control, self-controlled synchronous motor drive. Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

Text Books

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, New Age International Publication.

Reference Books

1. Electric motor drives, R. Krishnan, PHI
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

Electrical & Electronics Engineering			
ELP703	**Utilization of Electrical Power**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO12
CO1	3	2	2	2	3							1
CO2	3	2	2				2					1
CO3	3	2	2		2							1
CO4	3	2	2									1
CO5	3	2	2	2	2							1
Avg.	**3**	**2**	**2**	**2**	**2.33**		**2**					**1**

DETAILED SYLLABUS

Module I: Industrial Drives **(12 Lectures)**

Characteristics of electrical motors and their particular application for industrial drives. Motor enclosures, bearing, transmission of drives, choice of motor, motor used for lifts, cranes and general purpose machines, typical application in sugar, textile, paper and steel industries. Motors used in mining operations, rating of electric motors, calculation of size load equation of flywheels electric breaking; plugging, dynamic and regenerative breaking, breaking current, torque, speed time curves (number of revolutions made before stop)

Module II: Electrical Traction **(10 Lectures)**

General features and systems of track electrification, Tractive effort calculation of traction motors, traction motor control (series-parallel control).

Track equipment and collection gear, train movement, speed-time curve, Specific Energy Consumption (SEC) and factors affecting it.

Module III: Electric Heating **(5 Lectures)**

Introduction – Classification of methods of electric heating – Requirements of a good heating material – Design of heating element – Temperature control of resistance furnace – Electric arc furnace – Induction heating.

Module IV: Welding and Illumination **(13 Lectures)**

Dielectric heating – Electric welding – Resistance welding – Electric arc welding. Sources of light, incandescent and fluorescent lamps, Lighting Fittings, reflection factor illumination, calculation, solid angle, candle power, units of light and illumination, power curves, M. H. C. P and M. S. C. P. Illumination level and its measurement coefficient of utilization, waste light factor, illumination calculations for building and playgrounds, flood lighting, industrial lighting, Street lighting.

Module V **(2 Lectures**)

Electrolytic process and motor control circuit

Text Books:

1. "A first course on Electric Drives", S.K.Pillai, Wiley Eastern Ltd.
2. "Utilization of Electrical Energy", (S.I. Units), E.Open Shaw Taylor and V.V.L.Rao, Orient Long man.
3. "Generation, Distribution and Utilization of Electrical Energy", C.L. Wadhwa; Wiley Eastern Ltd.

Electrical & Electronics Engineering			
ELP705	**Power Quality**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various power quality issues.
CO2	Evaluate the power quality indices used in industrial power system.
CO3	Understand various mitigation techniques for compensating devices to improve the power quality.
CO4	Simulate the compensating devices to improve the power quality

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

DETAILED SYLLABUS

Module - I: Overview of Power Quality **(10 Lectures)**
Classification of power quality issues, characterization of electric power quality, power acceptability curves – power quality problems: poor load power factor, non linear and unbalanced loads, dc offset in loads, notching in load voltage, disturbance in supply voltage, flicker, transient phenomenon, voltage fluctuations, sags/swells, voltage unbalance, power quality indices, distortion index, C-message index, IT product, IEEE guides and recommended practices.

Module- II: Measurement and Analysis Methods **(8 Lectures)**
Voltage, current, power and energy measurements, power factor measurement and definitions, time domain methods, Instantaneous Reactive Power Theory, Synchronous Frame Theory, Synchronous Detection Method, instantaneous symmetrical components, Instantaneous real and reactive powers

Module- III: Harmonics & Voltage Fluctuations **(8 Lectures)**
Sources and effect of harmonics and inter harmonics, voltage fluctuations, flicker and impulses, flicker calculations, effect of voltage fluctuations and impulses, occurrence and causes of voltage unbalance, standardization, decomposition into symmetrical components.

Module IV: Power Quality Improvement-I **(8 Lectures)**

Utility- Customer interface, harmonic filter: passive, active and hybrid filter, compensation using shunt devices-DSTATCOM, voltage regulation using DSTATCOM, principle, working and construction, algorithms for control of DSTATCOM, some case study examples.

Module V: Power Quality Improvement-II **(8 Lectures)**

Series compensation, protecting sensitive loads using DVR, principle, working construction and control schemes for DVR, hybrid devices –UPQC, principle, working and construction, some case study examples.

Text /reference Books:

1. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer, 2009
2. Power Quality: VAR Compensation in Power Systems R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2008
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, Math H.J. Bollen, Wiley India Pvt Ltd, 2011.
4. Power Quality: Mitigation Technologies in a Distributed Environment,A Moreno Munoz, Springer India Private Limited 2007.
5. Power System Quality Assessment J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011.

Electrical & Electronics Engineering			
ELP707	**HVDC Transmission and Facts**	**L**	**T**
		3	**0**

Prerequisite: Power Electronics, Power System-II

Course Outcome:-

After successful completion of the course, the students will be able to:

COs	CO Description
CO1	**Compare** HVDC and EHVAC transmission systems
CO2	**Analyze** converter configurations used in HVDC and evaluate the performance metrics.
CO3	U**nderstand** controllers for controlling the power flow through a dc link and compute filter Parameters
CO4	**Apply** impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems with FACTS controller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	2	3	-	-	2	1	2	2	-	-	-	2
CO2	1	2	-	1	2	2	2	-	-	-	2	-
CO3	-	3	-	2	2	-	-	-	-	-	-	2
CO4	-	3	-	3	3	2	1	-	-	-	-	-
Avg.	**1.5**	**2.75**	**-**	**2**	**2.25**	**1.67**	**1.67**	**2**	**-**	**-**	**2**	**2**

DETAILED SYLLABUS

Module I: HVDC Power Transmission Technology **(4 Lectures)**

Evolution of HVDC transmission, Comparison of HVDC & HVAC system, Economics of power transmission, Technical performance, Reliability, Applications of HVDC transmission, Types of HVDC transmission links, Components of Converter station, Planning for HVDC transmission, Operating problems in HVDC system.

Module II: Analysis of HVDC converter **(7 Lectures)**

Introduction, Types of converters, Line commutated converter, Analysis of Line commutated converter, Choice of converter configuration for any pulse number, Analysis of voltage source converter, Basic 2-level Graetz bridge converter, 3 level voltage source converter, Converter charts.

Module III: HVDC System control **(7 Lectures)**

Principles of HVDC control links, Converter control characteristics, Control schemes & control comparisons, Firing angle control, current & Extinction angle control, Energization & de-energization of bridges, Starting & stopping of DC links, power control. Effects of Harmonics, sources of harmonic generation, Types of filters–Design examples

Module- IV: Flexible AC Transmission Systems (FACTS) (5 Lectures)
FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters.

Module V: Static Shunt Compensators (8 Lectures)
Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics.

Module VI: Static Series Compensators (6 Lectures)
Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control.

Module VII: Combined Compensators (5 Lectures)
Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Text Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. Narain G.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.
4. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

Reference Book:

1. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley Inter science, 1971.

Electrical & Electronics Engineering			
EEP704	Antennae & Wave Propagation	L	T
		3	0

Electrical & Electronics Engineering			
ELP708	**Smart Grid Technology**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** features of Smart Grid in the context of Indian Grid
CO2	**Assess** the role of automation in Transmission/Distribution
CO3	**Apply** Evolutionary Algorithms for the Smart Grid/Distribution Generation.
CO4	**Understand** operation and importance of PMUs, PDCs, WAMS, Voltage and Frequency control in Micro Grids

CO's- PO's Mapping:
Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	2	2	-	1	-	-	-	-	-	-
CO2	3	2	2	2	-	2	-	-	1	-	-	-
CO3	3	2	2	2	-	2	-	-	2	-	-	-
CO4	3	2	2	2	-	2	-	-	1	-	-	-
Avg.	**3**	**2**	**2**	**2**		**1.75**			**1**			

DETAILED SYLLABUS

Module I: **(5 Lectures)**
Introduction to Smart Grid, Architecture of Smart Grid System, Standards for Smart Grid System, Elements and Technologies of Smart Grid System.

Module II **(14 Lectures)**
Communication Technologies for Power System: Fiber Optical Networks, WAN base on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee. Information System for Control Centers (ICCS): ICCS Configuration, ICCS communication Network, ICCS Time Synchronization. E-Commerce of Electricity, GIS, GPS.

Module III **(8 Lectures)**
Integration, Control and Operation of Distributed Generation: Distributed Generation Technologies and its benefits, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid.

Module IV: **(12 Lectures)**

Monitoring the smart grid: Load dispatch centers, wide-area monitoring system (WAMS), Phasor Measurement Unit(PMU), ;Smart sensors/telemetry, advanced metering infrastructure (AMI);smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing. Concept of Islanding.

Module V: **(3 Lectures)**

Micro grid: Integration of distributed energy sources; concept, operation, control and protection of Micro.

Text/Reference Books:

1. Smart power grids by A Keyhani, M Marwali.
2. Computer Relaying for Power Systems by Arun Phadke
3. Microgrids Architecture and control by Nikos Hatziargyriou
4. Renewable Energy Systems by Fang Lin Luo, Hong Ye
5. Voltage-sourced converters in power systems_ modeling, control, and applications by Amirnaser Yazdani, Reza Iravani"grid. Hybrid Power Systems: Integration of conventional and non-conventional energy sources.

Electrical & Electronics Engineering			
ELP709	**Electrical and Hybrid Vehicles**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Demonstrate** the drive train and propulsion unit of hybrid vehicles and their performance
CO2	**Identify** the different possible ways of energy storage.
CO3	**Generalize** the different strategies related to energy management system.
CO4	**Design** the hybrid electric vehicle and battery electric vehicle.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	2	3	3	-	-	-	1	3
CO2	-	2	3	1	3	-	2	1	-	-	-	-
CO3	2	3	-	2	2	-	2	1	-	-	3	1
CO4	3	1	3	3	2	1	2	-	-	-	1	3
Total	**2.67**	**2**	**3**	**1.75**	**2.25**	**2**	**2.25**	**1**	**-**	**-**	**1.67**	**2.33**

DETAILED SYLLABUS

Module I: Introduction to Hybrid Electric Vehicles and Conventional Vehicles (3 Lectures)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Module II: Hybrid Electric Drive-trains (6 Lectures)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module III: Electric Propulsion Unit (9 Lectures)

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module IV: Energy Storage **(6 Lectures)**
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Electrical overlay harness and communications.

Module V: Sizing the Drive System **(5 Lectures)**
Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

Module VI Energy Management Strategies **(13 Lectures)**
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Rule and optimization based energy management strategies (EMS).
Case studies-Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, , John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton , “Electric and Hybrid Vehicles”, Routledge, 2016.

Electrical & Electronics Engineering			
ELO710	**Soft Optimization Techniques**	**L**	**T**
		3	**0**

Pre-requisite: None

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	Descriptions
CO1	**Understand** the concepts of population based optimization techniques.
CO2	**Evaluate** the importance of parameters in heuristic optimization techniques.
CO3	**Apply** for the solution of multi-objective optimization.

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	-	-	-	-	-	2
CO2	3	3	2	1	2	-	-	1	-	-	-	2
CO3	3	3	2	1	2	-	-	1	-	-	3	2
Avg.	**3**	**3**	**2**	**1**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Genetic Algorithm and Particle Swarm Optimization (12 Lectures)

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Module II: Ant Colony Optimization and Artificial Bee Colony Algorithms (10 Lectures)

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models- Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Module III: Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm (10 Lectures)

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse .

Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Module IV: Multi Objective Optimization **(4 Lectures)**
Application to multi-modal function optimization.Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Module V: Evolutionary Computing **(6 Lectures)**
Evolutionary Computing, Simulated Annealing, Random Search, Downhill Simplex Search.

Text Books/Reference:

1. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation,Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natural to Artificial Systems, Oxford university Press, 1999.
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimization and Intelligence: Advances and Applications, Information science reference, IGI Global, 2010.
7. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

Electrical & Electronics Engineering			
ELO711	**Illumination Technology**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students should be able to:

COs	CO Description
CO1	**Evaluate** the characteristics of illumination sources/devices.
CO2	**Understand** and determine the performance of various lighting systems.
CO3	**Design** of lighting controls and management.
CO4	**Understand** the standards of lighting systems and commissioning.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1.Slight (low)   2. Moderate (Medium)   3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	1	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	1	-	-	-	2
CO3	3	3	2	1	1	-	-	1	-	-	3	2
CO4	3	3	2	1	1	-		1	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Ballast based Systems (6Lectures)
Introduction - Magnetic and Electronic Ballast – Dimming Electronic Ballast for Fluorescent lamps - Lamp Ballast interactions – Electronic Ballast for HID Lamps - Pulse start metal halide system, Compact Fluorescent lamp.

Module II: Solid State Lamps (13 Lectures)
Introduction - Review of Light sources - white light generation techniques- Characterization of LEDs for illumination application. Power LEDs- High brightness LEDs- Electrical and optical properties – LED driver considerations.

Power management topologies- Thermal management considerations- Heat sink design-photometry and colorimetry - color issues of white LEDs- Dimming of LED sources -Designing usable lamp from white LEDs,- Luminaire design steps-SSL test standards. Dimming control scheme - Lighting controls for LED lamps.

Module III: Lighting Controls & Management (8 Lectures)
Introduction to lighting control – lighting control strategies - Energy Management strategies – Switching Control – sensor technology - occupancy sensors – PIR – Ultrasonic – location, coverage area & mounting configuration – special features –

Module IV: Applications of Sensors **(3 Lectures)**

Application. Photo sensors – spectral sensitivity – Photo sensor based control algorithms – Daylight-artificial light integrated schemes.

Module V: Commissioning of lighting controls **(10 Lectures)**

NASHRAE / IESNA standards & energy codes – international energy conservation code – compliance with controls Lighting Control Applications: Commercial lighting – stage and entertainment lighting – Architectural lighting – Residential Lighting Energy Management and building control systems.

Text Books/Reference:

1. Arturas Zukauskus, Michael S. Shur and Remis Gaska, "Introduction to solid state lighting", Wiley- Interscience, 2002.
2. E. Fred Schubert, "Light Emitting Diodes" (2nd edition), Cambridge University Press, 2006.
3. Craig DiLouie, Advanced Lighting Controls: Energy Saving Productivity, Technology & Applications, Fairmont Press, Inc., 2006.
4. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 1989.
5. Steve Winder, "Power Supplies for LED Driving" Newnens Publication, 2008.
6. Robert S Simpson, Lighting Control: Technology and Applications, Focal Press, 2003.
7. IES Lighting Handbook, 10th Edition IESNA, 2011.

Electrical & Electronics Engineering			
ELO712	**Process Instrumentation and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	-	-	-	-	2
CO3	3	3	2	1	1	-	-	-	-	-	-	2
CO4	3	3	2	1	1	-		-	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

MODULE I: Introduction **(7 Lectures)**

Special Characteristics of process systems: Large time constants, Interaction, Multistaging, Pure Lag; Control loops for simple systems: Dynamics and stability.

MODULE II: **(10 Lectures)**

Generation of control actions in electronic pneumatic controller. Tuning of controllers Zeigler Nichols and other techniques. Different control techniques and interaction of process parameters e.g. Feed forward,cascade, ratio, Override controls. Batch and continuous process controls. Multi variable control. Feed forward control schemes.

MODULE III: **(8 Lectures)**

Control valves, Valve positioners, Relief and safety valves, Relays,Volume boosters, Pneumatic transmitters for process variables.Various process schemes/ Unit operations and their control schemese.g. distillation columns , absorbers, Heat exchangers, Furnaces,Reactors, Mineral processing industries pH and blending processes.

MODULE IV: **(12 Lectures)**

Measurement, control and transmission of signals of process parameters like flow, pressure, level and temperature.

MODULE V: **(5 Lectures)**

Computer control of processes: Direct Digital Control, Supervisory Control and advanced control strategies.

Text/Reference Books:

1. Stephananopoulos G- Chemical Process control- An Introduction to theory and practice, PHI,1990
2. Luyben W L – Simulation and control for chemical engineers,1989, 2nd Edition, McGraw Hill,1989.

Electrical & Electronics Engineering			
ELO713	**Digital Signal Processing**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Understand** the concepts of different discrete transforms.
CO3	**Analyze** systems in complex frequency domain.
CO4	**Design** of different types of filters.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Discrete-Time Signals **(04 Lectures)**

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp &complex exponentials, arithmetic operations on sequences..

Module II: LTI Systems **(06 Lectures)**

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non recursive systems.

Module III: Discrete Fourier Transform **(10 Lectures)**

Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation,DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Module IV: Discrete Time Fourier Transform **(05 Lectures)**

Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain**.**

Module V: Fast Fourier Transforms **(04 Lectures)**

Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module VI: Z- Transforms **(08 Lectures)**

Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Perseval’s relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

ModuleVII: Filter Design **(5 Lectures)**

Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.

Text Books:

[1]. Digital Signal Processing-A computer based approach, S. Mitra, TMH
[2]. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI
[3]. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.
[4]. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Leasrning.

Reference Books

[1]. Digital Signal Processing, Chen, OUP
[2]. Digital Signal Processing, Johnson, PHI
[3]. Digital Signal Processing using MATLAB, Ingle, Vikas.

Electrical & Electronics Engineering			
ELO714	**Energy Storage Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of this course, students will be able to:

CO's	CO Descriptions
CO1	analyze the characteristics of energy from various sources and need for storage
CO2	classify various types of energy storage and various devices used for the purpose
CO3	Identify various real time applications

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1							2
CO2	3	3	3	2	1							2
CO3	3	3	3	2	1							2
CO4	3	3	3	3	1							2
CO5	3	3	3	2	1							2
Avg.	**3**	**3**	**3**	**2**	**1**							**2**

DETAILED SYLLABUS

Module I: Electrical Energy Storage Technologies **(08 Lectures)**

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Module II: Needs for Electrical Energy Storage **(08 Lectures)**

Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

Module III: Features of Energy Storage Systems **(08 Lectures)**

Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES),Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2),Synthetic natural gas (SNG).

Module IV: Types of Electrical Energy Storage systems **(06 Lectures)**

Electrical storage systems, Double-layer capacitors (DLC) ,Superconducting magnetic energy storage (SMES),Thermal storage systems ,Standards for EES, Technical comparison of EES technologies.

Module V: Applications **(10 Lectures)**

Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers),New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems ,Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA–aggregation of many dispersed batteries.

Text Books:

[1]. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

[2]. The Electrical Energy Storage by IEC Market Strategy Board.

Reference Book:

[1]. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

Electrical & Electronics Engineering			
ELO715	**Electrical Machine and Power Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of transformers, auto transformers, asynchronous and synchronous machines.
CO2	**Evaluate** performance characteristics of induction machine and synchronous machines.
CO3	**Analyze** the effects of excitation and mechanical input on the operation of synchronous machine.
CO4	**Understand** different elements and supply systems of power systems.
CO5	**Determine** the parameters of transmission lines

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1	1	1					1
CO2	3	1	3	2	2							1
CO3	3	2	3	2	2							1
CO4	3	3	3	3	3		1					1
CO5	3	2	3	2	2							1
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Transformers (8 Lectures)

Constructional features, types, Special constructional features – cruciform and multiple stepped cores, cooling methodology, conservators, breather, Buchholz relay, voltage, current and impedance relationships, equivalent circuits and phasor diagrams at no load and full load conditions,voltage regulation, losses and efficiency, all day efficiency, auto transformer and equivalent circuit, parallel operation and load sharing.

Module II: Asynchronous Machines (8 Lectures)

General constructional features of poly phase asynchronous motors, concept of rotating magnetic field, principle of operation, phasor diagram, Equivalent circuit, torque and power equations, torque-slip characteristics, losses and efficiency.

Module III: Synchronous Machines (9 Lectures)

General constructional features, armature winding, emf equation, effect of distribution and pitch factor,flux and mmf relationship, phasor diagram, non-salient pole machine, equivalent circuit, determination of equivalent circuit parameters by open and short circuit tests, voltage regulation using synchronous impedance method, power angle characteristics.

Module IV: Introduction to Power Systems **(9 Lectures)**
Single line diagram of power system, brief description of power system elements, synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator. Supply System: different kinds of supply system and their comparison, choice of transmission voltage. Transmission Lines: configurations, types of conductors, resistance of line, skin effect.

Module V: Transmission Lines **(8 Lectures)**
Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit ,transmission lines, representation and performance of short, medium and long transmission lines, Ferranti effect, surge impedance loading.

Text/Reference Books:

1. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, ‘Electric Machinery’, Tata McGraw Hill, 2006.
2. M.G. Say, ‘Performance and Design of Alternating Current Machines’, CBS Publishers, New Delhi, 2008 Nagrath I. J and Kothari D.P. ‘Electric Machines’, Tata McGraw Hill Publishing company Ltd, 2010.
3. Power System Analysis, J. Grainger and W.D. Stevenson, TMH, 2006.
4. Electrical Power Systems, C. L.Wadhwa, New age international Ltd. Third Edition,2010
5. Electric Power Generation, Transmission & Distribution, S.N.Singh, PHI Learning.

B. Tech 7th Semester (EE/EEE)

EL701P	**Power System Protection Laboratory**	**P**	**Credit**
		3	**1**

List of Experiments

Atleast 10 experiments should be performed from the following list of experiments.

1. To determine the operating current of a definite time over current relay.
2. To plot characteristics of an electromagnetic Inverse Definite Minimum Time (IDMT) relay.
3. To study the definite time relay testing kit and to compute its operating voltage.
4. To perform the Merz price/ differential protection for the transformer.
5. To perform the over voltage protection using transformer protection simulator.
6. To perform the over current protection using transformer protection simulator.
7. To determine the earth fault current of a 3-phase AC generator with 25% of its rated voltage.
8. To study operating mechanism of Vacuum Circuit Breaker (VCB) & Minimum Oil Circuit Breaker (MOCB).
9. To study the parallel feeder protection scheme.
10. To study the protection scheme of a synchronous Generator/Alternator.
11. To plot the operating characteristics of Numerical differential relay for protecting 3-phase transformer protection.
12. To study the protection scheme of induction motor using Numerical relay.
13. To study the High rupturing capacity (HRC) fuse & tripping of bi-metallic thermal overload protection and its characteristics.
14. To study the relay coordination in radial distribution system.
15. To study the working principle of impedance relay and its effect during faults in a transmission line.

PRODUCTION ENGINEERING

Production Engineering			
PEC701	Production Planning and Control	L	T
		3	0

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1	**Introduction to Production Planning and Control:** Production system, type of manufacturing systems and their characteristics, objectives and functions of production planning and control	03
2	**Pre-planning:** Demand forecasting, common techniques of demand forecasting, estimating factors of production, product mix and batch size decisions, aggregate planning	06
3	**Production Planning:** Routing, Loading and scheduling with their different techniques, dispatching, Progress Report, Expediting and corrective measures	05
4	**Inventory Control:** Field and scope of inventory control, inventory types and classification, Inventory control models, static model, dynamic model both deterministic and stochastic,Economic lot size, reorder point and their application, ABC analysis, FSN analysis and VED analysis, Modern practice in purchasing and store keeping	08
5	**Material Requirement Planning & JIT:** Material requirement planning (MRP), Manufacturing Resource planning (MRP II). Japanese approach to inventory management: JIT, KANBAN	08
6	**Value Engineering:** Introduction, Different phase of value Engineering. Concept of productivity	06
7	**Aggregate Planning:** Introduction, Nature of Aggregate planning, Costs, problem structure, Methods of Aggregate planning, Introduction to Capacity planning	06
	Total	42

Suggested Books:

[1]. S.N Chary, Production and Operation Management, Tata McGraw Hill
[2]. Dr. K. C. Arora Production and Operation Management, Laxmi Publication Pvt. Ltd.
[3]. R. K. Garg & V. Sharma, Production planning and Control Management, Dhanpat Rai & C Sons
[4]. E.D. Scheele, W.L. Westerman and R.J. Wimment, Principles and Design of Production Control Systems

[5]. Production Control Engineering D. K. Corke, Hodder Arnold
[6]. Production Planning and Inventory Control- Seetharama L. Narasimhan, Dennis W. McLeavey, Peter J. Billington.

Production Engineering			
PEP702	**Statistical Quality Control**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Introduction**: The meaning of quality and Quality improvement; Brief history of Quality methodology, Statistical methods for Quality Control and improvement; Total Quality management(quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement)	04
2.	**Methods and philosophy of SPC**: Chance and Assignable causes, Statistical basis of the control charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length - ARL)	06
3.	**Control Charts for Variables:** Control Charts for X-bar and R charts, Type I and Type II errors, the probability of Type II error, simple numerical problems.	08
4.	**Process Capability:** The foundation of process capability, Natural tolerance limits, C_p- process capability index, C_{pk}, P_p- process performance index, summary of process measures. Numerical problems.	06
5.	**Control Charts for Attributes:**Binomial distribution, Poisson Distribution (from the point of view of Quality Control), Control chart for fraction nonconforming, Control chart for number nonconforming, Control charts for nonconformities or defects, Control chart for number of nonconformities per unit, Numerical Problems	08
6.	**Lot by lot Acceptance Sampling for Attributes and CUSUM and EWMA control charts:** The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, Sequential sampling, AOQL, LTPD, OC curves, Cumulative sum control chart, Exponentially Weighted Moving Average control chart, Numerical Problems.	10
	Total	**42**

Suggested Books:

[1]. M. Mahajan., "Statistical Quality Control", 5th Edition, Dhanpat Rai and co.

[2]. Eugen L. Grant, Richard S. Leavenworth "Statistical Quality Control" 6th edition,

McGraw Hill
[3]. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Wiley India
[4]. S.A.H Rizvi, Zahid A. Khan., “Quality Control (for engineers and managers)”,

Production Engineering			
PEP703	Total Quality Management	L	T
		3	0

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Introduction to Quality Management** Evolution of Quality Management, Concepts of Product and Service Quality, Dimensions of Quality, Deming's, Juran's, Crosby's Quality Philosophy, Quality Cost	04
2.	**Process Quality Improvement** Introduction to Process Quality, Graphical and statistical techniques for Process Quality Improvement, Graphical tools for data representation, 7 QC tools, Sampling, sampling distribution, DMAIC process.	08
3.	Statistical Process control Control charts for variables, control charts for attributes, application of control charts.	08
4.	Process capability analysis, Measurement system analysis, Analysis of Variance (ANOVA), Design and Analysis of Experiment (DOE), Acceptance sampling plan.	12
5.	TQM, Leadership, Lean and JIT Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for Process Improvement, ISO 9001 and QS 9000, Quality Audit, Quality Circles.	06
6.	Quality Function Deployment, Robust Design and Taguchi Method. Design Failure Mode & Effect Analysis, Product Reliability Analysis of Six Sigma in Product Development.	04
	Total	**42**

Suggested Books:

[1]. Total Quality Management by Dale H. Besterfield, Pearson Publication

[2]. Principles of Total Quality Management by Vipin Mathur

[3]. Fundamentals of Quality Control and Management by Amitava Mitra, Wiley Publication

Production Engineering			
PEP704	**Quality and Reliability Engineering**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

Sl. No.	Contents	Contact Hours
1	Control chart : Introduction to quality control, objectives, applications and cost consideration. Control charts, general theory of control charts, Control charts for variables and attributes, Theory and application of control charts for averages, ranges, standard deviation, fraction defective and number of defects, Process capability study, Interpretation of control chart. Acceptance sampling : Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of o.c. curves, Sequential sampling techniques. Concept of quality circle. ISO - 9000 Quality systems. Total quality control-quality and competitiveness in a Global Market place, Establishing a customer focus. Employee involvement. Six sigma, Introduction to Taguchi methods.	**10**
2	Reliability concept, Failure-statistics: Failure density, Failure rate, Probability of failure, Mean failure rate, mean time to failure(MTTF), mean time between failure(MTBF).Graphical plots.	**6**
3	Hazard Models: Introduction, Constant Hazard, Linearly increasing Hazard, The weibull model. Distribution functions and Reliability analysis. Hazard Rate as Conditional Probability.	**6**
4	System Reliability: Introduction, Series configuration, Parallel configuration, Mixed configuration. Application to specific Hazard Models. Reliability analysis of (i) Complex systems and (ii)Systems not reducible to mixed Configuration. Mean time to failure of systems. Logic diagrams, Markov Models.	**6**
5	Reliability Improvement: Improvement of components, Redundancy (Element redundancy, Unit redundancy, Stand by redundancy), Optimization, Reliability Cost Trade-off.	**6**
6	Calculation of Reliability from: (i) Fault tree analysis (ii) Tie set and Cut-set methods (iii) by use of Boolean Algebra.	**4**
7	Maintainability and Availability: Introduction, Maintainability, System downtime, Availability, Inherent Availability, Achieved Availability, Operational Availability, Reliability and Maintainability Tradeoff.	**4**
	Total	**42**

Suggested Books:

[1]. Fundamentals of Quality Control and Improvement: Amitava Mitra, Wiley

[2]. Statistical Quality Control – Eugen L. Grant , Richard S. Leavenworth

[3]. Statistical Quality Control – M. Mahajan

[4]. Quality Control (For Engineers and Managers) – S.A.H. Rizvi, Zahid A. Khan, D.K. Singh, Gauhar Alam

[5]. Reliability Engineering – E. Balagurusamy

[6]. Reliability Engineering and Life Testing – V. N. A. Naikan

Production Engineering			
PEP705	**Tool Design**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	Jigs & Fixtures: Principal of design and construction, Location and clamping	04
2.	Basic concept for design of turning, Milling, Drilling & Indexing Jigs and fixtures	08
3.	Classification of dies, components of dies assembly, Simple dies, compound dies, combination dies and progressive dies	08
4.	Punch and die clearance, centre of pressure, calculation of blank diameter	12
5.	Design of tools for the production of holes, surfaces of revolution, and flat surfaces like single point tools, form tools, drills, milling cutters	06
6.	Materials for cutting tools, cutting dies and forming dies, Economics of Tooling	04
	Total	**42**

Suggested Books:

[1]. Umesh Chandra & Surender Kumar, Production Engineering Design (Tool Design) Satya Prakashan, New Delhi.

[2]. C. Donaldson, Tool Design, G.H.Lecain and V.C.Goold, Tata McGraw Hill.

[3]. Osterguard E., Basic Die Making, Mc-Graw Hill Book Co.

Production Engineering			
PEP706	**Advance Casting and Welding**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Gating system:** Elements of gating system**,** top and bottom getting system. Design of gating system ,Riser design-Caine method, modulus method, NRL method; time of pouring, casting yield	6
2.	**Meting and solidification of casting:** Melting and quality control of various steels and non-ferrous alloys - Nucleation and grain growth, solidification of pure metals, short and long freezing range alloys. Fluidity and its measurement	6
3.	**Special casting technique:** shell moulding, squeeze casting, vacuum die casting, counter-gravity flow-pressure casting, centrifugal casting, continuous casting & squeeze casting ,semisolid metal casting	5
4.	**Advance arc Welding process:** Plasma TIG, Hot wire TIG, cold metal transfer, Under water arc welding, Solid state welding; friction welding , Friction stir welding	5
5.	**Welding process used for special fabrication:** Thermit welding, Electroslag welding, electron beam welding, Laser beam welding, Ultrasonic Welding; special welding process (friction stir welding and hybrid (laser +GMAW/GTAW) process	7
6.	**Inspection and testing of welding**: Defects, Destructive tests – Non-destructive testing techniques – surface treatments-safety aspects in welding processes-	5
7.	**CAE of Welding And Casting:** Design of weldment, application of finite element method in welding – determination of distortion in weldments, modeling of temperature distribution – case studies. Design for casting, application of finite element method in casting-determination of hot spots, location of turbulence, and other defects, modeling of flow in molds, modeling of heat transfer in castings case studies	8
	Total	**42**

Suggested Books:

[1]. **P**.L.Jain “ Principles of foundry Technology” Tata Mc Graw Hill Publishers
[2]. Dr.R.S.Parmer “Welding processes and Technology” Khanna Publishers.
[3]. Howard B Cary, “ Modern Welding Technology” Prentice Hall, 2002
[4]. “Manufacturing & Technology: Foundry Forming and Welding”,P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
[5]. H.S.Bawa “Manufacturing Technology-I” Tata Mc Graw Hill Publishers New Delhi, 2007.

[6]. S.V.Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd.

Production Engineering			
PEP707	Material Deformation Process	L	T
		3	0

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Basic Concepts** State of stress at a point, equilibrium equations, stress tensor, spherical tensor and deviator stress tensor, principal stress, deformation tensor	05
2.	**Theory of Plasticity** Engineering and true stress –strain, flow curve, idealized stress-strain model, plastic deformation equations, levy–mises equations, prandlt–reuss equations, strain hardening, strain rate and bauschinger effects	07
3.	**Flow Rule and Yield Criterion** Velocity field and strain rate, compatibility equation, von – mises and tresca yield criterion, biaxial and triaxial yield surfaces, experimental verification of yield criterion, lode–stress, parameter	07
4.	**Friction and Lubrication** Interfacial friction laws–Coulombs friction law, constant shear factor law, composite friction, law and hydrodynamic friction law, friction mechanism during plastic deformation, lubrication mechanisms–boundary, hydrodynamic and solid lubrication, metal working, lubricants–types and characteristic	10
5.	**Plain Strain Deformation Processes** Basic concepts of slip-line method, slab method (equilibrium technique) and energy method, (upper bound technique), analysis of following deformation processes, Forging of strip: pressure distribution and forging load Rolling of strip: pressure distribution, roll–separating force and driving torque	06
6.	**Axi-Symmetric Deformation Processes** Analysis of following deformation processes:-Forging of disc: pressure distribution and forging load Extrusion of cylindrical rod: extrusion load and frictional power loss Drawing of cylindrical wire: drawing load and maximum allowable reduction	07
	Total	**42**

Suggested Books:

[1]. Principle of Industrial Metal Working G.W. Rowe, Edward Arnold , London

[2]. Principles of Metal Working S. Kumar, IBH & Co., New Delhi

[3]. Metal Working Processes and Analysis B. Avitzur, McGraw Hill, USA Metal Working Processes and Analysis B. Avitzur, McGraw Hill, USA

[4]. Metal Working Processes and Analysis B. Avitzur, McGraw Hill, USA

Production Engineering			
PEO708	**Supply Chain Management**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1	Introduction to Supply Chain Management: Concepts, Objectives, Information and Material flows in the Supply Chain, Supply Chain Planning, Supply Chain Decision Making, Managing uncertainties in Supply chain, Benefits of Supply Chain Management in Industry	4
2	Dynamics of SCM: Supply Chain Process Cycles, Supply Chain Integration, Bullwhip effect in Supply Chain, Information Systems and Processing in Supply Chain, Collaborative Planning Forecasting and Replenishment (CPFR), Inventory Planning and control	6
3	Information and Communication Technology used in Supply Chain: Need and Role of an Information System in SCM, Enterprise Resource Planning (ERP), Concept of SAP in Supply chain, Current Trends of use of IT in SCM, Use of IT enabled technologies / services in Logistical system	7
4	Supply Chain Management Practices: Bar-coding, Tierization of suppliers, Vendor Managed Inventory, Hub and Spoke concept, Dynamic pricing, Third Party Logistics (3 PL's) providers, Fourth Party Logistics (4 PL's) providers, Reverse Logistics, Green Logistics, Electronic Data Interface, Lean Operations	7
5	Procurement and Outsourcing Strategies: Make / In sourcing or Buy / Outsourcing Decisions, Green Purchasing, Strategic Outsourcing, Strategic partnership with the suppliers, Suppler Selection process, Supplier Rating and Control, Strategic Sourcing Decisions, Continuous Improvement of Suppliers, Quality Assurance Program of suppliers	8
6	Customer Relationship Management in Supply Chain: CRM, Strategic Partnership with the Customer, Linkage between CRM and SRM, Functional components of a CRM system, CRM Business cycle	5
7	Performance Benchmarking in SCM Implementation: Supply Chain Integration, Supply Chain Operations Reference (SCOR) Model, Supply Chain Performance Benchmarking	5
	Total	42

Suggested Books:

[1]. Chopra, Sunil and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, Prentice Hall of India.6th Edition

[2]. Sunil Sharma, Supply Chain Management - Concepts, Practices and Implementation, Oxford University Press
[3]. Mohanty R. P and S. G. Desmukh, Essentials of Supply Chain Management, Phoenix publishing
[4]. Ballou, Donald H. and S. Srivastava, Business Logistics / Supply Chain Management, Pearson Education, 5th Edition,
[5]. Simchi - Levi, D.P Kaminsky, Edith Simchi –Levi, Designing and Managing the supply Chain concepts, Strategies and Cases Tata McGraw – Hill, 3rd Edition,
[6]. Buffa, E. S. and Sarin, R. K., John Wiley & Sons Ltd , Modern Production / Operations Management, 8th Revised Edition,

Production Engineering			
PEO709	Enterprise Resource Planning	L	T
		3	0

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Enterprise:** An Overview: Business Functions and Business Processes, importance of Information: Characteristics of information; Types of information, Information System: Components of an information system; Different types of information systems; Management information system, Enterprise Resource Planning: Business modelling; Integrated data model	6s
2.	**Introduction to ERP:**Defining ERP, Origin and Need for an ERP System, Benefits of an ERP System, Reasons for the Growth of ERP Market, Reasons for the Failure of ERP Implementation: Roadmap for successful ERP implementation	7
3.	**ERP and Related Technologies:**Business Process Re-engineering, Management Information systems, Decision Support Systems, Executive Information Systems- Advantages of EIS; Disadvantages of EIS, Data Warehousing, Data Mining, On-Line Analytical Processing, Product Life Cycle Management, Supply Chain Management, ERP Security	7
4.	**ERP Implementation Life Cycle:**ERP Tools and Software, ERP Selection Methods and Criteria, ERP Selection Process, ERP Vendor Selection, ERP Implementation Lifecycle, Pros and cons of ERP implementation, Factors for the Success of an ERP Implementation	6
5.	**ERP Modules Structure**: Finance, Sales and Distribution, Manufacturing and Production Planning- Material and Capacity Planning; Shop Floor Control; Quality Management; JIT/Repetitive Manufacturing; Cost Management ; Engineering Data Management; Engineering Change Control ; Configuration Management ;Tooling, Human Resource, Plant Maintenance- Preventive Maintenance Control; Equipment Tracking; Component Tracking; Plant Maintenance Calibration Tracking; Plant Maintenance Warranty Claims Tracking, Quality Management Materials Management- Pre-purchasing; Purchasing; Vendor Evaluation; Inventory Management and Invoice Verification and Material Inspection	8
6.	**ERP – A Manufacturing Perspective:** Role of Enterprise Resource Planning (ERP) in manufacturing, Computer Aided Design/Computer Aided Manufacturing (CAD/CAM), Materials Requirement Planning (MRP)-Master Production Schedule (MPS);Bill of Material (BOM);Inventory Records; Closed Loop MRP; Manufacturing Resource Planning (MRP-II), Manufacturing and Production Planning Module of an ERP System , Distribution Requirements Planning (DRP), Just-in-Time(JIT) & KANBAN - Kanban; Benefits of JIT	8

		Total	**42**

Suggested Books:

[1]. Manufacturing Resource Planning (MRP II) with Introduction to ERP; SCM; an CRM by Khalid Sheikh, Publisher: McGraw-Hill
[2]. ERP and Supply Chain Management by Christian N. Madu, Publisher: CHI
[3]. Implementing SAP ERP Sales & Distribution by Glynn C. Williams, Publisher McGraw-Hill.
[4]. The Impact of Enterprise Systems on Corporate Performance: A study of ERP, SCM, and CRM System Implementations [An article from: Journal of Operations Management] by K.B. Hendricks; V.R. Singhal; and J.K. Stratman, Publisher: Elsevier.

Production Engineering			
PEO710	**Management Information System**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**The Meaning and Role of Management Information System**: Decision support system, System Approach, The system view of Business, MIS organization within the company. **Management Organizational Theory and the System Approach:** Development of organizational theory, Management and organizational behavior, Management, Information, and the system approach.	08
2.	**Computer System and M I S** : Data processing and the computer, operation of a manual information system, component of computer system/conversion of Manual to computer-based systems, The data bank concept, Computer-based applications. **Data Base Management**: The Business setting, Data base management system, Objective of a DBMS, Computer, Data base Technical overview.	08
3.	**Information System for Decision Making:** Evaluation of an information system, Basic information systems, Decision making and MIS, MIS as a technique for making programmed decisions, Decision Assisting Information Systems.	06
4.	**Strategic and Project Planning for M I S:** General Business planning, Appropriate MIS response, General MIS planning, Detailed MIS planning. **Conceptual System Design**: System objectives, Constraints, Information needs, Information sources, Alternative conceptual designs and selection, Documentation of the system concept, Conceptual design report.	08
5.	**Detailed System Design :** Aim of detailed design, Project management of MIS detailed design, Dominent and Trade-off criteria, Subsystem, Detailed operating subsystems and information flows, Degree of automation of operations; Inputs outputs and processing; system testing Software, hardware and tools; Documentation of detailed design.	08
6.	**Implementation Evaluation and Maintenance of MIS** : Implementation planning, Organize for implementation; Training of operating personnel, Development of forms for data collection and information, testing of system, cutover, Documentation of the system, Evaluation of MIS, Control and maintenance of the system.	06
	Total	**42**

Suggested Books:

[1]. Information system for modern management by Robert Murdick & James Claggett, PHI Publication

[2]. Management Information Systems by James A. O’Brien, George M. Marakas, McGraw Hill Education

[3]. Management Information System by Olson MIS- Rahul De, Wiley Publication

Production Engineering			
PEO711	Marketing Management	L	T
		3	0

DETAILED SYLLABUS

S.No.	Contents	Contact Hours
1	Fundamentals of Marketing: Core concepts of marketing and Company orientation towards the market place, Market Oriented Strategic Planning: Defining the Mission, Defining SBUs, Business Portfolio Evaluation and assigning resources to SBUs, Scanning the Marketing Environment: Analyzing trends in the components of the company's Macro & Micro environment.	6
2	Market segmentation, targeting and positioning: Purpose of Segmentation, Bases of segmenting Consumer Markets - Demographic, Geographic, Psychographic & Behavioral, Evaluating & Selecting Market Segments, Dealing with competition: Identifying and analyzing competitors, Strategies for the Market leader, Follower, Challenger	8
3	Analyzing Consumer Markets: Consumer behavior- Factors affecting consumer behavior & consumer decision making process, Creating customer value, satisfaction & loyalty: Customer perceived value, customer satisfaction, measuring satisfaction, measuring customer life time value, CRM & building loyalty	6
4	Product Strategy: Classification of products, product levels, Analysis of product line & product mix, Product Life Cycle: Concept, Strategies for Introduction, Growth, Maturity & Decline Phase. Criticism of the Product Life Cycle.	5
5	Pricing Strategies: Selecting the pricing Objective, Determining demand, estimating costs, analyzing competitors, selecting a pricing method, initiating & responding to price changes, Integrated Marketing Communication: Meaning and Role of IMC, designing effective communication program, Meaning and role of the elements of communication mix, Leveraging Social Media for effective communication.	6
6	Distribution Strategies: Concept of Value Networks, Role of marketing channels. Channel design decisions, channel management decisions. Channel Integration through Vertical Marketing systems & Horizontal Marketing Systems, Retailing: Classification of Store Formats, Types of Retail Formats, Retail positioning, Store Location, Product assortment & Services, Price, promotion, Store Atmosphere	8

7	Managing services: Importance, Distinctive Characteristics, Green Marketing, Rural Marketing and Consumer Protection - Introduction and significance	3
	Total	42

Suggested Books:

[1]. Kotler, Keller, Koshy & Jha, Marketing Management A South Asian Perspective Prentice Hall/Pearson, Fourteenth Edition,

[2]. Rajan Saxena, Marketing Management, TMH, Fourth Edition,

[3]. Arun Kumar, N Meenakshi, Marketing Management, Vikas Publishing , 3rd Edition,

[4]. Bruce Walker & Stanton, Fundamentals of Marketing, McGraw Hill

[5]. W.D. Perraut & E.J. Mc Carthy, Basic Marketing, TMH

[6]. Russel S. Winner, Marketing Management , Pearson.

Production Engineering			
PEO712	**Intelligent Manufacturing Systems**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	Basic concepts of Artificial intelligence and expert systems, System Components , System architecture and Data flow, System Operations	06
2.	Knowledge based systems, knowledge representation , knowledge acquisition and optimization, Knowledge based approaches to design mechanical parts and mechansims and design forautomated assembly	08
3.	Knowledge based system for material selection, Intelligent process planning system	06
4.	Intelligent system for equipment selection, Intelligent system for project management & factorymonitoring.	06
5.	Intelligent system for Scheduling in manufacturing , scheduling the shop floor , Diagnosis & troubleshooting	08
6.	The role of Artificial Intelligence in the factory of the future , Intelligent systems	08
	Total	**42**

Suggested Books:

[1]. Intelligent Manufacturing Systems, Andrew Kussiak, Prentice Hall

[2]. Introducing Artificial Intelligence, Simons, G.L, NCC Pub

[3]. Intelligent Scheduling,.by Monte Zweben, Morgan Kaufmann Publishers

Production Engineering			
PEO713	**Finite Element Method**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1	Basic concepts: Variational and Residual methods-Introduction - Different approaches in Finite Element Method - Direct Stiffness approach, simple examples Variational approach, Elements of variational calculus – Euler's-Lagrange equation, Rayliegh Ritz method , Weighted Residual methods, Point Collation method, Sub domain Collation method, Galerkins method - Steps involved in FEM.	08
2	Elements and Interpolation Functions: Elements and coordinate system – Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two dimensional elements, triangular and rectangular elements - Local and Natural Co-ordinate systems.	07
3	Finite Element Solution of Field Problems: Field problems – Finite element formation of field problems - Classification of partial differential equations - Quasiharmonic equation - Steady state problems - Eigen value problems - Propogation problems - Examples, Torsional problem – Fluid flow and Heat transfer problems - Acoustic vibrations – Application in manufacturing problems – metal cutting and metal forming.	07
4	Finite Element Solution of Structural Problems: Solid mechanic problems – Finite element formulation of solid mechanic problems - Axial force member - element matrices for axial force members - Truss element analysis of pinned truss - Two dimensional elasticity problems.	08
5	Higher Order Elements and Numerical Methods: Numerical method and computer implementation –Numerical method in FEM and Computer implementation. Evaluation of shape functions - One dimensional & triangular elements	07
6	Quadrilateral elements, Isoparametric elements - Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations - Cholesky decomposition, Skyline storage - Computer implementation- Use of FEM software.	05
	Total	**42**

Suggested Books:

[1]. Larry J Segerlind ,“ Applied Finite Element Analysis”, John Wiley

[2]. Bathe, K.J., “Finite Element Procedures”, Prentice Hall

[3]. Huebner,K.H. and Thornton, E.A., “The Finite Element Method for Engineers”, John Wiley.

[4]. Reddy,J.N., “Introduction to Finite Element Method”, McGraw Hill,

[5]. S.S.Rao, “The Finite element method”, Elsevier.

[6]. Zienkiewich . O.C., and Taylor . R.L., “The Finite Element Method”, McGraw Hill

Production Engineering			
PEO714	**Modern Optimization Technique**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	Dynamic Programming : Multistage Decision Processes, Concept of Suboptimization and Principle of Optimality,Computational Procedure in Dynamic Programming Continuous Dynamic Programming.	08
2.	Integer Programming: Gomory's Cutting Plane Method ,Integer Polynomial Programming, Branch and Bound Method,Sequential Linear Discrete Programming,Generalized Penalty Function Method	07
3.	Stochastic Programming:Random Variables and Probability Density Functions,Stochastic Linear Programming,Stochastic Nonlinear Programming	05
4.	Optimal Control and Optimality Criteria Methods:Calculus of Variations,Optimal Control Theory,Optimality Criteria Methods	05
5.	Modern Methods of Optimization:Genetic Algorithms,Particle Swarm Optimization,Optimization of Fuzzy Systems,Neural-Network-Based Optimization	10
6.	Practical Aspects of Optimization: Sensitivity of Optimum Solution to Problem Parameters,Multilevel Optimization,Multiobjective Optimization	07
	Total	**42**

Suggested Books:

[1]. Engineering Optimization: Theory and Practice, S.S. Rao ,New Age Inter. Pvt Ltd.,
[2]. Operation Research by Hamdy A. Taha, Pearson publication
[3]. Optimization for Engineering Design Algorithms and Examples, K. Deb, Prentice-Hall of India Pvt. Ltd
[4]. Modern heuristic optimization techniques, Kwang Y.Lee, Mohammed A.El Sharkawi John Wiley and Sons,
[5]. Dynamic Programming and Optimal Control, Dimitri P. Bertsekas,Athena Scientific
[6]. Prabhakar Pai, Operation Research, Oxford University Press.
[7]. Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd.

Production Engineering

PEO715	Mechatronics	L	T
		3	0

DETAILED SYLLABUS

Sr. No.	Contents	Contact Hours
1.	Introduction: Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach.	2
2.	Sensors and Transducers: Sensors and transducers, performance terminology, photoelectric transducers, flow transducers, optical sensors and transducers, semiconductor lasers, selection of sensors, mechanical / electrical switches, inputting data by switches.	7
3.	Actuators: Actuation systems, pneumatic and hydraulic systems, process control valves, rotary actuators, mechanical actuation systems, electrical actuation systems.	5
4.	Signal Conditioning: Signal conditioning, filtering digital signal, multiplexers, data acquisition, digital signal processing, pulse modulation, data presentation systems.	5
5.	Microprocessors and Microcontrollers: Microcomputer structure, microcontrollers, applications, programmable logic controllers.	8
6.	Modeling and System Response: Mathematical models, bond graph models, mechanical, electrical, hydraulic and thermal systems, dynamic response of systems, transfer function and frequency response, closed loop controllers.	7
7.	Design and Mechatronics: Input/output systems, computer based modular design, system validation, remote monitoring and control, designing, possible design solutions, detailed case studies of mechatronic systems used in photocopier, automobile, robots.	7
	Total	**42**

Suggested Books:

[1]. Bolton, W., “Mechatronics”, Longman.
[2]. Alciatore, D. G. and Histrand, M. B., “Introduction to Mechatronics”, Tata McGraw Hill
[3]. Shetty, D. and Richard, A.K., “Mechatronics System Design”, PWS Pub. Boston
[4]. Mahalik, N., “Principles, Concept and Applications: Mechatronics”, Tata McGraw.
[5]. Bishop, R.H. “Mechatronics Handbook”, CRC Press.
[6]. Bolton, W., “Mechatronics: A Multidisciplinary Approach”, 4th Ed., Prentice.
[7]. Merzouki R., Samantaray A. K., Pathak P.M., Bouamama B. Ould, Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, Springer.

Production Engineering			
PEO716	**Project Engineering**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	The scope of project, characteristics of a project, stages of a project, Project constraints, Project Management structures, Responsibilities of project manager,	08
2.	Project productivity. The anatomy of a project. Environmental considerations in project evaluation.	07
3.	Main issues and secondary issues in feasibility study, Social cost benefit analysis, Commissioning, Evaluation of competing projects. Budgetary aspects and considerations of a project.	05
4.	Industrial/Engineering projects, R & D Projects, Turnkey projects, Network Modeling of a project, Deterministic & probabilistic activity networks, Line of Balance, Time-cost trade-off in a project, Mega projects.	05
5.	Project scheduling techniques, PERT, CPM Models.	08
6.	Project monitoring techniques, Performance and Cost Evaluation (PACE), Project Staffing Requirements, Resource leveling. Project Documentation, Computer Application in Project Engineering.	9
	Total	**42**

Suggested Books:

[1].Elements of Project Management, K. Nagarajan, New Age International
[2].Production and Operation Management, S.N Chary, Tata McGraw Hill
[3].Information Technology Project Management, Kathy Schwable, Cengage Learning Australia
[4].Guidelines for Project Evaluation, Pratha Dasgupta, Amartya Sen, & Stephen Marglin, United Nations,
[5].Strategic Project Management Made Simple: Practical Tools for Leaders and Teams,Terry Schmidt.
[6].Effective Project Management: Robert K. Wysocki ,Traditional, Agile, Extreme, 5th Edition.
[7].Project Engineering: The Essential Toolbox for Young Engineers, Frederick Plummer.
[8].Project Management Panneerselvam R, PHI Learning Pvt. Ltd.

Optimization Lab Sessional (PE 701P)

List of Experiments

1. Design and Analysis of Linear Programming Problem
2. Graphical method for solving LPP
3. Solving LPP using Simplex method
4. Solving LPP using BIG-M method
5. Concept of duality for solving optimization problem
6. Concept of Transportation and Assignment problem solving
7. Optimization using Genetic Algorithms
8. Optimization using particle swarm optimization
9. Some of statistical methods (Regression/ANOVA/Correlation)
10. Multiobjective Optimization Approaches

CIVIL ENGINEERING

Civil Engineering			
CEC701	**Advanced Steel Design**	**L**	**T**
		3	**0**

1. Moment resistant connections:- framed connection, eccentric connections brackets. (08 Hrs)
2. Industrial building:- loads, General arrangement and stability considerations design of purlins, roof trusses, gantry girder and bracings. (08 Hrs)
3. Bridge:- Steel footbridge with rankers and Lateral restraining including end bearings. (08)
4. Tanks :- pressed steel water tank, Staging for tanks (06 Hrs)
5. Towers:- Transmission line Towers, microwave Towers, design loads classification, design procedure and specifications. (08 Hrs)
6. Tubular structures:- Introduction to tubular structures. (04 Hrs)

Reference Books:

1. Design of steel structure by S. Duggal
2. Design of steel structure by S. Subrahmaniam
3. Design of steel structure by P. Daya Ratnam
4. Design of steel structure by S. S. Bhavikatti
5. Design of steel structure by L. S. Negi

Civil Engineering			
CEP702	Hydraulic Structures	**L**	**T**
		3	**0**

Pre-requisites: WRE-I, WRE-II

Course Outcomes: At the end of the course, the students will be able to

CO1	Integrate the hydraulics and water resources background by involving the students in water structures design applications.
CO2	Encourage class discussions for formulating and solving multi-variable hydraulic design problems in an open-ended solution space.
CO3	To develop understanding of the basic principles and concepts of analysis and design of hydraulic structures.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Reservoir: Reservoir planning types of reservoirs elements of a Reservoir, mass curve and demand curve, yield of Reservoir, life of Reservoir.	**6**
2.	Types of dams and stability. Gravity dam, forces acting on gravity dam, load combination for stability analysis, elementary profile and practical profile, Foundation treatments, joint and Seal, galleries	**8**
3.	Arch dam: types of Arch dams, constant radium and constant Central angle, using thin and thick cylindrical theories, USSR guidelines for designing arch dam.	**8**
4.	Buttress: Types of buttress dam, design of flat slab buttress Dam, advantages and disadvantages of buttress dam.	**8**
5.	Embankment dams: Earth and rockfill Dam, types of embankment dam, causes of failure, design principles, method of	**8**

	construction, seepage through dams and foundation and remedial measurement.	
6.	Spillway and energy dissipation device: types of spillways, requirement, serviceability, design of straight drop and Ogee spillways, energy dissipation past spillways, types of stilling basin and design of stilling basin.	**8**

Civil Engineering			
CEP703	Composite Materials	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to:

CO1	Explain the mechanical behavior of layered composites compared to isotropic materials.
CO2	Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.
CO3	Determine stresses and strains relation in composites materials.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	**Introduction:** Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres.	**14**
2.	**Various types of composites:** Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites.	**10**
3.	**Fabrication methods: Processing of Composite Materials:** Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-	**8**

	transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films.	
4.	Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.	**8**

Civil Engineering			
CEP704	**Prestressed Concrete**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand the concepts of pre-stressing in concrete structures and identify the materials for pre-stressing.
CO2	Analyse a Pre-stressed Concrete section and Estimate losses of pre-stressing
CO3	Design pre-tensioned and post tensioned girders for flexure and shear

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction: Fundamentals of prestressing - Classification and types of prestressing Concrete Strength and strain characteristics - Steel mechanical properties – Auxiliary Materials like duct formers.	**8**
2.	Prestressing Systems: Principles of pretensioning and post tensioning - study of common systems of prestressing for wires strands and bars and Losses of Prestress: Losses of prestress in pre tensioned and post tensioned members, I.S. code provisions.	**8**
3.	Analysis of Sections: In flexure, simple sections in flexure, kern distance - cable profile -limiting zones - composite sections cracking moment of rectangular sections.	**8**
4.	Design of Simply Supported Beams: Allowable stress as per I.S. 1343 - elastic design of rectangular and I-sections.	**8**
5.	Shear and Bond: Shear and bond is prestressed concrete beams - conventional design of shear reinforcement - Ultimate shear strength of a section - Prestress transfer in pretensioned beams- Principles of end block design.	**8**

Civil Engineering			
CEP705	**Ground Water Hydrology**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	list and describe the properties of aquifers that control the movement and storage of groundwater
CO2	use Darcy's Law to explain the roles of aquifer properties and driving forces in governing the rate of groundwater flow
CO3	interpret the current and historical balance between groundwater recharge and water extraction from well hydrographs

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	INTRODUCTION: Ground water utilization & historical background, ground water in hydrologic cycle, ground water budget, ground water level fluctuations & environmental influence , occurrence and movement of ground water: Origin & age of ground water, rock properties affecting groundwater, groundwater column, zones of aeration & saturation, aquifers and their characteristics/classification, groundwater basins & springs, Darcy's Law, permeability & its determination, Dupuit assumptions, heterogeneity &anisotropy, Ground water flow rates & flow directions, general flow equations through porous media.	**10**
2.	ADVANCED WELL HYDRAULICS: steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions, partially penetrating/horizontal wells & multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield	**8**
3.	POLLUTION AND QUALITY ANALYSIS OF GROUND	**8**

	WATER: Municipal /industrial /agricultural /miscellaneous sources & causes of pollution, attenuation/ underground distribution / potential evaluation of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples, graphical representations of ground water quality.	
4.	SURFACE/ SUB-SURFACE INVESTIGATION OF GROUND WATER: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction based methods for surface investigation of ground water, test drilling & ground water level measurement, sub-surface ground water investigation through geophysical / resistivity /spontaneous potential /radiation / temperature / caliper / fluid conductivity / fluid velocity /miscellaneous logging	**8**
5.	MODELING AND MANAGEMENT OF GROUND WATER: Ground water modeling through porous media /analog / electric analog / digital computer models, ground water basin management concept, hydrologic equilibrium equation, ground water basin investigations, data collection & field work, dynamic equilibrium in natural aquifers, management potential & safe yield of aquifers, stream-aquifer interaction.	**8**

Civil Engineering			
CEP706	**Earthquake Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	To explain the concept of earthquakes and knowledge of earthquake engineering practices applied to Civil Engineering problems
CO2	To determine different design parameter under different degree of freedom.
CO3	To identify the remedial measures of earthquake disaster
CO4	Practice of Earthquake code and application

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Elements of Seismology, Definitions of Magnitude, Intensity, Epicenter, etc. General features of tectonic of seismic regions, Seismographs. Theory of Vibrations.	**8**
2.	Free vibrations of single degree, two degree and multiple degree freedom systems. Computation of dynamic response to time dependent forces. Vibration isolation. Vibration absorbers.	**8**
3.	Principles of Earthquake Resistant Design Response spectrum theory. Brief introduction to accelerographs and S.R.R.'s.	**8**
4.	Nature of dynamic loading resulting from earthquakes. Application of Response spectrum. Theory to a seismic design to structures. Resistance of structural elements and structures for dynamic loads, design criteria-strength and deflection. Ductility and absorption of energy.	**8**
5.	Dynamic Properties of Soils, Remedial measures and management of earthquake disaster, Introduction to Indian Standard Codes IS : 1893 – 1984 and IS: 4326 – 1993.	**8**

Civil Engineering			
CEP707	**Construction Planning and Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	To describe different planning stages for any project.
CO2	To distinguish between CPM and PERT and its elements.
CO3	To create network diagram using CPM and PERT
CO4	To estimate earth work using Mass Haul diagram

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Management: Introduction, development of management and its recent trends, principle of management, function of management, administration of management and organization.	**6**
2.	Constructional planning: Need for construction planning, construction resources, stages in construction Job Lay-Out, preparation of construction schedule preparatory work for project, Inspection and quality control. Objective of C. P. M. and PERT, elements of network, network rules, constraints errors in network	**6**
3.	CPM: Critical path analysis, activity times and floats, optimization through CPM Technique, PERT: PERT and three Estimates, critical path and analysis of PERT network. Probability of completion of project, controlling and monitoring	**12**
4.	MASS HAUL DIAGRAM: Characteristics of mass Haul diagram, Earth work calculation by mass haul diagram, objective of motion study, objective/uses of time study, motion/time study procedure.	**6**

5.	SAFETY IN CONSTRUCTION: Hazards in construction projects, causes of accidents, costs of an accident, safety programme for construction, protective equipment, safety measures, construction element of a building.	**6**
6.	PREFABRICATION: Need for prefabrication, classification of prefabrication, scope of prefabrication in India, advantages and disadvantages of prefabrication design principle of prefabricate system.	**4**

Civil Engineering			
CEP708	**Industrial Waste Treatment**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Ability to plan minimization of industrial wastes.
CO2	Ability to design facilities for the processing and reclamation of industrial waste water.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	INTRODUCTION: Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.	**8**
2.	CLEANER PRODUCTION: Waste management Approach – Waste Audit – Volume and strength reduction – Material and process modifications – Recycle, reuse and byproduct recovery – Applications.	**8**
3.	POLLUTION FROM MAJOR INDUSTRIES: Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts.	**9**
4.	TREATMENT TECHNOLOGIES: Equalisation – Neutralisation – Removal of suspended and dissolved organic solids – Chemical oxidation – Adsorption – Removal of dissolved inorganics – Combined treatment of industrial and municipal wastes – Residue management – Dewatering – Disposal.	**11**

Civil Engineering			
CEP709	**Sustainable Construction Methods**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand rating systems and compares key features such as cost, ease of use, and building performance
CO2	Know rating systems in detail, including its evolution, objectives, criteria, levels of certification benefits,and shortcomings
CO3	Know a series of case studies representing diverse project types, sizes, certification levels, and climate regions
CO4	Know what are “lessons learned” of sustainable construction through case studies

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction: Sustainability in the Built Environment, Environmental/Resources Issues & Industrial/Construction Metabolism.	**8**
2.	Environmental Economics and Life Cycle Costing, Life Cycle Assessment, Embodied Energy, Energy, and Materials.	**8**
3.	Building Assessment and Eco-labels, Sustainability Frameworks and Sustainable Communities and Sustainability Indicators.	**8**
4.	Energy Systems, Energy, Entropy, Energy Conservation, and Renewable Energy,Water Resources, Wastewater, and Storm-water and Urban Planning, Land Development, New Urbanism, and Landscaping.	**8**
5.	Design for the Environment, Ecological Principles, Passive Design, and Climatic Design and Construction Operations, Advanced Construction Waste Management and Demolition, Building Health, Building Commissioning and Facility Management, Industrial Ecology and Construction Ecology.	**8**

Civil Engineering			
CEP710	**Elements of Fluivial Hydraulics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand rating systems and compares key features such as cost, ease of use, and building performance
CO2	Know rating systems in detail, including its evolution, objectives, criteria, levels of certification benefits,and shortcomings
CO3	Know a series of case studies representing diverse project types, sizes, certification levels, and climate regions
CO4	Know what are "lessons learned" of sustainable construction through case studies

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction, Definition, Historical Development of Native Problem. Origin and Properties of sediment Introduction, Origin and Formation of sediment, Fundamental properties.	**8**
2.	Incipient motion Introduction, competent, life concept critical tractive Force, Critical attractive stress of cohesionless, cohesive material.	**8**
3.	Regime of flow :- Introduction, Description ripple dune, Antidune, Importance of regime flow prediction of regime flow.	**8**
4.	Bed load transport : Introduction, Mechanism,suspended saltation & total load transport.semi theoretical approach, Einstein's theory.	**8**
5.	Bed level variation in Alluvial channel Introduction, Mechanism, Aggredation, Degradation, scour, local scour, scour causes& protection.	**8**

Civil Engineering			
CEP711	**Railway Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Explain Components of Railway Track, different Railway Gauges and design track Gradients as per given requirements.
CO2	Discuss various Types of Track Turnouts and describe purposes and facilities at Railway Stations.
CO3	Explain Interlocking and modern signal system and describe Surface Defects on Railway Track and Their Remedial Measures.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	**Introduction**: Alignment of Railway Lines Rails, Track Fittings and Track Stresses. Describe history and recent developments in railways. Explain Components of Railway Track, different Railway Gauges. Discuss requirements of an ideal alignment. Comprehend the Standard Rail Sections. Explain Causes and effects of Creep and Measures to Reduce Creep. Explain Fittings and Fastening and their Requirements. Discuss Forces Acting on Track and Coning of Wheels History of Indian Railways, Importance of Railways For Environment. Recent Developments. Role of Civil Engineers In Construction And Maintenance. Components of Railway Track .Definition of Railway Gauges, Types, Uniformity of Gauge. Different Gauges on Indian Railways,. Cross- Section of Permanent Way as Per IRS .Problems Caused By Change of Gauge. Basic Requirements and selection of An Ideal Alignment. Functions and Types Of Rails .Standard Rail Sections. Causes and Effects Of Creep, Measures To Reduce Creep. Fittings and Fastening and their requirements. Forces Acting On Track. Coning Of Wheels.	**8**

2.	**Sleeper & Geometric Design of Track:** Describe Functions & Requirements of sleepers. Explain Method of Fixing Rails with Prestressed Concrete and Wooden Sleepers. Explain the necessity and details of geometric design . Design track Gradients as per given requirements .Functions & Requirements of sleepers 2.2 Types and Spacing of Sleepers, 2.3 Method Of Fixing Rails With Pre-stressed Concrete And Wooden Sleepers, 2.4 Function and Specifications of Track Ballast 2.5 Necessity and Details of geometric design of track 2.6 Design of track Gradients, 2.7 Grade compensation on curves. 2.8 Curves and Super elevation.	**8**
3.	**Resistance to Traction, Points And Crossings**: 3a. Describe resistance to-friction 3b. Explain stress in rails 3c. Explain Necessity of Points & Crossing 3d. Draw Track Layouts And Sketches of Turn Out, 3e. Discuss various Types of Track Turnouts 3.1 Resistance to-friction, wave action, speed, track irregularity, wind, 3.2 Resistance to gradient, curvature, starting and accelerating. 3.3 Stress in rails, sleepers, ballast and formation 3.4 Necessity of Points & Crossing 3.5 Track Layouts And Sketches of Turn Out, 3.6 Types Of Crossing 3.7 Types of Track Turnouts.	**8**
4.	**Railway Stations and Yards**: 4a. Describe purposes and facilities at Railway Stations. 4b.Explain Station Yard 4.1. Purposes 4.2. Facilities Required at Railway Stations. 4.3. Requirements Of Station Yard, 4.4. Classification Of Railway Stations, 4.5. Types Of Yards.	**8**
5.	**Signaling And Interlocking**: 5a. Describe objectives of signaling 5b. Explain Interlocking and modern signal system 5.1 Objectives of signaling 5.2 Classification of signals 5.3 Types and working of Interlocking 5.4 Modern signal system.	**6**
6.	**Maintenance Of Railway Track:** 6a. Explain various types of railway track Maintenance 6b.Describe Surface Defects and Their Remedial Measures 6.1. Introduction of Maintenance Programme. 6.2. Monsoon, Pre-Monsoon & Post- Monsoon Maintenance. 6.3. Causes For Maintenance, 6.4. Routine Maintenance 6.5. Tools For Railway Track Maintenance &Their Functions. 6.6. Surface Defects And Their Remedial Measure.	**6**

Civil Engineering			
CEO712	**Reliability Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Introduce concepts and methods in the field of reliability engineering and use of TQM (Total Quality Management) tools to measure and evaluate the quality of products.
CO2	Perform reliability analysis of a system and designing the same and apply the acquired knowledge in a practical operational problems or research projects.
CO3	Evaluate the use of reliability engineering for industrial activities.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	**Introduction:** Definitions and concepts, Reliability, Probability, Impossible and certain events. Failure-data and its Analysis, Hazard rate and Failure density, Reliability in terms of hazard rate, Failure density in other situations.	**10**
2.	**Hazard Models:** Type of distribution and standard deviation and variance, Expectations, Conditional probabilities.	**8**
3.	**System Reliability:** Series, Parallel and mixed configurations. Methods of solving Complex systems.	**8**
4.	**Reliability improvement:** Types of redundancies, Reliability allocation for a series of system, Optimization Reliability- cost trade-off.	**8**

Civil Engineering			
CEO713	Geographical Information System	L	T
		3	0

Course Outcomes: At the end of the course, the students will be able to

CO1	Describe the functional basis of a GIS AND appreciate the potential uses of GIS in ICM.
CO2	Consider the benefits and shortcomings of using GIS for ICM.
CO3	Outline the key data quality issues involved in using GIS AND develop a strategy to implement an effective GIS.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Basic concepts of GIS Introduction- Information Systems, spatial and non- spatial information, geographical concepts and terminology, Advantages of GIS. Basic components of GIS. Commercially available GIS hardware and software, organisation of Data in GIS.	**12**
2.	GIS Data: Input data-field data, statiatical data, Maps, Aerial photographs, Satellite data, points, lines and areas features, Vector and Raster data, Advantages and Disadvantages, Data entry through keyboard, digitizers and scanners, digital data. Pre-processing of data- Rectification and Registration. Interpolation techniques.	**12**
3.	Data management: Database Management System (DBMS). Various data models. Run length encoding, Quadtrees, Data Analysis - Data Layers, analysis of spatial and non-spatial data, Data overlay modelling, Data Presentation - Hardcopy devices, softcopy devices.	**8**
4.	Application of GIS.	**8**

Civil Engineering			
CEO714	**Quality Control and Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Explain the different meanings of the quality concept and its influence.
CO2	Describe, distinguish and use the several techniques and quality management tools.
CO3	Explain and distinguish the Normalisation, homologation and certification activities.
CO4	Predict the errors in the measuring process, distinguishing its nature and the root causes.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Construction projects, Agencies involved in construction projects, mutual relationship, quality control at site, why and whose job is it.	**12**
2.	ISO / IS Requirements: IS 9000 (Parts 1 to 4), (Pt 1: 1994, Pt 2: 1993 Pt 3: 1994 Pt 4: 1993 for total quality management. ISO] 4000 – 988 for environment – impact of large construction projects.	**12**
3.	Quality control on construction projects, Inspection of reinforced concrete, masonry and steel works. testing techniques & quality audit reports.	**8**
4.	Statistical Analysis, Sampling frequencies, statistical & reliability analysis, optimum sample size.	**8**

Civil Engineering			
CEO715	**Repairs & Rehabilitation of Structures**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Perform structural health monitoring AND Perform notable applications of structural health monitoring in civil applications
CO2	Diagnosis the damage of distress structures and Investigate the condition assessment of structures
CO3	Select the proper repair materials and its application and Select the method to Strengthen the distressed structures

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.	**6**
2.	Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature.	**6**
3.	Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes.	**8**
4.	Corrosion – Effects of cover thickness; Corrosion monitoring, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic	**8**

	protection; Repair, Rehabilitation and Retrofitting of Structures.	
5.	Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting; and Techniques for Repair and Protection Methods- Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning.	**6**
6.	Non-Destructive testing systems; Use of external plates, carbon fibre wrapping and carbon composites in repairs. Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods – Case studies.	**6**

*****Soft Skills and Interpersonal Communication (syllabus prepared and taught by Humanities Department)

Civil Engineering			
CEO716	Engineering Economics and Accountancy	L	T
		3	0

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals.	9
2.	Methods of Economic analysis. The effect of borrowing on investment- Various concepts of National Income – Significance of National Income estimation and its limitations.	9
3.	Inflation –Definition – Process and Theories of Inflation and measures to control, New Economic Policy 1991 – Impact on industry.	9
4	Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet.	9
5	Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations.	9

Reading:

1. Engineering Economic Principles, Henry Malcom Stenar- McGraw Hill Pub.

2. “Modern Economic Theory”, Siltan Chand & Co.

3. Agrawal AN, “Indian Economy”, Dewett K.K., - Wiley Eastern Ltd, New Delhi.

4. “Accounting Part-I’, Jain and Narang - Kalyani Publishers.

5. “Cost Accounting”, Arora, M.N. - Vikas Publications.

Civil Engineering			
CEO717	**Basics of Computational Hydraulics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Derive the governing equations of transients in pipes and channels
CO2	Apply method of characteristics and finite difference methods to solve unsteady flow problems in pipes and channels
CO3	Analyze transients in pumping and hydropower
CO4	Analyze dam break problem

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction: Basic equations of fluid motion, heat and mass transfer, need for their numerical solution.	**12**
2.	Solution Techniques: Classification of governing equations-parabolic, elliptic and hyperbolic type, method of characteristics, explicit and implicit finite difference schemes – Crank Nicholson, Penceman-Rachford ADI, Leaffrom, Lax-Wendroff, Successive over-relaxation methods.	**12**
3.	Types of Problems: Analysis of water distribution networks, hydraulic transients in closed conducts, flood routing in stream using Saint-Venant equations, numerical solutions for one –dimensional convection and diffusion equation. Analysis of dam break problems. Positive and negative surge analysis, design and analysis of surge shocks.	**16**

Civil Engineering			
CEO718	**Urban Hydrology and Hydraulics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Analyze urban storm water systems, urban precipitation and storm water runoff.
CO2	Learn quantification of impacts of climate change on short duration high intensity rainfall in urban areas.
CO3	Case studies of several cities in India are dealt with, in the seminars presented by the students, and thus they get an exposure to a variety of urban flooding problems.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Review of basic hydrology; Strom water runoff generation; Return period; Hydrologic risk; Frequency analysis	**10**
2.	IDF relationships; Design storm; Open channel flow in urban watersheds; Interception storage, Infiltration, Depression storage	**10**
3.	Combined loss models; Estimation of runoff rates from urban watersheds; Flow routing; Storm water drainage structures	**10**
4.	Storm water detention; structural and non-structural control measures; Source control techniques; urban storm water models; introduction to urban groundwater systems.	**10**

Civil Engineering			
CEO719	**Intelligent Transportation Systems**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Differentiate different ITS user services
CO2	Select appropriate ITS technology depending upon site specific conditions
CO3	Design and implement ITS components

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Fundamentals of ITS: Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS.	**6**
2.	Sensor technologies and Data requirements of ITS: Importance of telecommunications in the ITS. Information Management, Traffic Management Centers (TMC).Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centers; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection.	**8**
3.	ITS User Needs and Services and Functional areas – Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS).	**8**
4.	ITS Architecture –Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods;	**8**

	Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning.	
5.	ITS applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.	**10**

Civil Engineering			
CEO720	**Structural geology**	**L**	**T**
		3	**0**

Pre-requisites:

Course Outcomes: At the end of the course, the students will be able to

CO1	Acquire knowledge on the geometry and type of structures present in earth.
CO2	Understand and describe the features formed in rocks when subjected to stress and impact of structural geology to active tectonic settings
CO3	Interpret graphs and models used in structural geology to understand and demonstratepoly phase deformations.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Description, classification, and origin of earth structures. Ways in which the continental crust can deform; link scales of structure from the field, outcrops, handspecimen, thin section by integrating analytical techniques with practical examples.	**10**
2.	Theoretical and meso to micro-scale analysis of structures developed through a linked series of lectures and practical; practical 2D strain analysis; 3D strain concepts	**10**
3.	Incremental strain, kinematics and polyphase deformations; fold construction and classes; fault evolution and section balancing; fault rock microstructures;	**10**
4.	Fault and fold mechanics, current concepts in plate tectonics, cross-section construction techniques, structural interpretation of seismic data, structural styles in different tectonic settings (thrust and fold belts, rifts, strike and slip, gravity tectonics, inversion), structural geology of reservoir units.	**10**

Civil Engineering			
CEO721	**Environmental, Health and Safety Management**	**L**	**T**
		3	**0**

MODULE	CONTENTS	Hrs
1.	Occupation, Safety And Management; Occupational Safety, Health and Environmental Safety, Management – Principles & practices, Role of Management in Industrial Safety, Organization Behaviaraion Human factors contributing to accident. Planning for Safety: Planning: Definition, purpose, nature, scope and procedure. Management by objectives and its role in Safety, Health and Management (SHE)	**8**
2.	Monitoring for Safety, Health & Environment: Occupational Safety, Health and Environment Management System, Bureau of Indian Standards on Safety and Health: 14489 – 1998 and 15001 – 2000, ILO and EPA Standards. Principles of Accident Prevention: Definition: Incident, accident, injury, dangerous, occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes etc.	**8**
3.	Education, Training and Employee Participation in Safety: Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs.	**8**
4	Competence Building Techniques (CBT), Concept for training, safety as an on-line function. Employee Participation: Purpose, areas of participation, methods, Role of trade union in Safety, Health and Environment Protection.	**8**
5	Management Information System: Sources of information on Safety, Health and Environment Protection. Compilation and collation of information, Analysis & use of modern methods of programming, storing and retrieval of MIS for Safety, Health and Environment. QCC HS Computer Software Application and Limitations.	**8**

CE701P: Advance Steel Structure Detailing Lab

List of Experiments

(1) Drawing of Moment resisting connection

(2) Design and drawing of Roof Truss

(3) Design and drawing of Gantry Girder

(4) Design of Steel Foot Bridges

(5) Design and drawing of pressed steel water tanks

(6) Design and drawing of transmission line towers

Electronics & Communication Engineering

Electronics & Communication Engineering			
ECC701	**Optical Fiber Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Identify and Develop the basic knowledge of different components of an Optical Fiber Communication theory.
CO2	Analyze the problems related to optical source, Fiber and Detector operational parameters.
CO3	Design and Investigate thecomplex problems related to high speed links, MUX, DEMUX, and different optical fiber link design parameters.
CO4	Use Modern Tool to analyze the concepts of WDM, Optical Amplifiers, Optical Switching and networking technology.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	-	-	-	-	-	-	-	2
CO2	1	3	-	-	1	-	-	-	-	-	-	1
CO3	1	-	3	2	-	-	-	-	-	-	-	1
CO4	-	-	1	1	3	-	-	-	-	-	-	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to optical fiber communication**: Principles and systems, Different types of fibers, SMF & MMF, Ray Theory analysis for step index fiber only. Fiber optic transmitters using LEDs and Laser diodes, Bias stabilization of LEDs and Lasers, Driver circuits for analog and digital modulation, Temperature stabilization of laser diodes, Modulation bandwidths of lasers and LEDs.	**8**
2	Fiber optic receivers using PIN and APD photodiodes, photo-diode amplifiers, SNR in PID and APD receivers, Receiver sensitivity, Eye diagram.	**8**
3	Coupling mechanisms of optical power from source to fiber and fiber to photo detector, Transmission characteristics of fibers and their effects on system performance, Selection of optical fiber types for short-haul, long-haul and high speed data links, optical power budget calculations of a fiber optic communication link.	**8**

4	Fiber optic interconnectivity devices for fiber optic communication links and networks: Optical isolators, polarizer, circulators, attenuators, Bragg grating filters, add/drop multiplexers, WDM MUX / DEMUX, fiber amplifiers, guided wave devices as external optical modulators.	**8**
5	Fiber optic analog modulation methods, Sub-carrier multiplexed analog communication principles, IM-DD systems, Fundamentals of optical coherent detection, Optical pulse format for digital communication systems, Performance of a 10 Mb/s digital fiber optic link and a 10 Gb/s data link, Effects of charp and line widths of lasers on system performance, Fiber optic networks for LAN, MAN and WAN – a brief study.	**8**

Text Books:

1. Optical fiber communications: principles and practice. Front Cover. John M. Senior.
2. “Cabling: The Complete Guide to Copper and Fiber-Optic Networking” by Andrew Oliviero and Bill Woodward.
3. “Fiber-Optic Transmission Networks: Efficient Design and Dynamic Operation (Signals and Communication Technology)” by Stephan Pachnicke.
4. “Fiber Optics Illustrated Dictionary (Advanced & Emerging Communications Technologies)” by J K Petersen.

Electronics & Communication Engineering			
ECP702	**Mobile Communication**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand WLANs and their architecture
CO2	Design WAP pages using Wireless MarkUp language
CO3	Classify and distinguish different mobile communication generations and their architecture
CO4	To gain knowledge of different mobile transport layers

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	-	-	-
CO2	2	-	-	2	3	-	-	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**An Overview of Wireless Systems:** Introduction, Mobility versus portability, Mobile devices, Wireless communication and the layer model, First and Second Generation Cellular Systems, Cellular Communications from 1G to 3G Road Map for Higher Data Rate Capability in 3G, Wireless 4G Systems, Future Wireless Networks, Standardization Activities for Cellular Systems.	**8**
2	**Cellular System design concepts and fundamentals:** Frequency Reuse, Channel Assignment, Handoff Strategies, Interference and System Capacity, Trunking and Grade of service, Improving Coverage and Capacity in cellular systems. Mobile Radio Wave propagation, Large scale path loss and propagation models, Reflection, Diffraction, Scattering, Practical link budget design, Outdoor propagation models, Indoor propagation models	**8**
3	**Mobile Radio Wave propagation:** Small-Scale fading and multipath propagation, Rayleigh and Ricean Distributions, Multiple	**8**

	Access Techniques for Wireless Communications, FDMA, TDMA, Spread Spectrum multiple access, FHMA, CDMA, SDMA.	
4	**Multiple Access Techniques for Wireless Communications:** Packet radio, Pure ALOHA, Slotted ALOHA, CSMA, Reservation ALOHA, PRMA, Capacity of Cellular Systems, Wireless systems and standards, AMPS and ETACS, IS 54 and IS 136 GSM features, Architecture, Radio subsystems, Traffic channels, call processing.	**8**
5	**Wireless systems and standards:** CDMA features, Architecture, IS-95 Forward and reverse channels, power control, system capacity. Wireless Networking, WLAN, PAN, Mobile network layer, Mobile Transport layer, Wireless data services, Common channel signaling; Introduction to OFDM . **Wireless Networking:** Satellite data communication, cellular data communications, third generation UMTS system features, Wi MAX, RFID	**10**

Text Books:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N. Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.

Electronics & Communication Engineering			
ECP703	**Satellite Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the orbital and functional principles of satellite communication systems
CO2	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems.
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve the link Performance.
CO4	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.
CO5	Specify, design, prototype and test analog and digital satellite communication systems as per given specifications.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	2	1	2	1	-	-	-	2	2
CO2	1	-	-	1	2	2	2	-	-	-	2	2
CO3	-	-	-	-	2	2	1	-	-	-	2	2
CO4	1	-	-	-	3	2	1	-	-	-	2	2
CO5	1	1	-	-	3	2	1	-	-	-	2	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction:** Overview of Satellite Communications, GEO, MEO and LEO satellite systems, frequency bands Orbital Mechanics: Orbit Equations, Locating the satellite w.r.t. the earth, Orbital elements, look Angles, Orbital perturbation, Effects of earth's oblate ness ,moon and sun , Satellite eclipse, sun transit outage, Coverage angle, slant range, satellite launching.	**10**
2	**Satellite subsystems:** Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System (TT&C), Power System, Satellite antennas, Communications subsystem, transponders.	**8**

3	**Satellite Link Design:** Basic transmission theory, System noise temperature and G/T ratio, CNR, CIR, ACI, IMI, down link design, up link design, System design examples.	**6**
4	**Modulation and Multiplexing:** FM with multiplexed telephone signals, Analog FM SCPC, PSK, QPSK, Multiple Access Schemes: FDM/FM/FDMA, TDMA, Frame structure, frame acquisition, synchronization, TDMA in VSAT network, On-board processing, CDMA, Spread spectrum transmission and reception, DS-SS CDMA capacity.	**8**
5	**Error Control for Digital Satellite Links:** Error control coding, Block codes, Convolution codes, Implementation of error detection on satellite links. **VSAT Systems:** Overview of VSAT systems, Network architectures, Access control, multiple access selection. **LEO Satellite systems:** Orbits, Coverage and frequency bands, off axis scanning, delay and throughput, NGSO constellation design, Problems.	**8**

Text Books:

1. Timothy Pratt, Charles Bostian Jermey Allnutt, Satellite Communications, John Wiley, Singapore, Second Edition, reprint 2013.
2. M. Richharaia, Satellite Communication Systems, BS Publishers, Second Edition, 2008.
3. TRI.T. HA, Digital Satellite Communications, McGraw-Hill, 2000.

Electronics & Communication Engineering			
ECP704	**Nanotechnology and Application**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	**Understand the properties of Nano-materials and applications.**
CO2	**Apply chemical engineering principles to Nano-particle production.**
CO3	**Solve the quantum confinement equations.**
CO4	**Characterize Nano-materials.**
CO5	**Scale up the production Nanoparticles for Electronics and Chemical industries.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	2	-	-	3
CO3	3	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	2	-	-	3
CO5	-	-	-	-	-	-	-	-	-	-	2	3

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to Nanotechnology:** Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.	**5**
2	**Fabrication of Nanomaterials:** Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions. Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance,	**10**

	Layers of surface charges, Zeta Potential and pH.	
3	**Carbon Nanomaterials:** Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C60, bucky onions, nanotubes, nanocones. **Quantum mechanics:** Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots.	**7**
4	**Nanomaterials characterization:** Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application, Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy. **Applications:** Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials, Nano inroganic materials of CaCO3 synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices.	**10**
5	**Nanobiology:** Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts.	**6**

Text books:

1) Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2) Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3) Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4) Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press.
5) Davies, J.H. ‘The Physics of Low Dimensional Semiconductors: An Introduction’, Cambridge University Press, 1998.

Electronics & Communication Engineering			
ECP705	**Antenna & Wave Propagation**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the concept of radiation through mathematical formulation
CO2	Plot the characteristics of wire and aperture antennas
CO3	Develop the performance characteristics of array antennas
CO4	Measure the antenna parameters
CO5	Apply the concept of antenna in mobile communication

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	2	-	-	-	-	-	-	-	-	-
CO3	-	2	-	2	-	-	-	-	-	-	-	-
CO4	-	-	3	3	2	-	-	-	-	-	-	-
CO5	3	2	-	2	3	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course Content	No. of Lecture
1	**Antenna Fundamentals:** Introduction to antennas & its significance, Scalar electric potential, vector magnetic potential, radiation from an alternating current element, Induction field, radiation field, power radiated by a current element, Definition of electric dipole, radiation by a half wave dipole. Power by a half wave dipole & its radiation resistance, Radiation from a quarter wave monopole Power radiation and radiation resistance of dipole & monopole, Radiation resistance of aerials and loop, problems Isotropic radiator, network theorem, application of network theorem to antennas.	**8**
2	**Antenna Parameters:** Radiation pattern, power pattern, field pattern Radiation intensity, Antenna impedance, mutual impedance, gain and directivity, bandwidth, Polarization, efficiency, effective length, area or aperture, scattering loss, Collecting aperture, physical aperture, relation between large aperture and gain Effective aperture of a small elementary dipole, half wave antenna, effective length, front to back ratio, Antenna beam	**9**

	width and side lobes. Friss Transmission formula, Radar range equation**.**	
3	**Design of Arrays:** N-element linear array- broadside array, End fire array, multiplication of patterns Effect of earth on vertical pattern mutual impedance effects, Binomial arrays, problem solving.	**6**
4	**Practical antennas:** VLF, LF, MF transmitting antennas, resonant & non resonant antennas, V antenna, travelling wave antenna, Rhombic antenna, VHF &UHF antennas, horn antenna Folded dipole & Yagi-Uda antenna, Parabolic reflector antenna,, Corner reflector, Parabolic reflector antenna, Micro strip Antennas**.**	**8**
5	**Antenna impedance measurements:** Radiation pattern measurements Measurement of antenna beam width and gain, Polarization measurements. Measurement of radiation resistance. **Wave Propagation:** Types of wave propagation, space wave propagation and line of sight distance for flat and curved surfaces.	**10**

Text Books:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007.
2. Antenna Theory: Analysis and Design, Constantine A. Balanis, John Wiley & Sons, 3rd Ed., 2009.
3. David K. Cheng, “Field and Wave Electromagnetics”, Pearson, 2e, 2014.
4. John D. Kraus, Antennas, 2nd Edition, McGraw Hill, 1988.
5. R.E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
6. David M. Pozar, “Microwave Engineering”, Wiley, 4e, 2012.
7. Ahmed El Zooghby, ‘Smart Antenna Engineering’, ARTECH HOUSE, INC, 2005.
8. Frank B. Gross, ‘Smart antenna with MATLAB’, Second Edition, McGraw-Hill, 2015.

Electronics & Communication Engineering			
ECP706	**RF IC Design**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Ability to design a system, component, or process, and synthesise solutions to achieve desired needs.
CO2	Perform calculation related to modulation and detection
CO3	Design of Critical Components in CMOS RF-IC Design.
CO4	Design of CMOS Low-Noise Amplifier and Mixer
CO5	Perform small signal conversion gain simulation

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	3	2	3	-	-	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to RF and Wireless Technology:** Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology. **Basic Concepts in RF design:** Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.	**10**
2	**Multiple Access:** Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.	**8**
3	**Transceiver Architectures:** General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.	**7**
4	**Amplifiers, Mixers and Oscillators:** LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.	**7**

5	**Power Amplifiers:** General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques.	**8**

Text Books:

1. Razavi Behzad, RF Microelectronics, Prentice-Hall, 1998
2. Couch L W, Digital and Analog Communication Systems, Pearson/Prentice-Hall, c2007.
3. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2001.
4. Leung Bosco, VLSI for Wireless Communication, Prentice Hall, 2002

Electronics & Communication Engineering			
ECP707	**Real Time Embedded System**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Illustrate different types of embedded system and present its mathematical model under time Constraint.
CO2	Design methodologies for real time system and its application.
CO3	To understand RTOS and distinguishes between GPOS and RTOS.
CO4	To work on real time language.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	3	2	-	-	-	-	-	-	-
CO2	1		3	2	-	-	-	-	-	-	-	-
CO3	2	1	-	3	-	-	-	-	-	-	-	-
CO4	-	-	2	2	3	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	Introduction-defining Real time systems, Embedded Real Time Systems, Special Characteristics of real time systems, a brief evolutionary history. Hardware Architectures of Real Time systems	**12**
2	Software architectures (concepts of interrupt driven activation, need for real time monitor, pseudo parallelism), meeting of dead-lines & real time constraints.	**5**
3	Overview of WARD & MELLOR Methodology: Ward & Mellor Life Cycle, the essential model step, the implementation model, real time extensions of DFD.	**10**
4	Real time languages: overview of ADA/Java Extension	**4**
5	Real time Operating Systems, System Development Methodologies.	**6**

Text Books:

1. Introduction to Embedded Systems -Shibu K.V, McGraw Hill

2. Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.
3. Embedded System Design -Frank Vahid, Tony Givargis, John Wiley.
4. Embedded/Real-Time Systems: Concepts Design and Programming, K.V.K.K. Prasad Dreamtech, 2005.
5. Embedded Systems –Lyla, Pearson, 2013.
6. An Embedded Software Primer -David E. Simon, Pearson Education.

Electronics and Communication Engineering			
ECO708	**Soft Computing Technique**	**L**	**T**
		3	**0**

Course Outcomes:

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Mapping of course outcomes with program outcomes:

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	1	1	1	2	1	1	2
CO2	3	3	2	2	3	1	1	1	3	1	1	3
CO3	3	3	2	2	3	1	1	1	3	1	3	3
CO4	3	3	2	2	3	1	1	1	3	1	3	3

Detailed Syllabus:

Module 1. FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES L-12
Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques-Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems -Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

Module 2. GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION L-10
Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Module 3. ANT COLONY OPTIMIZATION AND ARTIFICIAL BEE COLONY ALGORITHMS L-10
Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO modelsTouring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Module 4. SHUFFLED FROG-LEAPING ALGORITHM AND BAT OPTIMIZATION ALGORITHM L-10

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogscomparison of memes and genes -memeplex formation- memeplex updation. Application to multi-modal function optimization Introduction to Multi- Objective optimization-Concept of Pareto optimality.

Reading:

1. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb "Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, "Swarm Intelligence", The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, "Swarm Intelligence-From natural to Artificial Systems", Oxford university Press, 1999.
5. David Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, "Particle Swarm Optimization and Intelligence: Advances and Applications", InformatIon science reference, IGI Global, 2010.
7. N P Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

Electronics & Communication Engineering			
ECO709	**VLSI Design***	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	APPLY the knowledge of semiconductor to review MOSFET characteristics, small geometry effects and scaling.
CO2	DEVELOP voltage, current sources and amplifiers and Operational amplifier made by CMOS.
CO3	CONSTRUCT switched capacitor filters, ADC, DAC and interconnects
CO4	ANALYZE CMOS Inverter, Dynamic CMOS, Pass transistor and transmission gates
CO5	DESIGN CMOS combinational, sequential circuits and memories

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	1	-	-	-	-	-	-	1
CO2	3	3	3	3	3	-	-	-	-	-	-	1
CO3	3	3	3	3	3	-	-	-	-	-	-	1
CO4	3	3	3	3	3	-	-	-	-	-	-	1
CO5	3	3	3	3	3	-	-	-	-	-	-	1

DETAILED SYLLABUS

Module	Content	No. of Lectures
1	**Introduction:** Review of MOSFET characteristics, scaling and small-geometry effects, and MOSFET capacitances. MOS resistor, MOS current source, current mirror circuits. MOS voltage source, linear voltage and current converters.	**6**

2	**CMOS operational amplifier (OPAMP) design:** Differential amplifier, level shifter, source follower, output stage voltage and power amplifiers. Cascode OP-AMP. Compensation techniques. **Analog Filters:** Switched capacitor (SC) fundamentals, first order SC circuits, second-order SC circuits and cascade design. Analog to digital and digital to analog converters, speed of conversion and over sampling issues. **VLSI Interconnects:** Distributed RC model, transmission line model. Future inter connect technologies.	**14**
3	**Digital VLSI Circuit Design:** MOS inverters, CMOS inverter, state characteristics, switching characteristics, power dissipation issues. **CMOS logic gates:** NAND, NOR, XOR, CMOS logic design of half and full adders. CMOS transmission gates, pseudo-nMOS, domino logic gates.	**9**
4	**Sequential MOS Logic Circuits:** The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit, Comparator. **Dynamic Logic Circuits:** Pass transistor logic, synchronous dynamic circuit techniques.	**8**
5	**Semiconductor Memories:** ROM circuits, SRAM circuits, DRAM circuits, drivers and buffers, Buffer scaling and design issues	**5**

Text Books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective,
   4th Edition, Pearson Education, 2015.

Electronics & Communication Engineering			
ECO710	**5G Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Learn 5G technology & its features.
CO2	Learn the Key RF, PHY, MAC, and air interface changes required to support 5G.
CO3	Understand the Radio technology that enables devices to communicate directly with each other without any additional network infrastructure.
CO4	Evaluate implementation options for 5G.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	2	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Overview of 5G Broadband Wireless Communications:** Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G. **5G wireless Propagation Channels**: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling.	8
2	**5G Wireless System Architecture**: Basic Radio Accesses Network (RAN) architecture, High level requirements for the 5G Technology, Functional Architecture and flexibility–integration of LTE, LTEA and new air-interface to fulfill 5G requirements, Enhanced multi RAT coordination towards 5G, Physical Architecture and Deployment, Deployment enablers, flexible function placement in 5G deployments.	9
3	**Transmission and Design Techniques for 5G:** Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques– orthogonal frequency division multiple accesses (OFDMA), Generalized	9

	frequency division multiple accesses (GFDMA).	
4	**Non-orthogonal multiple accesses (NOMA):** Device-to-device (D2D) and machine-to-machine (M2M) type communications–Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications, Millimeter-wave Communications, spectrum regulations, deployment scenarios, beam-forming, physical layer techniques, interference and mobility management, Massive MIMO.	**8**
5	**MAC Layer for 5G:** Overview of Wireless MAC Protocols and its Characteristics, Case Study, Implementation and Analysis of MAC Protocols in Lab View/MATLAB.	**6**

Text Books:

1. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.
2. Afif Osseiran, Jose. F. Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks”, Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.
5. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.

Electronics & Communication Engineering			
ECO711	**Low Power VLSI Circuits**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Identify the sources of power consumption in a given VLSI Circuit
CO2	Analyze and estimate dynamic, leakage power components in a DSM VLSI circuit
CO3	Choose SRAMs/ DRAMs for Low power applications
CO4	Design low power arithmetic circuits and systems
CO5	Decide at which level of abstraction it is advantageous to implement low power techniques in a VLSI system design

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	3	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	1	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction:** Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation, Circuit Techniques for Leakage Power Reduction.	**8**
2	**Adders:** Standard Adder Cells, CMOS Adders Architectures, Low Voltage Low Power Design Techniques, Current Mode Adders.	**8**
3	**Multipliers:** Types Of Multiplier Architectures; Braun, Booth Multipliers and their performance comparison, Low Voltage Low Power Design Techniques.	**10**
4	**Memories:** Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques.	**10**
5	**Wires:** Increased delays of wires, new materials for wires and dielectrics, Basic background on testing, Low power and safely operating circuits, Case study–A Low power subsystem design.	**8**

Text Books:

1. Kiat Seng Yeo and Kaushik Roy, Low- Voltage, Low-Power VLSI Subsystemss, Edition 2009, Tata Mc Graw Hill .
2. Soudris D, Piguet C and Goutis C, Designing CMOS Circuits for Low Power, Kluwer Academic Publishers, 2002.
3. Jan Rabaey, Low Power Design Essentials, Springer.

Electronics & Communication Engineering			
ECO712	**Biomedical Instrumentation**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	UNDERSTAND the origin of bio-potentials, anatomy and their physical significance
CO2	ANALYZE ECG, EEG and EMG signals and respiratory system measurement
CO3	ANALYZE medical imaging systems
CO4	DESIGN Therapeutic and prosthetic devices.
CO5	APPLY Medical application of LASER and safety measures of instruments.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	3	-	-	-	-	-	-	3
CO3	3	-	-	-	3	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	3
CO5	2	-	-	-	3	-	-	-	-	-	-	3

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Basic Medical Instrumentation System**: Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. **Bio-Potential Electrodes and Physiological Transducers:** Electrode potential, Electrode equivalent circuit, Types of Electrodes-Surface Electrodes, Needle Electrodes, Micro Electrodes. Pressure transducers, Transducers for body temperature measurement.	**14**
2	Electrical Conduction system of the heart, Block diagram Of Electrocardiograph, ECG leads, Einthoven triangle, ECG amplifier, EEG 10-20 lead system, Specifications and Interpretation of ECG, EEG, EMG.	**8**

3	**Blood flow meters:** Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter. Blood pressure measurement- Ultrasonic blood pressure monitoring. **Physiological Assist Devices & Therapeutic Equipment:** Pacemakers, External & internal, Defibrillators, External & internal, Hemodialysis machine.	**10**
4	Spirometry, Pnemuotachograph, Ventilators Monitoring Equipment: Arrhythmia Monitor, Foetal Monitor, and Incubator. **Medical Imaging Equipment:** X-ray generation, X-ray tube, X-ray machine, Computed Tomography (CT), Ultrasound Imaging system.	**10**
5	Electric shock hazards, Leakage currents, Test instruments for checking safety parameters of biomedical equipments.	**8**

Text Books:

1. L. A. Geddes and Wiley, Principles of Biomedical Instrumentation L. E. Baker (2nd Ed.)
2. L. Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.
3. John G. Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
5. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication.
6. Medical Instrumentation Application and Design by J. G. Webster, Wiley Publication.

Electronics & Communication Engineering			
ECO713	**MEMS Technology**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Understanding of MEMS and Microfabrication.
CO2	Understanding of MEMS materials.
CO3	Application of Sensing and Actuation.
CO4	Understanding of Micromachining.
CO5	Understanding of Optical MEMS.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	-	-	-	-	-	-	-
CO2	-	3	-	1	-	-	-	-	-	-	-	-
CO3	-	3	-	3	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-1	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to MEMS and Microfabrication:** History of MEMS Development, Characteristics of MEMS-miniaturization–microelectronics integration-Mass fabrication with precision. Micro fabrication-microelectronics fabrication process-silicon based MEMS processes-new material and fabrication processing-points of consideration for processing.	**14**
2	**Electrical and Mechanical Properties of MEMS Materials:** Conductivity of semiconductors, crystal plane and orientation, stress and stain–definition– relationship between tensile stress and stain-mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Types of beam- deflection of beam-longitudinal stain under pure bending spring constant, torsional deflection, intrinsic stress, resonance and quality factor.	**8**

3	**Sensing and Actuation:** Electrostatic sensing and actuation-parallel plate capacitor–Application-Inertial, pressure and tactile sensor parallel plate actuator-comb drive. Thermal sensing and Actuations-thermal sensors-Actuators-Applications-Inertial, Flow and Infrared sensors. Piezo resistive sensors- piezo resistive sensor material- stress in flexural cantilever and membrane-Application-Inertial, pressure, flow and tactile sensor. Piezoelectric sensing and actuation- piezoelectric material properties-quartz-PZT-PVDF–ZnO Application-Inertial, Acoustic, tactile, flow-surface elastic waves. Magnetic actuation- Micro magnetic actuation principle- deposition of magnetic materials-Design and fabrication of magnetic coil.	**10**
4	**Bulk and Surface Micromachining:** Anisotropic wet etching, Dry etching of silicon, deep reactive ion etching (DRIE), and Isotropic wet etching, Basic surface micromachining process- structural and sacrificial material, stiction and antistiction methods, Foundry process.	**10**
5	**Polymer and Optical MEMS:** Polymers in MEMS- polymide-SU-8 liquid; crystal polymer (LCP)-PDMS-PMMA-Parylene-Flurocorbon, Application-Acceleration, pressure, flow and tactile sensors. Optical MEMS-passive MEMS, optical components-lenses-mirrors-Actuation for active optical MEMS.	**8**

Text Books:

1) Foundation of MEMS, Chang Liu, Prentice Hall.
2) Microsystem Design, Stephen D. Senturia, Springer.
3) Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier.

Electronics & Communication Engineering			
ECO714	**Smart Antenna**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	To Familiarize with smart and adaptive antennas.
CO2	To study about the different adaptive algorithms for the antenna.
CO3	Understanding the concept of direction of arrival and angle of arrival.
CO4	To analyze the effect of mutual coupling and to study the space time.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	-	-	3	-	-	-	-	-	-
CO2	3	-	-	-	3	-	3	-	-	-	-	-
CO3	3	2	-	-	2	-	2	-	-	-	-	-
CO4	2	1	-	-	1	3	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**INTRODUCTION:** Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Smart Antenna Configurations: Switched and Fixed Beam Antennas, Adaptive Antenna Approach, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.	**8**
2	**FIXED BEAM SMART ANTENNA SYSTEMS:** Introduction, Conventional Sectorization, Antenna Arrays Fundamentals: Linear Arrays, Array. Weighting, Circular Arrays, Rectangular Planar Arrays, Fixed Side lobe Canceling, Retro directive Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beam formers, Switched Beam Systems, Multiple Fixed Beam System.	**8**
3	**ADAPTIVE ARRAY SYSTEMS:** Uplink Processing: Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beam forming, Fixed Multiple Beams versus Adaptive Beam forming. Downlink Processing: Transmit Diversity Concepts, Downlink Beam forming, Spatial Signature Based Beam forming, and DOA-Based Beam forming.	**9**

4	**ANGLE-OF-ARRIVAL ESTIMATION:** Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.	**9**
5	**MOBILE STATIONS' SMART ANTENNAS:** Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO,MIMO.	**8**

Text Books:

1. Ahmed El Zooghby, 'Smart Antenna Engineering', ARTECH HOUSE, INC, 2005.
2. Frank B. Gross, 'Smart antenna with MATLAB', Second Edition, McGraw-Hill, 2015.

Optical Fibre Lab

List of experiments

1) Demonstration of OTDR.
2) To cut and splice Fibre.
3) To calculate splicing loss.
4) To calculate the loss in Fibre.
5) To calculate bending loss in Fibre.
6) To calculate MFD.
7) To calculate the Numerical Aperture of given Fibre.
8) To study polarization of Fibre.
9) To study Coupling loss in Fibre.
10) To establish a Fibre network.

Mining Engineering

Mining Engineering			
MNC701	**Mine Legislation & Safety Engineering**	**L**	**T**
		3	**0**

Course objective:

Introduce students to the different laws of Indian Mining industry. To categorize, analyze and develop capability by measure actions to prevent and mitigate mine accidents. To ameliorate different past and recent case studies dealing with mine hazards and accidents. Course aims for the students to identify and evaluate any real-life scenario of mine disasters henceforth, also comprehend and absorb inherent knowledge of mitigation strategies to achieve minimal casualties within the mines.

DETAILED SYLLABUS

Module-1: Statutory laws: Statutory law regarding development and conservation of minerals, Mines and mineral (regulation and development) act 1957.

Module-2: Mineral concession rules: Procedure for obtaining mineral concession, Mineral concession rules 1960, Mineral concession and development rules 1958.

Module-3: Regulation and Development: Coal mines (regulation and development) act 1974, Mines and mineral (regulation and development) act 1957, Mines act 1952.

Module-4: Mines Regulations: Coal mines regulations 1957, Metal liferous mines regulation 1961, Mine rules: Coal mines rescue rules, Crèche rules, Electricity act and rules pertaining to mining.

Module-5: Safety in Mining: Safety organization, Role of management, Supervisors and workers, Pit safety committees, Workmen’s Inspector role, Role of safety officers.

Module-6: Accidents in Mining: Classification of accidents, Statistics, causes and prevention of accidents, Accidents rate in Indian mines, Accident enquiries and reports. Mine Fires; Surface and underground mine fire -causes and prevention, causes and nature of spontaneous heating. Dealing with the underground fire. Sealed off Area and Reopening: the study of atmosphere behind sealed off area. Factors, conditions, danger and safety measure for reopening. Methods of firefighting, firefighting-organization, and Rescue work related to connection with mine fires.

Inundations and Related Rescue Operations: Rescue work pertaining with connection with mine fires Causes and protective measures for inundations. Precautions to be taken while approaching the old- working design construction of water dams. Dewatering and recovery of waterlogged working and water danger plan, Rescue work related to mine inundations. Fire damp explosions, causes, preventive measures, Coal dust explosions, causes, preventive measures, Rescue work related to mine explosions.

Module-7: Health and disease in Mining: Health of workmen, Occupational disease in mining, International labour organization and its model code in the field of safety and accident prevention, Airborne Dust: Dust production, Assessment and control of mine dust and associated hazards.

Module-8: Management, relation and welfare in Mining: Principles of management and organization, Industrial relations, Welfare organization, Development of safety consciousness; Interest, publicity and propaganda for safety; Audio-visual aids, Safety drives campaigns. Different types of rescue equipment. Use of organization for rescue work, Disaster management plan of mines.

Course outcomes

To develop an understanding of the principles and concepts of law underpinning mining and energy law in India, including the following:

1. The development of mining legislation in India, including issues of constitutional law and international law.
2. The regulation of onshore and offshore mineral and petroleum exploration and production.
3. Judicial arrangements and appeals, in particular the jurisdiction of the Warden's Court.
4. The relationship between mining and indigenous peoples, including Native Title law;
5. Environmental controls over mining and energy production, including mining in protected areas such as national parks and reserves;
6. The regulation of the Indian electricity industry.
7. After completion of the course students will be able to find and explain the various kinds of the disasters which takes place within underground mines and opencast mines.
8. Able to summarize the categories hazards due to fire, inundation, dust and explosions.
9. Able to recall and identify various causes, factors and mitigation strategies associated with the above risks.
10. Able to demonstrate, distinguish and perform various rescue operations, apparatus their specification, and workings in case of any mishap in the mines.
11. Able to recall and relate main provisions, regulations and rules laid down by the statutory bodies in the country concerning the safety of mine workers.

Reference/text books:

1. Banerjee S. P., "Prevention combating Mine Fires", Lovely Prakashan, Dhanbad, India.
2. The coal mines regulations – CMR 2017.

3. The mines rule Coal mines pithead bath rules, Mineral concession rules Mines and minerals (development and regulation) act, The metalliferous mines regulations, Mines Act - 1952
4. Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.
5. Deshmukh, D. J. (2008); "Elements of Mining Technology, Vol. II"; Denett& Co., Nagpur, India.
6. Hartman, H. L., Mutmansky, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.
7. Karmakar, N. C. (2001); "Handbook of gas testing"; Lovely Prakashan, Dhanbad, India.
8. Le Roux, W. L. (1972); Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.
9. McPherson, M. J. (1993); Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.
10. Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.
11. Ramlu, M. A. (1991); "Mine fires, Explosions, Rescue, Recovery and Inundations"; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.
13. Kejriwal, B.K," A Survey ofAccidents, Their Causes &Prevention''.
14. Kaku L.C, "Fire in Coal Mine", LovelyPrakashan, Dhanbad, India.
15. GhatakS., "Mine Ventilation. 1 & Vol. 2, LovelyPrakashan, Dhanbad, India.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3				
CO2		3		2		3	2		2	3	3	3
CO3				2	3			3				
CO4			2			2	3		3	1	2	2
Avg.	3	3	2	2	3	2.5	2.5	3	2.5	2	2.5	2.5

Mining Engineering			
MNP702	**Applied Rock Mechanics**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding of the applied aspects of rock mechanics in mining, design and stability analysis of underground excavations including pillar design, design of protective pillar, support design and reinforcement requirement, mechanics of surface subsidence and slope stability in surface mines which depicts bench slope and waste dump slope stability analysis.

Course Outcome:

After completion of the course, students will be able to:

1. Understand the stability of rock structure, support and reinforcement requirement in underground excavation.
2. Understand the subsidence impacts and mechanics, caving mechanism and rock burst and bump in underground structure.
3. Understand the blasting mechanics which include tensile cracking and blastability of rocks.
4. Understanding on the stability aspects of rock slopes.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	2
CO4			2			2	2		3	2	2	
Avg.	2	3	2	2	3	2	2.5	3	2.5	2.5	2	2.5

DETAILED SYLLABUS

Module 1. Design and stability of underground structures in rock:Intact rock and rock mass classification systems, methods for design and stability analysis of underground excavations, design of single and multiple openings in massive, stratified and jointed rock mass, mine pillars and their classification, pillar stresses, pillar design, stability analysis of pillars, design of protective pillar

Module 2. Design of support and reinforcement for underground excavation: Types& classification of support and reinforcement systems, support and reinforcement requirement – influencing parameters, estimation and selection, support and reinforcement principle, method of design

Module 3. Subsidence:Causes and impacts of subsidence, mechanics of surface subsidence, discontinuous andcontinuous subsidence, monitoring, prediction, control and management of subsidence.

Module 4. Caving of overlying rock mass:Rock caving in underground mining, mechanics of rock caving, assessment of cavability, induced caving methods. Rockburst and Coal Bumps: Phenomenology of rock bursts, prediction and control of rock bursts, coal bumps and gas outbursts.

Module 5. Mechanics of Blasting: Mechanics of blasting, tensile cracking and blastability of rocks.

Module 6. Slope stability in surface mines: Types of mine slope including waste dumps, common modes of slope failure, factors influencing slope stability, slope stability assessment techniques, stability analysis, measures to enhance slope stability, monitoring of slopes.

Text/Reference Books:

1. Rock Mechanics for underground mining, third edition B. H. G. Brady, E. T. Brown
2. Engineering rock mechanics, Vol. I & II, John A. Hudson and John P. Harrison
3. Engineering rock mass classification, Z.T Bieniawski.
4. Rock Slopes: Design, Excavation, Stabilization, Hoek Y Bray
5. Fundamental and Applied Rock Mechanics, D. Deb, A.K. Verma
6. Rock Blasting, P. Pal Roy

Mining Engineering			
MNP703	**Numerical Methods in Geomechanics**	**L**	**T**
		3	**0**

Course objectives:

This course starts with Principle of continuum mechanics and Numerical Methods. It will elaborate the different numerical methods for Mathematical Modelling and need of Numerical Modelling in designing excavation by analysing stresses around the excavation. The course will also explain different Numerical Techniques such FDM, FEM, BEM and introduction to some software's based on these techniques.

The objective of this course are to:

- Introduce students to application of Numerical Methods in Mathematical Modelling
- Introduce students to practical application of Numerical Simulation in civil and mining industry
- Introduce students to different Numerical Techniques and software's based on this.

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- Understand different Numerical Methods.
- Identify and apply different Numerical Methods in different kind of Modelling
- Understand working of different FEM/ FDM/ BEM based software's

Skills

- Analyse and evaluate different kind of Numerical Techniques (FEM) for different conditions
- Can use different software's for designing Civil and Mining structures
  Able to write some programmes for various applications in Civil and Mining Industry

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2		2			3	

CO2		3		2			3	2	3	2		2
CO3				2	3	2		2			3	
CO4			2				2		3	2		2
Avg.	3	3	2	2	3	2	2.5	2	3	2	3	2

DETAILED SYLLABUS

Module-1: Introduction:Principle of continuum mechanics, Numerical Methodsin general, Solutionof Equations by Iteration, Interpolation.

Module-2: Numerical Integration and Differentiation**:** Numerical Integration and Differentiation

Module-3: Numerical Methods in Linear Algebra:Linear systems: Gauss Elimination, Solution byIteration.

Module-4: Numerical Modelling:Need for numerical modelling in design of excavation in mines,domain and boundary conditions and its application in Mathematical Modelling.

Module-5: Finite Element Method:Basic principle, assembling elements to form a structuralstiffness matrix, imposing boundary conditions, solving structural equations using plane truss, elements on assumed displacements, constant strain triangle, iso-parametric formulation.

Module-6: Finite Difference Method:Basic principle, explicit finite difference method, finitedifference equation, solution stability.

Module-7: Boundary Element Method:Basic principle, introductory ideas of its application inmining excavations.

Text/Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th edition; John wiley& sons, Part E (Numerical Methods)
2. Debasis Deb, Finite Element Method: Concept and Applications in Geomechanics; Prentice Hall of India
3. J. B. Martins, Numerical Methods in Geomechanics; Springer
4. G. Swoboda, Numerical Methods in Geomechanics, 6th edition; CRC Press
5. http://vle.du.ac.in/course/view.php?id=562

Mining Engineering			
MNP704	**GEO-Statistics**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding to use the statistical tool in mining industries. It will give the idea of interpretation of reserve estimation using three-dimensional modelling software.

Course Outcome:

After completion of the course, students will be able to:

1. Understand use of statistics tools to use in mining fields.
2. Know reserve estimation methods using statistics tool.
3. Understand and interpret the 3 – D model of reserve.
4. Understand the use of mine modelling software like Surpac, Minex.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2			2			
CO2		3		2			3	3		3	2	3
CO3				2	3	2			2			
CO4			2				3	2		3	3	2
Avg.	3	3	2	2	3	2	3	2.5	2	3	2.5	2.5

DETAILED SYLLABUS

Module 1: Geo - statistics: Introduction, Concept.

Module 2: Basics of Probability and Statistics: Mean, Median, Mode, Probability Distribution (normal & log normal), Variance, Cumulative frequency and Cumulative probability.

Module 3. Mineral Inventory: Prospecting, exploration, method to quantify the size, shape & distribution of the ore reserve. Ore reserve calculation

Module 4. Extension method and application of classical statistics: Regionalized variables, variogram and semi – variogram modelling, regularization, auxiliary functions.

Module 5. Kriging: Introduction, concept of development, types of kriging, linear kriging methodology, and their application in mining industries, common problems associated with the use of kriging.

Module 6. Geo - statistics for quality control: Basis of non-parametric geo - statistics and indicator kriging. Introduction to SURPAC, STATISTICA, SPSS/SYSTAC software.

Text/Reference Books:

1. Open Pit Mine Planning and Design, Two Volume Set, Second Edition by William A. Hustrulid (Author), Mark Kuchta (Author)
2. Mining Geostatistics by A. G Journel& Ch. J. Huijbregts.
3. Advanced Geostatistics in the Mining Industry: Proceedings of the NATO Advanced Study Institute held at the Istituto di Geologia Applicata of the 13–25 October 1975 (Nato Science Series C:) Paperback – Import, 26 Mar 2012 by M. Guarascio (Editor), C.J. Huybrechts (Editor), M. David (Editor).
4. Geostatistics, Rendu J.M
5. Surface Mining, Kennedy Wiley

Mining Engineering			
MNP705	**Instrumentation in Rock Mechanics**	**L**	**T**
		3	**0**

Course Outcome:

The course is designed to provide a better understanding to evaluate use of instrumentation in mining and civil engineering projects. Strata control instrumentation and monitoring aims at evaluation and monitoring the trends of changing rock mechanical parameters, namely, dilation, load, convergence, stress and axial loading etc., during mining so that rock mechanical un-eventualities are apprehended well before for effective corrective measures. Host rock geometry in coal mining is represented by stratified rock masses of relative weaker strength. Such stratifications are compound and unite in their virgin state before any kind of mining. Dilation / bed separation causes change in stress from its in-situ state, which in turn is propagated in the rocks around. Such induced effect of stress can be revealed in the workings with the help of instrumentation, aiding apprehension of strata movement and subsequent assessments.

Course Outcomes:

After completion of the course, students will be able to:

1. Understand use of instrumentation of in rock mechanics.
2. Know Causes and impacts of rock failure, rock strength and stresses induced in rocks.
3. Understand the time dependent deformation in rock structure.
4. Understand the effect of water on rock structure and their stability.
5. Understand the dynamic characteristics of rock and rock mass.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					3		3		3		3
CO2		3		2			2		2		2	
CO3				2	3	2		2		3		3
CO4			2				2		2		3	
Avg.	3	3	2	2	3		2	2.5	2	3	2.5	3

DETAILED SYLLABUS

Module 1: Load and Pressure Measuring Instruments: Load cells, pressure measuring instruments – stress capsules, stress meters, borehole pressure cells and flat jacks. Strain gauges and transducers, readout units, sensors, transmitters and data acquisition systems.

Module 2: Deformation and Strain Measuring Instruments: Convergence meters, convergence recorders, tape extensometers, bore hole deformation gauge, multipoint borehole extensometers and bore hole camera.

Module 3: Testing Equipment: UTM, MTS and acoustic emission equipment. Rock bolt pull tester. Monitoring and interpretation of the data.

Module 4: Soil Mechanics: Instrumentation for shear strength and bearing capacity of soils.

Module 5: Applications: Mining and Civil Engineering applications.

Text/Reference Books:

1. Rock mechanics instrumentation for mine design by U.S. Dept. of the Interior, Bureau of Mines, 1973.
2. Fundamental and Applied Rock Mechanics, D. Deb, A.K. Verma
3. Fundamental and Rock Mechanics, B. K. Shrivastava, A. Jaiswal

Mining Engineering			
MNP706	**Mine Planning and Design**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding of planning and design stage, for opening of the mine. This subject focuses on understanding the complete mining context and characteristics of the deposit, and of recognizing and addressing the specific constraints of each project in order to select the appropriate mining method and a robust mine plan.

Course Outcome:

After completion of the course, students will be able to:

1. Prepare the conceptual note, mine planning report, feasibility report and mine closure report.
2. Evaluate economic reserve estimation for ore and sedimentary deposit
3. Understand the choice of technology deploy in the mine
4. Understand the optimum location of mine entries
5. Understand the selection of equipment, size of the mine and mine life.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				2		3	2		2		3
CO2		3	2	2		3			3		3	
CO3	2			2	3		2	2		2		
CO4		2	2			3		2	2		3	3
Avg.	2	2.5	2	2	2.5	3	2.5	2	2.5	2	3	3

DETAILED SYLLABUS

Module 1: Introduction to Mine Planning: Principle of the planning, short range and long-range planning, role of planning in mining ventures.

Module 2: Reserve Estimation: Ore reserve estimation, economic block model.

Module 3: Mine Planning Input: Geological, mineralogical, structural, economical, environmental and technical inputs.

Module 4: Mine Life: Determination of optimum output, life of a mine and size of mine field based on economic consideration, Taylor's mine life rule, ultimate pit configuration.

Module 5: Mine Entry: Optimum location of mine entries, theoretical considerations of opening and development of mine field.

Module 6: Production Planning and Scheduling**:** Production planning and scheduling, mine equipment planning, estimation of their numbers, infrastructure planning.

Module 7: Mine Closure: Mine Closure-ongoing and final report preparation

Module 8: Mine Planning Report**:** Feasibility report and project report - contents and preparation

Text/Reference Books:

1. Principles of Mine Planning, Jayant Bhattacharjee
2. Open Pit Mine Planning and Design, 3rd Edition, 2013 Vol. I & II, William A. Hustrulid, MarkKuchta, Randall K. Martin
3. SME Mining Engineering Handbook, Third Edition, 2011Vol. I & II, Peter Darling
4. Mine Planning and Equipment Selection 2001: Proceedings of the Tenth International Symposium on Mine Planning and Equipment Selection, New Delhi, India, November 19-21, 2001, Raj K. Singhal, Bhaskar P. Singh
5. Underground Winning of Coal, 1992, T.N. Singh
6. GEOVIA SURPAC, Tutorials for ore deposit
7. GEOVIA MINEX, Tutorials for sedimentary deposit

Mining Engineering			
MNP707	**Mine Closure**	**L**	**T**
		3	**0**

Course objectives:

The course objectifies to ensure long term physical, chemical and biological stability of the site to minimize potential environmental and health risk.

Goals and Outcomes:

This course provides the necessary and legal aspects of mine closure to comply with uninterrupted mining process. It gives special focus on the preparation of mine closure plan on elemental basis. With this course, the students will be able to:

- Know the insight into mine closure plan
- Prepare a mine closure plan
- Know the various legal aspects related with mine closure plan

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3						3			3		
CO2		3		2		3		3	2		2	3
CO3				2	3					3		
CO4			2			2	2	2	2		3	3
Avg.	3	3	2	2	3	2.5	2.5	2.5	2	3	2.5	3

DETAILED SYLLABUS

Module-1: Mine closure planning: importance, methodology, statutes concerning mine closure.

Module-2: Principles, planning, financial provisions, implementation, standards for closure criteria, systems approach for mine closure.

Module-3: Various legal aspectsof mine closure planning, its advantages and amendments. Guidelines from ministry of environment and forest.

Module-4: Mine closure plan, guidelinesfor preparation of mine closure plan.

Module-5: Standards of Mine Closure in Indian Mines, components, process, monitoring rules.

Text/reference books:

1. Guide for mine closure planning, Sánchez, L.E.; Silva-Sánchez, S.S.; Neri, A.C, Brasília, 2014, IBRAM – Brazilian Mining Association.
2. Mine Closure - A. Robertson & S. Shaw
3. Mineral Conservation and Development Rules, 2017, Indian Bureau of Mines
4. Guidelines for preparation of Mine Closure Plan, Ministry of Coal, GOI

Mining Engineering			
MNP708	**Mine Reclamation and Rehabilitation**	**L**	**T**
		3	**0**

Course objectives:

The role of reclamation and closure in any mineral exploration project can be regarded as the final chapter in the life of that project. When the exploration project develops further into a feasibility study or a full-scale mining operation, however, then the reclamation process undertaken at the exploration stage becomes the first step in the final rehabilitation of the mine. There are many definitions used in describing reclamation and closure. These include: Decommissioning. This is the transitional period between the cessation of operations and the final closure of that operation. Reclamation. This refers to the physical aspects of earth moving, regrading and revegetation. Rehabilitation.

Goals and outcomes:

This course provides the basis for estimating the financial liability associated with a mining project. The objective of rehabilitating a typical exploration site is to minimize long-term environmental liability by maintaining geotechnical stability, restoring native ecosystems, striving to achieve a more beneficial land use, etc. Provide ideas and process about closing a mine, how to do reclamation and necessity of reclamation. The students will be able to:

- Understand the post mining liabilities associated with mines.
- Know the technical aspects to mitigate the adverse impacts.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				2		3			2		3
CO2		3	2	2		2		2	3		3	
CO3	3			2	3		3			3		3
CO4		2	2			2		2	1		2	
Avg.	2.5	2.5	2	2	2.5	2	3	2	2	2.5	2.5	3

<u>**DETAILED SYLLABUS**</u>

Module-1: Economical and technical aspects of reclamation of mined out land.

Module-2: Reclamation Methods: Back filling, outside dumps and their stability.

Module-3: Top soil handling, assessment of soil productivity potential, re-vegetation, factors for plant Growth, parameters for soil quality and their importance.

Module-4: Reclamation plan and land use plan, general requirements of protection of hydrologic balance.

Module-5: Erosion of soil: types of erosion, estimation of top soil erosion, Landscaping of disturbed and, estimation of reclamation cost and benefits, use of reclaimed land and structures.

Module-6: Mine Closure Planning: Importance, methodology, statutes concerning mine closure, Land reclamation as post mining operation, Statutes concerning reclamation of mined out area. Mine rehabilitation: Planning, Principles of Rehabilitation, Standard Rehabilitation, Monitoring, Maintenance and Relinquishment of Restored Mines.

Text/reference books:

1. Surface Mining Technology, S.K. Das
2. Elements of Mining Technology Vol I, D.J. Deshmukh
3. Bio-Geotechnologies for Mine Site Rehabilitation, M.N.V. Prasad, Paulo Jorge deCampos Favas, Subodh Kumar Maiti
4. Spoil to Soil: Mine Site Rehabilitation and Revegetation. 1st Edition, by N.S. Bolan,M.B. Kirkham, Y.S. Ok
5. Mine rehabilitation: A Handbook for the Coal Mining Industry – 1984, J. C. Hannan

Mining Engineering			
MNP709	**Sustainable Mining Practices**	**L**	**T**
		3	**0**

Course objectives:

The Strategy for incorporating involved in extracting non-renewable resources have come under increasing pressure to embed the concept of sustainability into strategic decision-making processes and operations. In addition to these considerations, responsible corporations have been able to move towards sustainability by developing a range of appropriate stewardship initiatives. Economic development, environmental impact and social responsibilities must be well managed, and productive relationships must exist between government, non-government organisations, industry and stakeholders.

Goals and outcomes:

This course provides the inside into the less know environment impacts related with coal preparation plants and throw the light into regulatory frameworks related with these plants.
The students will be able to understand the:

- Environmental problems associated with the coal preparation plants.
- The mitigating measures associated with those issues.
- Regulatory frameworks associated with those issues.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							2				2
CO2		3	2	2		2	3		3	2	3	
CO3	2			3	3							3
CO4			2			2	2	2	2	2	1	
Avg.	2.5	3	2	2.5	3	2	2.5	2	2.5	2	2	2.5

DETAILED SYLLABUS

Module-1: Coal preparation and washing: The Needs of Coal Preparation, Coal preparation process –physical, chemical or mechanical processes

Module-2: Coal dust generation: Sources, characterization, ill effects, measurement, monitoring, standards, mitigating measures

Module-3: Air pollution: Sources, characterization, ill effects, measurement, monitoring, standards, mitigating measures.

Module-4: Water pollution: Sources, ill effects, water quality parameters–physico-chemical, biological and bacteriological. Water quality criteria, standards, monitoring and mitigating measures. Heavy metal pollution and its abatement; Surface water pollution – detection and management.

Module-5: Environmental Impact Assessment: Methods of EIA and their applicability.

Module-6: Environmental Management Plan: Structure and preparation of EMP, Environmental Laws

Text/reference books:

1. Elements of Fuel technology, Godfrey Wilfred Himus, Leonard Hill Limited. 1958.

2. Fuels: Solid, liquid and gaseous fuels, J. Brame and King, Kessinger Publishing, LLC, 2007.

3. Coal, Oil Shale, Natural Bitumen, Heavy Oil and Peat - Volume I, Gao Jinsheng - 2009

4. Coal, Oil Shale, Natural Bitumen, Heavy Oil and Peat - Volume II, Gao Jinsheng - 2009

Mining Engineering			
MNO710	**Mine Economics and Resource Management**	**L**	**T**
		3	**0**

Course Objective:

This course examines the economic factors affecting the mining cycle; it consists of mineral economics, exploration of the global resource market, performing project economic evaluations. Assessing and estimating the resource and reserve estimation techniques of coal and metal liferous deposits. Learners should be able to skim the roadmap regarding resource management and planning by focusing on the cost efficiency at every mining process and developing decision making based on costs.

Course outcomes:

Upon the successful completion of the course, the students would be able to:

- Analyze and construct essential and relevant economic forecasts and financing plans throughout the mine life cycle.

- Assemble cash flow information and able to evaluate and determine the economic feasibility of the mine project.
- Able to recognize and interpret the sustainability perspective related to the mineral industry.
- Assess the project's impact on the economy of the country and, apply and improve economic criteria to real life decision making.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							2		2		2
CO2		3		2		3	2		3		3	
CO3	2			2	3			2		2		
CO4			2			2	2		2		2	3
Avg.	2	3	2	2	3	2.5	2	2	2.5	2	2.5	2.5

DETAILED SYLLABUS

Module1: Mineral Sampling: Definition, purpose, and classes of samples, Chip, Grab, Groove, Bore hole, Dump, Alluvial & Bulk sampling. Development & stope sampling, Samples size reduction techniques. Errors in sampling- its minimization.

Module 2: Geo-Statistics: Use of statistical techniques in mine sampling. Reliability of samplingresults. Calculation of average assay, width and tonnage of mineral deposits, Introductory principles of Geo-statistics.

Module 3: Mineral resource: Mineral reserve estimations - various categories. Mine Valuation: Depreciation. Amortization of capital. Theory of mine valuation- its purpose, Factors affecting the value of a mine.

Module 4: cash flow evaluation: Hoskold, Morkill and other classical methods for mine valuation. Pay back method and Discount cash flow (DCF) methods of project evaluation (NPV & IRR).

Module5: Financial Management: Mine accounts, mining costs, cost categorization, break even analysis, balance sheet, profit and loss accounts, mine budgeting.

Module 6: Management Techniques: Elements of Management function, Project management, Organizational structures in mines.

Module7: Application of operation research techniques in mining PERT, CPM and Linear Programming methods with special reference to mining industry.

Reference/text books:

1. Sharma N.L, "Mineral Economics".
2. Rubawsky "Mineral Economics", Elsevier Science Pub.
3. Deshmukh R.T "Mineral Economics", Meera Publication, Nagpur.
4. Chatterjee K.K "Mineral Economics", Willey Eastern.
5. Misra G.B- "Mineral Economics".
6. Mineral Economics Sinha & Roy
7. Mine Valuation, Baxter, Addition Wesley
8. Mine Economics & Strategy, Runge, SME, USA

Mining Engineering			
MNO711	**Mine Management**	**L**	**T**
		3	**0**

Course Objectives:

This course introduces Objective of mine management, characteristics of minerals and coal, crushing methods, separation methods, methods of concentration, fields of application and limitations.

Course Outcomes:

1. Recognize and appreciate the holistic nature of the mine management process
2. Identify the key stakeholders in a mining project and their respective needs.
3. Demonstrate an awareness of management theory and processes.
4. Recognize the factors that motivate people’s behaviour in the mine working environment.
5. Apply the principal performance measures used in mine management.
6. Demonstrate an awareness of mining law (safety, mining leases etc).
7. Recognize and appraise the factors contributing to safety & risk management issues in specific mining-related processes.
8. Investigate the causes and consequences of mining-related serious incidents and propose risk management strategies
9. Demonstrate an awareness of contractor management (vs owner-operated).
10. Assess and understand the economic conditions in which the mining industry operates

CO-PO Mapping:

COs/POs		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3						3					
CO2			3		2		3		2	3	2	3	3
CO3		2			2	3		2					
CO4				2			2		2	2	2	2	
Avg.		2.5	3	2	2	3	2.5	2.5	2	2.5	2	2.5	3

DETAILED SYLLABUS

Module 1: Introduction: Evolution of management; theory and practice; principles of scientific management; elements of management function; planning; organization and control; structure and design of organization for mining enterprises.

Module 2: Personal Management: Selection; training and development of human resources formining enterprises; leadership; study of traditional leader behaviour; autocratic; democratic and Laissez-Faire behaviour;

Module 3: Production Management: Determination of norms and standards of operations by work study; analysis of mine capacities and capability; production planning; scheduling and control; short term and long-term planning; productivity; concepts and measurements; application of Ergonomics in mine operation.

Module 4: Financial Management: Capital budgeting; techniques for mining project; project evaluation; payback period and IRR; methods of cost analysis and cost control; breakeven charts; working capital management.

Module 5: Materials Management: ABC Analysis, Inventory Management; Purchase policies, P and Q system, inventory control, Review period, lead time.

Module 6: Behavioural Sciences for Management: Conflict management; conflict in organization; sources of conflict; dealing with conflict; organizing for conflict resolution; conflict and growth; Individual motivation; two-way personal communication.

Module 7: Maintenance Management: Definition, Classifying Reliability, Types of Maintenance; Break-down, scheduled, preventive, predictive, protective and lean maintenance.

Module 8: Marketing Management: Strategic planning & marketing management processes, marketing environment, marketing information systems, market management and forecasting; New product development processes.

Text/Reference Books:

1. I M Pandey, Financial Management, Vikash Publishing House Pvt. Ltd., New Delhi
2. P. Gopalakrishnan & M. Sundaresam, Materials Management- An Integrate Approach, Prentice Hall India Pvt. Ltd., New Delhi
3. SC Saksena, Business Administration and Management, Sahitya Bhawan, Agra.
4. P. Kstler, Marketing Management, Prentice Hall India Pvt. Ltd. New Delhi
5. M. Telsang, Industrial Engineering and Production Management, S. Chand & Co. Ltd., New Delhi

6. Lee &Dobbler, Purchasing and Materials Management, Tata Mc-Grand Hill Publishing Co. Ltd. New Delhi

Mining Engineering			
MNO712	**Remote Sensing & Geographical Information System**	**L**	**T**
		3	**0**

Course Objectives:

Remote Sensing and GIS is a relatively young scientific discipline and is an area of emerging technology which has witnessed phenomenal growth over last three decades. In the recent past, there has been tremendous development in the field of Remote Sensing data collection, analysis and utilization. The science of Remote Sensing is no more an art of Map making from satellite image. The digital data handling led to the development of GIS (Geographical Information System) followed by another innovation of GPS (Global Positing System). Remote Sensing coupled with GIS and GPS techniques has dramatically enhanced human capability for resources exploration, mapping and monitoring on local and global scale.The application of Remote Sensing techniques and Geographical Information System(GIS) in various activities including resources evaluation, environmental monitoring and Landuse/Landcover mapping etc, have grown considerably during the last three decades and Remote Sensing data products are being increasingly used for plan information at all levels. An essentials pre-requisite to partaking in these opportunities is the building of various indigenous capacities for the development and utilization of space science and technology. This has led to a spurt in the demand for qualified manpower.

This course is designed to address the following:

- Understanding the Geo-informatics approach
- Teach fundamental principles involved in RS and GIS
- Understand the Fundamentals of Remote Sensing Products
- Know the Indian Remote Sensing Program
- Role of Remote Sensing for various surveys and information extraction
- Know about different software available in RS and GIS
- Learn fundamental procedures in RS and GIS
- Teach data integration and defining problems in digital format

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- Know Understand the remote sensing process;
- Understand digital data in different and their formats

- Know about National and International RS Programs
- Know about various satellites and images
- Know about changing field practices in Survey
- Know how to generate different types of digital data
- Know about Application areas

Skills

Use operations of RS & GIS to:

- Geotechnical investigations (soil studies, dam site studies)
- Water resources management
- Environmental studies (EIA and Land Use Land cover studies)
- Transportation planning, Urban Planning, E-Governance.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2		3		3	3	3	2	3
CO3				2	3							3
CO4			2			2		2	1	3	3	
Avg.	3	3	2	2	3	2.5		2.5	2	3	2.5	3

DETAILED SYLLABUS

Module 1: Definition & Scope of Remote Sensing: Electromagnetic energy & spectrum, Atmospheric windows. Remote Sensing Systems, Sensors & Scanners, Resolution of sensors, Multispectral, thermal & Radar data. Radiometers, spectral Signatures.

Module 2: Elements of Remote Sensing Systems: Terrestrial, airborne &spaceborneplatforms, sunsynchronous & Geostationary satellites. Various earth resources satellites, Indian Remote Sensing Programs.

Module 3: Remote Sensing Data products & their types: Analogue & Digital data Formats,errors.

Module 4: Interpretation Techniques: Elements & Methods of interpretation, Reliefdisplacement and vertical exaggeration, Photogrammetric determination of elevation from Remote Sensing Data.

Module 5: Digital Image Processing: Image rectification & restoration, imageenhancements, image classification; supervised & unsupervised, accuracy assessments.

Module 6: Geographical Information Systems: Raster & Vector Data, Components of GIS, concepts & basic characteristics of Vectorization, topology generation, attribute data attachment, editing and analysis. Buffer, Overlay and Interpolation techniques. Managing networks in GIS.

Module 7: Global Positioning Systems:Types and method, Applications:Integrated approach of RS & GIS application; Geotechnicalinvestigations (soil studies, dam site studies), water resources management, environmental studies (EIA and Land Use Land cover studies), transportation planning, Urban Planning, E-Governance.

Text/Reference Books:

1. M. Anji Reddy BS Publications Remote Sensing and Geographical Information Systems Third Edition.

2. C.P LO Albert KW Yeung, Concepts and techniques of Geographic Information Systems Pritince Hall of India 2002.

3. John R Jensen Remote Sensing of the Environment an Earth Resource Perspective Pearson Education 2006.

4. Geographic Information System and Environment Modelling Keith C. Clerk, Bradley O Parks, Michel P Crane Pritince Hall of India 2002.

5. Bhatta Remote Sensing and GIS Oxford University Press First Edition.Surveying (Vol – 1,2 & 3), by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain – Laxmi Publications (P) Ltd., New Delhi.

Mining Engineering			
MNO713	**Social-Environmetal Impact of Opencast Mines**	**L**	**T**
		3	**0**

Course objective:

This course outlines various factors which effects the ecological and societal imbalance, repercussions due to mega open cast mining projects. Following course summarizes those environmental and social issues that formed the basis for the Mining and Critical Ecosystems framework. Environmental and social impacts are divided into waste management issues, impacts to biodiversity and habitat, indirect impacts, and poverty alleviation and wealth distribution.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		3	2	2		2		3	2		3	3
CO3	2			2	3							
CO4		2	2					2	2		2	
Avg.	2	2.5	2	2	3	2		2.5	2		2.5	3

Detailed Syllabus

Module-1: Introduction: History of environmental problems in mines and present environmental scenario. Techno-economics of environmental management.

Module-2: Environmental Parameters and Standards: Baseline data. Impact of mining activities on environmental parameters. Mitigating measures, monitoring and control. National and international standards and regulations. ISO principles and series

Module-3: Environmental Standards: National and International standards of various environmental parameters.

Module-4: Environmental Impact Assessment (EIA**)**: Framework for EIA, screening, scoping and baseline studies. EIA methodologies and their applicability, Environmental Impact Indices, uncertainties in EIA.

Module-5: Environmental Management Plan (EMP):Scope, structure and legislative requirements. Preparation of EMP

Module-6: Land Acquisition & Revenue: Concepts, Related laws and regulations. Corporate Social Responsibility: Concepts and principles. Mine closure**:** Concepts and principles. Environmental administration: Laws related to mining environment.

References:

1. Environmental Legislation in India, Region Asia.
2. Pollution control acts, rules and notifications issued thereunder, CPCB-India Environmental Law of India, S.K. Choudhury, Oxford & IBH Publishers.
3. Handbook of Environmental laws, Acts, Guidelines, Compliances & Standards Policy, Trivedy, BS Publishers.
4. Environmental Impact Assessment -Larry, W. Canter (2nd ed), McGraw Hill Inc. Singapore, 1996.
5. Strategic Environmental Assessment – Riki Therirvel, E. Wilson, S. Thompson, D. Heaney, D. Pritchard. Earth scan, London, 1992.
6. Environmental Impact Assessment-Cutting edge for the 21st century - Alan Gilpin, CUP, London, 1994.
7. Environmental Impact Assessment-Theory & Practice - Peter Wathern, Unwin Hynman, Sydney, 1988.
8. Renewable Energy Environment and Development-Maheswar Dayal Konark Pub. Pvt. Ltd. 1998.

Mining Engineering			
MNO714	**Sustainable Energy Resources**	**L**	**T**
		3	**0**

Course objectives:

The course should enable the students to:

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
5. Analyse the environmental aspects of renewable energy resources.

Goals and Outcomes:

This course gives a flavour of sustainable sources of energy to the students. This covers generation, design, efficiency and characteristics of various sustainable energy sources including wind, hydro and tidal systems. Student should be able to

- Analyze solar radiation data, extra-terrestrial radiation, radiation on earth's surface.
- Design solar thermal collections.
- Design solar photo voltaic systems.
- Develop maximum power point techniques in solar PV and wind.
- Explain wind energy conversion systems, Betz coefficient, tip speed ratio.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2		3	3	2	3	2	3	3
CO3				2	3							
CO4			2			2		2	2	2	2	
Avg.	3	3	2	2	3	2.5	3	2	2.5	2	2.5	3

DETAILED SYLLABUS

Module-1: Wind Energy Conversion: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. Site

Selection Criteria: Advantages, Limitations, Wind Rose Diagram, Indian Wind Energy Data, Organizations like C-WET etc., Wind Energy Conversion System, Design, Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandtl's tip loss correction.

Module-2: Design of Wind Turbine: Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods. Wind Energy Application - Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies.

Module-3: Small Hydropower Systems: Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works.

Module-4: Speed and voltage regulation: Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India. SHP: Renovation and Modernization, Testing Methods

Module-5: OTEC-Tidal Energy: Geothermal, MHD, Thermionic- Thermoelectric energy conversion system, Fuel Cells, Batteries, Micro Alge, Biodiesel from Alge.

Text/reference books:

1. G L Johnson, Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.
2. David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)
3. Erich Hau, Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Verlag; (2000)
4. Paul Gipe, Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company; (1999)
5. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained, John Wiley & Sons; 1st edition (2002)

MNO715	OPENCAST MINING MACHINERY	3L-0T-0P	3 CREDITS

Course Objective:
To give an overall idea about the various heavy-duty machines employed in mines and their structure and applications.

Syllabus
Module 1: Introduction to Surface mining equipment. Hydraulic Transmission system, Suspension System, Tyres, Wheels and Axle assembly, Braking and Steering system, Under Carriage unit of Crawler mounted machine; Hydraulic systems used in Heavy Earth Moving Equipment.
Module 2: Classification of equipment; system with different combination of excavator and transport equipment. Applicability of different surface mining equipment, Mechanics of rock cutting / loading by excavator
bucket.
Module 3: Prime movers used in surface mining equipment: Turbo-charged diesel engine, construction, operation and maintenance of its subsystems, trouble shooting of the engine.
Module 4: Classification, construction, operation and maintenance of various sub-systems of Shovel, Dragline, Bucket wheel excavator, Scraper, Surface Miner, Dumper, Dozer, Ripper, Grader, Loader, Compactor, Drills and Highwall miner Construction and Operations of subsystems of HEMM.
Module 5: Drilling Machine: Classification, construction, operation and maintenance of Rotary Blast Hole Drill, Jack Hammer Drill, DTH Drill; Drill Bits and Tubes / Rods, Drilling fluids., Construction and Operation of Exploratory drilling.
Module 6: Recent trends and development of surface mining equipment: Automation and control in HEMM. Selection criteria of open cast mining equipment. Safety aspects related to open cast mining equipment: Fire protection system used in HEMM.

Outcome Assessment Strategies:
• Individual, small group and full class discussions may be used as part of student assessment. Homework assignments, tutorials, surprise tests, mid semester examination and end semester examination will be used to assess outcomes.
• Specific details of the assessment procedure will be given the first week of class. In general, student assessment would depend on class attendance, input and feedback during the lecture and problem-solving sessions, homework, and written examinations.

Course Outcome:
Students will have a brief idea about the various systems and functioning of the heavy-duty machineries in terms of hydraulic circuits being employed and the transmission systems.

References/Books:
1. Recent Development of Heavy earth Moving machineries – A. De, Lovely Prakashan
2. Moving the Earth – Nicholes
3. On and with the Earth – J. Singh
4. Drilling Technology Handbook– C. P. Chugh

Mining Engineering			
MNO716	**Mine Disaster and Prevention Management**	**L**	**T**
		3	**0**

Course Objective:

To categorize, analyze and develop capability by measure actions to prevent and mitigate mine accidents. To ameliorate different past and recent case studies dealing with mine hazards and accidents.

Course aims for the students to identify and evaluate any real-life scenario of mine disasters henceforth, also comprehend and absorb inherent knowledge of mitigation strategies to achieve minimal casualties within the mines.

Module:

Module 1: Mine Fires; Surface and underground mine fire -causes and prevention, causes and nature of spontaneous heating. Dealing with the underground fire.

Module 2: Sealed Off Area and Reopening: the study of atmosphere behind sealed off area. Factors, conditions, danger and safety measure for reopening.

Module 3: Mitigation of Fire: Methods of firefighting, firefighting- organization, and Rescue work related to connection with mine fires.

Module 4: Inundations and Related Rescue Operations: Rescue work pertaining with connection with mine fires Causes and protective measures for inundations. Precautions to be taken while approaching the old- working design construction of water dams. Dewatering and recovery of waterlogged working and water danger plan, Rescue work related to mine inundations.

Module 5: Firedamp and Coal Dust Explosion: Fire damp explosions, causes, preventive measures, Coal dust explosions, causes, preventive measures, Rescue work related to mine explosions.

Module 6: Airborne Dust: Dust production, Assessment and control of mine dust and associated hazards.

Module 7: Rescue Operation: Different types of rescue equipment. Use of organization for rescue work Disaster management plan of mines.

Course outcomes:

- After completion of the course students will be able to find and explain the various kinds of the disasters which takes place within underground mines and opencast mines.
- Able to summarize the categories hazards due to fire, inundation, dust and explosions.
- Able to recall and identify various causes, factors and mitigation strategies associated with the above risks.

- Able to demonstrate, distinguish and perform various rescue operations, apparatus their specification, and workings in case of any mishap in the mines.
- Able to recall and relate main provisions, regulations and rules laid down by the statutory bodies in the country concerning the safety of mine workers.

Reference/text books:

1. Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.
2. Deshmukh, D. J. (2008); "Elements of Mining Technology, Vol. II"; Denett & Co., Nagpur, India.
3. Hartman, H. L., Mutmansky, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.
4. Karmakar, N. C. (2001); "Handbook of gas testing"; Lovely Prakashan, Dhanbad, India.
5. Le Roux, W. L. (1972); Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.
6. McPherson, M. J. (1993); Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.
7. Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.
8. Ramlu, M. A. (1991); "Mine fires, Explosions, Rescue, Recovery and Inundations"; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.
10. Kejriwal, B.K," A Survey of Accidents, Their Causes &Prevention''.
11. Kaku L.C, "Fire in Coal Mine", Lovely Prakashan, Dhanbad, India.
12. Ghatak S., "Mine Ventilation" Vol. 1 & Vol. 2, Lovely Prakashan, Dhanbad, India.
13. Banerjee S.P., "Prevention combating Mine Fires", Lovely Prakashan, Dhanbad, India.

Mine Planning & Design Lab

The list of experiments

MN 721P	Mine Planning & Design Lab	0L:0T:3P	1 CREDITS

S. No.	Name of Experiment
1.	To determine the percentage of extraction and its variation in B & P mining as per regulation 99 of CMR 2017.
2.	To design the layout of semi mechanized B & P depillaring working with caving under given geo -mining condition including estimation of OMS.
3.	To design the layout of semi mechanized B & P depillaring working with hydraulic sand stowing under given geo -mining condition including estimation of OMS.
4.	To design systematic support for a depillaring panel under Caving & Hydraulic sand stowing.
5.	To design the layout of mechanized longwall working including gate roads and face elements under given geo - mining conditions and target production.
6.	Layout of Open stoping in thin and steep ore body following (a) Overhand sequence of extraction (b) Underhand sequence of extraction
7.	To design the layout for cut & fill stoping in thick and steep ore body.
8.	To design the layout of a mechanized opencast mine for specified unit operation under given geo-mining conditions.
9.	To draw the layout of tandem operation of dragline excavator.
10.	To design the shovel – dumper combination for a given targeted output.
11.	To draw the layout of in-pit crushing and conveying system.
12.	Manpower planning against given targeted production in an underground project including estimation of OMS & EMS.

Metallurgical Engineering

Metallurgical Engineering			
Code: MLC701	Foundry Technology	**L**	**T**
		3	**0**

Objectives of the course:

- To study the science and engineering of casting.
- To study the various processing techniques.
- Analyze the causes of various foundry related defects and their remedies.

Course Outcomes:

After completing this course the student have:

CO1	Knowledge of technical procedures of making castings
CO2	The ability to analyze defects, microstructure and phases in castings
CO3	The ability to perform computational analysis of castings

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	3	3	1	1	-	-	-	-	-	-	1	-

Detailed contents

Module 1: Pattern Making: Various pattern materials, allowances and types of patterns. (3 Hours)

Module 2: Molding and Core making: Principle ingredients of molding and core sand, their characteristics.Various types of binders and additives to molding, Sand Conditioning, Various sand control tests.Machine molding, high pressure molding, Sand molding processes based on Sodium Silicate, Organic Binders and other special molding processes.Shell molding and its full details. (12 Hours)

Module 3: Design of gating and risering of cast pertaining to iron and steel and non-ferrous casting. Different methods of casting such as die casting, centrifugal casting, rheo casting. (5 Hours)

Module 4: Various types of melting furnaces used in foundries such as Cupola, Electric Furnace, Induction Furnace. Melting of Cast Iron, Steel, Non-Ferrous Metals and Alloys. (8 Hours)

Module 5: Casting defects, their causes and remedies. Metallurgical inspection and quality control in foundries. (6 Hours)

Module 6: Consideration of environment, safety, energy optimization, and productivity associated with the above mentioned topics. Use of CAD CAM in foundries. (6 Hours)

Text / Reference Books:

1. Principles of Foundry Technology, P. Jain, McGraw Hill, 2017
2. Foundry Technology, Peter Beeley, 2nd Edition, Butterworth-Heinemann
3. Introduction to Foundry Technology, M. Lal, Khanna Publications
4. Foundry Technology, O. P. Khanna, DhanpatRai Publications
5. Materials and Processes in Manufacturing, E.P. DeGamo, Black and Kohser.

Metallurgical Engineering			
MLP702	Advances in Steel Making	**L**	**T**
		3	**0**

Course Objective:

To study and learn steel making process and also studied the advances on steel making.

Course outcomes:

1. Understand the Importance & Mechanisms of Reactions in Steel Making.
2. Explain secondary steel making Processes & its significance.
3. Identify the inclusion types & Methods of Preventions.
4. Understands the Merit & Demerits of Ingot Castings & Continuous castings

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	-
CO 3	3	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	3	1	1	-	-	-	-	-	-	-	-

5
.

Course Content:

Module 1: Secondary steel making process: Introduction, process, variation, stirring techniques, synthetic slag refining with stirring and perrin process. (7 Hours)

Module 2: Classification and propertied of alloy steel, raw materials for alloy steel making. Manufacturing of alloy steel like stainless steel, Hadfield steel and high speed steel. (7 Hours)

Module 3: Development in stainless steel making, Rust less process, Ajax process, Tendum furnace process, continuous steel making process,Spray steel making process, IRSID, SIP process, EOF process and dual hearth furnace process. (7 Hours)

Module 4: Decarburization Techniques: AOD and VOD process,CLU process and MRP process.Injection metallurgy: Plunging technique, power injection, Wire Feeding, their economic analysis. (7 Hours)

Module 5: Remelting Process: Vacuum Arc Remelting and Electro slag remelting process. Teeming methods: Direct pouring, Tundish teeming and bottom teeming. (7 Hours)

Module 6: Vacuum treatment of liquid steel: Principles, vacuum raising equipments, degassing process: ladle degassing and stream degassing, Present scenario in India and abroad. (7 Hours)

Text / Reference Books:

1. Iron Making and Steel Making: Theory and Practice, Author: Ahindra Ghosh, Amit Chatterjee, Publisher: PHI Learning Pvt. Ltd.
2. An Introduction to Steel Making, Author: Tupkary R.H. Publisher: Khanna Publishers

3. Steel Making Publisher: Kudrin V. Mir Publisher

Metallurgical Engineering			
MLP703	NON DESTRUCTIVE TESTING	**L**	**T**
		3	**0**

Course Objective:

To study the different nondestructive testing techniques of materials components and their specific applications.

Course Outcomes:

CO1	Understand the basics of materials joining, processes related to joining, welding defects and remedies
CO2	Understand welding metallurgy, and weldability characteristics.
CO3	Practice and analyze the various NDT techniques
CO4	Selection of NDT and understand their capabilities

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	3	3	1	1	-	-	-	-	-	-	1	-
CO 4	-	3	1	1	-	-	-	-	-	-	-	-

Course Content:

Module 1: Visual examination, Basic principles of liquid penetrant testing and Magnetic particle testing. (6 Hours)

Module 2: Radiography - basic principle, electromagnetic radiation sources, radiographic imaging, inspection techniques, applications, limitations and safety. (6 Hours)

Module 3: Eddy current testing - principle, application, limitation. (6 Hours)

Module 4: Ultrasonic testing - basic properties of sound beam, transducers, inspection methods, flaw characterization technique, immersion testing, advantage, limitations; acoustic emission testing. (6 Hours)

Module 5: Leak testing, Holography and Thermography - principles, procedures and applications, Comparison and selection of NDT methods; defects in casting, forging, rolling and others. (6 Hours)

Text / Reference Books:

1. Baldevraj, Jayakumar T., Thavasimuthu M., „Practical Non-Destructive Testing", Narosa Publishing, 1997

2. Suryanarayana, „Testing of Metallic Materials", Prentice Hall India, 1979

Metallurgical Engineering			
MLP704	LIGHT METAL ALLOYS	**L**	**T**
		3	**0**

Course Objectives:

Upon Successful completion of this course, each student should be able to:

- To understand various light metal alloys and their applications.
- To know principles of casting these alloys.
- To know various mechanical processing techniques.
- To understand failure analysis of these alloys.

Course Outcomes:

CO1	1. Understand the different light metal alloys and their specific applications.
CO2	2. To understand the melting ad casting characteristics of an alloys.
CO3	3. Understand the physical metallurgy of light metal alloys.
CO4	4. Understand the defects and failure analysis of light metal components

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	3	1	1	1	-	-	-	-	-	-	1	-

CO 4	-	2	1	1	-	-	-	-	-	-	-	-

Course Content:

Module 1: Classification of light metal alloys, their properties, importance of strength / wt. ratio in engineering applications. Detailed engineering applications, Indian / International specifications. (8 hours)

Module 2: Melting methodology of light metal alloys used of melting / refining flows.
Casting characteristics of light metal alloys (Ag, Mg, Te alloys). (8 hours)

Module 3: Light metal alloys foundry practices, master alloy used in melting.
Physical metallurgy of light metals alloys, rolling, sheet metal working, extrusion etc.
Special Alloys: Duralumin, Al-Li, Mg-Li alloys - production and processing techniques & applications. (8 hours)

Module 4: Titanium alloys: Alloying elements and their effects, types of alloys, their processing, heat treatment, properties and selection. (8 hours)

Module 5: Strategic applications of light metal alloys, air craft industries. Functional considerations. Defects analysis in cast and rolled products. Failure analysis of light metal alloys components. (8 hours)

Text / Reference Books:

1. Raudebaugh R.J.; Non-ferrous Physical Metallurgy; Pitmavi Publishing Corpn., 1952.
2. Polmear I.J.; Light Alloys (3rd Edition); Arnold, 1995.
3. Bickert C.M.; Light Metals; Minerals Metals & Materials Society, 1990.
4. Brooks C.R.; Heat Treatment Processing & Structure Properties of Non Ferrous Alloys; ASM, 1984.

Metallurgical Engineering			
MLP705	SPECIAL STEELS AND CAST IRONS	**L**	**T**
		3	**0**

Course objective:

To know different types of steel and Cast-iron.

Course Outcome:

CO1	Represent the problems in developing high strength steels
CO2	Understand the basic concepts of special steels with regard to their manufacturing, processing, heat treatments and micro-structural evaluation.
CO3	Classify dual phase steels, TRIP steels, maraging steels and stainless steels
CO4	Understand the principles of micro-alloying and thermo-mechanical processing
CO5	Analyze the problems associated with heat treatment of tool steels and ultrafine grained steels.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	2	2	1	-	-	-	-	-	-	-	-
CO 3	3	1	1	1	-	-	-	-	-	-	1	-
CO 4	-	3	1	1	-	-	-	-	-	-	-	-

Course Content:

Module1: Definition of high strength steels, problems in developing high strength steels; discussion on fracture toughness; HSLA steels, principle of microalloying and thermomechanical processing; importance of fine grained steels. (8 Hours)

Module 2: Phase diagrams, composition, properties and applications of ferritic, austenitic, martensitic, duplex and precipitation hardenable stainless steels. (8 Hours)

Module 3: Dual phase steels, TRIP steels, maraging steels, metallurgical advantages, heat treatment, properties and applications. (8 Hours)

Module 4: Tool steels; classification, composition, and application, constitution diagram of high speed steels, special problems in heat treatment of tool steels. (8 Hours)

Module 5: Types of cast irons - grey, SG, white, malleable; austempered ductile iron; alloy cast irons, Ni hard, high silicon cast irons, heat resistant cast irons- high chrome cast iron- structure, property and engineering applications. (8 Hours)

Text / Reference Books:

1. *Leslie W. C., „The Physical Metallurgy of Steels", McGraw Hill, 1982*

2. Pickering P. B., „Physical Metallurgy and the Design of Steels", Applied Science Publishers, 1983

Metallurgical Engineering			
MLP706	Non Metallic Materials	**L**	**T**
		3	**0**

Objectives of the course

- To introduce the student to the range of non-metallic materials available for engineering.
- To get an exposure to the techniques associated with the synthesis, processing andcharacterization of these materials and to make them aware of the applications wherethese materials are preferred.

Course Outcomes

After completing this course the student can:

CO1	List the prominent non-metallic materials available for engineering applications
CO2	Indicate the uses for which these materials are preferred
CO3	Indicate the structure property relations in these materials
CO4	Indicate the synthesis and processing steps associated with these materials

Detailed contents

Synthesis, processing, structure, properties, characterization, applications, failure modes and deterioration mechanisms of the following will be studied

Module 1: Polymers (10 Hours)
Module 2: Ceramics (10 Hours)
Module 3: Glasses (2 Hours)
Module 4: Composites (12 Hours)
Module 5: Textiles (2 Hours)
Module 6: Adhesives (2 Hours)
Module 7: Foams (2 Hours)

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	2	1	1	-	-	1	-	-	-	-	-

Text / Reference Books:

1. Textbook of Polymer Science; Fred W. Billmeyer, Wiley 2007
2. Introduction to Ceramics; Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012

Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Metallurgical Engineering			
MLP707	Principles of Management	**L**	**T**
		3	**0**

Objectives:

To understand the principles of management and their application to the functioning of an organization.

Course Outcomes:

CO1	Understand the meaning of management and science
CO2	Nature and purpose of Planning, types of Planning
CO3	Upon completion of this course, the students will get a clear understanding of management functions in an organization

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	1	1	-	-	1	-	-	-	-	-

Contents:

Module 1: Definition of management, science or art, manager vs entrepreneur; Types of managers-managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management. (8 hours)

Module 2: Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes. (8 hours)

Module 3: Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management. (8 hours)

Module 4: Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication. (8 hours)

Module 5: Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting. (8 hours)

Text / Reference Books:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999.

Metallurgical Engineering			
MLP708	ALLOY STEELS & HIGH TEMPERATURE ALLOYS	**L**	**T**
		3	**0**

Course Objectives:

- To make the candidate understand effect of various alloying elements in steel
- To make the candidate understand various kind of specifications and heat treatments of different alloy steels

Course outcomes:

CO1	Understand the different types of steels and effects of their alloying components.
CO2	Studied the structural steels and their applications
CO3	Applications of different heat treatments and their effects in their microstructure.
CO4	Studied of light metal alloys applications.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Module 1: Classification of Alloy Steels depending on alloying content, effect of alloying elements on the constitution, structure and properties of steels, ferrite former and carbide former, alloy cast irons.

Module 2: Studies of low alloy structural steels, High strength low alloy steels, Dual phase steels, General Engineering Steels, Medium alloy and high alloy tool steels such as HCHC, HSS etc.
Module 3: Corrosion resistant stainless steels, processing and heat treatment of Hadfield's Mn Steel, spring steel, electrical sheet steels, steels for magnetic application, Maraging steel, Ausformed steel and TRIP Steels.
Module 4: Heat treatment equipment's, techniques employed for low, medium and high alloy steels with special emphasis on high speed tool steel, stainless steel, spring steels, alloy cast iron, Various specification viz. AISI, BSS, DIN & IS for alloy steels and alloy cast iron.
Module 5: Heat resistant alloys - general properties, metallurgical structure, processing, applications and limitations, super base alloys- Ni-base alloys, Co-base alloys, Fe-base alloys, Ni-Fe base alloys. Titanium alloys for high temperature aeronautical applications, their processing, properties, and selection.

Text / Reference Books:

1. Roberts G.A.; Tools Steels; American Society of Metals, 1980.
2. Clark, Varney W.R.; Metallurgy for Engineers; East West Press, 1962.
3. Peter Payson; The Metallurgy of Tools Steels; John Wiley & Sons, 1962.
4. ASM Handbook –Vol.1 (10th Edition); ASM International, 1995.

Metallurgical Engineering			
MLP709	High Temperature Materials	**L**	**T**
		3	**0**

Course Objective:

To study the high temperature materials and their mechanical properties.

Course Outcomes:

CO1	Select materials for various temperature ranges
CO2	Develop materials for high temperature applications
CO3	Interpret the influence of creep, thermal fatigue, oxidation, high temperature corrosion, erosion and ageing on materials
CO4	Analyze life of creep resistant steels, superalloys, ceramics and polymers at elevated temperature
CO5	List the usage of high strength steels and spring steels

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-
CO 5	1	-	1	2	-	-	1	-	1	-	-	1

Detailed syllabus

Module 1: Introduction and Elevated temperature characteristics of engineering materials. Corrosion at elevated temperatures. High temperature creep, thermal and thermomechanical fatigue of structural alloys. Elevated temperature crack growth and creep-fatigue interaction. (8 hours)

Module 2: Elevated temperature mechanical characteristics of carbon alloy steels and Stainless steels. Elevated temperature corrosion properties of carbon alloy steels and Stainless steels. Elevated temperature mechanical and corrosion properties of high alloy cast steels. (5 hours)

Module 3: Super-alloys: their processing, high temperature mechanical properties, corrosion behavior, microstructural degradation behavior of super alloys. Titanium and titanium alloys. Nickel alloys. Refractory metals, alloys and Structural inter-metallic. Ceramics for applications in refractory technology. (13 hours)

Module 4: Oxidation resistant coatings. Thermal barrier coatings. High temperature polymers. Carbon - carbon composites. Ceramic Matrix composites for refractory applications. Thermal barriers in space vehicles and satellites. (11 hours)

Module 5: Materials for in extreme environments: Case studies for applications in industry, defense and nuclear applications. (5 hours)

Text / Reference Books:

1. Evans, R.W and Wilshire, B. Creep of Metals and Alloys. Institute of Metals, 1985, London.
2. J. R. Davis, ASM Specialty Hand Book: Heat – Resistant Materials, ASM, 1997.

Metallurgical Engineering			
MLP710	Computer Applications in Materials and Engineering	**L**	**T**
		3	**0**

Objectives of the course

This course introduces computational methods in the domain of metallurgical and materials engineering. At the end of the course the student should be able to

Course Outcomes:

CO1	Analyze a metallurgical problem to create a well posed numerical problem
CO2	Identify initial and boundary conditions of a problem relevant to materials domain
CO3	Propose a solution procedure for a numerical problem in the domain of materials engineering
CO4	Demonstrate ability to quantify a materials engineering problem through numerical analysis

Detailed syllabus:

Module 1: Computer Basics and programming, Techniques in Computer simulation. (10hours)
Module 2: Finite Element Analysis, Monte-Carlo Methods, Mathematical Modelling of Physical Concepts. Atomic level design of materials based on the first-principles simulation techniques. (10hours)
Module 3:CALPHAD, Microstructure Modelling, Process Modelling. (10hours)
Module 4: Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories. (10hours)

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Text / Reference Books:

1. R J Arsenault, J R Beeler Jr, D M Easterling (Eds): Computer Simulation in Materials Science, ASM International, 1986.

2. K. Ohno, K. Esfarjani, and Y. Kawazoe : Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.

3. Wolfram Hergert, Arthur Ernst, Markus Dane: Computational Materials Science – From Basic Principles to Materials Properties, Springer, 2004.

Mapping of course outcomes with program outcomes

Metallurgical Engineering			
MLP711	PHYSICAL CHEMISTRY OF IRON AND STEEL MAKING	**L**	**T**
		3	**0**

Course Objective:

1. To import the knowledge of reactions taking place during iron and steel making
2. To develop the skill of analysis of the reasons of not producing quality steel
3. To make inclusion free quality steel products

Course Outcomes

At the end of this course, the students would be able to:

CO1	Understand the quality production of Iron and steel.
CO2	Make clean steel products through conventional and continuous casting.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	1	2	-	-	1	-	-	-	-	-

Course Content:

Module 1: Liquid properties : Surface Tension, Viscosities of liquid metals, Diffusion in metals and alloys, Physico-chemical properties of molten gasses, slag and matte, surface tension and transport properties. (8 hours)

Module 2: Reaction in iron making, kinetics of reduction of ores, pellets and sinter. Slag-Metal reaction of S-Si in Blast furnace. (8 hours)

Module 3: Reaction in Steel Making: Slag –metal reaction in Hearth process. Gas/Slag/Metal

Reactions in Pneumatic and Oxygen steel making process. (8 hours)

Module 4: Discussions of Phosphorous and Carbon reactions and their interdependence. (8 hours)

Module 5: Deoxidation Theory and Practice: Ladle treatment of steel like gas purging, vacuum treatment and Ladle furnace. Reaction during solidification of steel in Moulds and /or during continuous casting. (8 hours)

Text / Reference Books:

1.An Introduction to the Physical Chemistry of Iron & Steel Making

Book by Robert George Ward.

2.Physical chemistry of iron and steel manufacture by Bodsworth C.

Metallurgical Engineering			
MLO712	Composite Materials	**L**	**T**
		3	**0**

Objectives of the course

- To obtain knowledge on classification, processing, characterization and applicationsof composite materials.
- To obtain knowledge on mechanical properties and failure mechanisms of compositesunder loading conditions for engineering applications

Course Outcomes:

After completing this course, students will have:

CO1	Knowledge on classification, processing, characterization and applications of various composite materials
CO2	Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	1	2	1	1	-	-	-	-	-	-	1	-
CO 2	-	1	1	2	-	-	1	-	-	-	-	-

Detailed contents

Module 1: Introduction: Definition, history, characteristics, classifications, advantages and limitations, industrial scenario and applications. (2 hours)

Module 2: Material and microstructural parameters of composites. Unidirectional-fibre composites: Fibre characteristics. Longitudinal strength and modulus of composites, minimum and critical fibre volume fractions, factors affecting strength. Transverse strength and modulus. (8 hours)

Module 3: Failure modes. Single and multiple fractures. Short-fibre composites: Stress transfer, critical fibre length. Modulus and strength. Whiskers and whisker reinforced composites. (6 hours)
Module 4: Particulate composites: Large-particle composites and dispersion-strengthened composites. Cermets. Zirconia toughened ceramics. Interface: Interface characteristics and their effects on adhesive, frictional and mechanical bonding mechanisms. Coupling agents and their role on the properties composites. Interface coatings. (10 hours)
Module 5: Properties of composites: Static mechanical properties, fatigue, impact and creep properties, fracture behaviour and damage tolerance. (10 hours)
Module 6: Advanced composites: Nano composites, hybrid composites, sandwich composites, in-situ composites, smart composites, self-healing composites, and carbon-carbon composites (4 hours).

Text / Reference Books:

1. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Metallurgical Engineering			
MLO713	ADVANCED ENGINEERING MATERIALS	**L**	**T**
		3	**0**

Course Objective:

To study the metallurgy and properties of advanced engineering materials. To learn the advanced material processing to their specific applications.

Course outcomes:

CO1	Study the several advanced engineering materials
CO2	Understand the microstructure and metallurgy of advanced engineering materials.
CO3	To study the processing of advanced engineering materials.
CO4	Learn different processing techniques

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Course Content:

Module 1: Electronic Polymers, Organic electronics, Melanin, Organic semiconductor, Printed electronics, Organic LED. Nanostructures, Nanomaterials, Nanocomposites. (7 hours)

Module 2: Biomaterials: Metallic biomaterials like 316L stainless steel, Co-Cr Alloys, Titanium Ti6Al4V, Ceramic biomaterials like Alumina, Zirconia, Carbon Hydroxyapatite, Polymeric biomaterials like Ultra high molecular weight polyethylene, Polyurethane. (7 hours)

Module 3: Smart Materials: Piezoelectric materials, Shape memory alloys and shape memory polymers. High Performance Alloys, Nickel super alloys, Ti alloys, Al-Li alloys, Hastelloy, Inconel, Monel, Nitronic, Cobalt based alloys and commercially available pure nickel alloys. (7 hours)

Module 4: Functional and Engineering Ceramics: diverse applications as cutting tools, mobile phone microwave devices, polycrystalline diamond and fuel cells. (7 hours)

Module 5: Hybrid Materials: Design, Synthesis and Properties of hybrid materials created by blending disparate materials such as plastics with metals. (7 hours)

Module 6: Processing of Advanced Materials, Superplastic, spray forming, rapid solidification. Materials selection and design. (7 hours)

Text / Reference Books:

1. Overview Leonard V. Interrante, Mark J. Hampden-Smith Wiley, *Chemistry of Advanced Materials*, An -VCH; 1st edition (1997)
ISBN-10: 0471185906 ISBN-13: 978-0471185901.

2. R E Smallman, A. H. W. Ngan, Butterworth-Heinemann, *Physical Metallurgy and Advanced Materials*, Seventh Edition, 2007,
ISBN: 0750669063. Supplementary
Reading:

1. M. Meyers, M Sarikaya, R. Ritchie, Elsevier, *Nano and Microstructural Design of Advanced Materials 2003*, ISBN-13: 978-0-08-
044373-7, ISBN-10: 0-08-044373-7.

Metallurgical Engineering			
MLO714	**EMERGING MATERIALS**	**L**	**T**
		3	**0**

Course objective:

To define new engineering materials and apply for multi-functional areas.

Course outcomes:

Upon completion of the course, the student will be able to:

CO1	Describe various processing techniques of different engineering materials.
CO2	Analyse the Phase diagram and Microstructure using Microscope for different type of Stainless steel materials.
CO3	Select the material for Biological, Nuclear, Space and Cryogenic service applications.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	1
CO 3	-	1	1	2	-	-	1	-	-	-	-	-

Course content:

Module 1: Techniques of rapid solidification. Production of metallic glasses, atomic arrangement, comparison with crystalline alloys - mechanical, electrical, magnetic, superconducting and chemical properties and applications. (10 hours)

Module 2: Phase diagrams of ferritic, martensitic and austenitic stainless steels, duplex stainless steels, precipitation hardenable stainless steels, mechanical and metallurgical properties of stainless steels, HSLA steels, micro-alloyed steels Aluminium alloys, magnesium alloys and titanium alloys; metallurgical aspects, mechanical properties and applications. (10 hours)

Module 3: Development of super alloys-iron base, nickel base and cobalt base - properties and their applications; materials for cryogenic service, materials in nuclear field, materials used in space. (10 hours)

Module 4: Carbonaceous materials - including nano tubes and fullerenes; shape memory alloys, functionally gradient materials, high temperature super conductors - bio materials. (10 hours)

Text / Reference Books:

1. Sukh Dev Sehgal, Lindberg R.A., „Materials, their Nature, Properties and Fabrication‟, S Chand, 1973

2. Polmear I. J. „Light alloys: Metallurgy of Light Metals‟, 3rd Edition, Arnold, 1995

Metallurgical Engineering			
MLO715	Nano materials	**L**	**T**
		3	**0**

Objectives of the course

To recognize the differences between nano-materials and conventional materials and to become familiar with a wide range of nano-materials, their synthesis, characterization, properties and applications.

Course Outcomes:

After completing this course, the student should be able to:

CO1	Indicate the differences between nano-materials and conventional materials
CO2	Indicate how specific synthesis techniques can result in nano-materials
CO3	Give examples of specific nano-materials and explain the scientific reasons for the properties displayed by them
CO4	Describe how specific characterization techniques can be used to analyze nano-materials

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	2	-	-	-	-	-	-	1	-
CO 4	-	2	1	2	-	-	1	-	-	-	-	-

Detailed contents

Module 1: History of nanomaterials (2 Hours)
Module 2: Discussion of the Feynman talk “There is plenty of room at the bottom” (4 Hours)
Module 3: Synthesis routes for nano and ultra-fine grained materials: bottom up and top down approaches (2 Hours)
Module 4: Specific synthesis routes such as vapor deposition, sol-gel, rapid solidification

processing, high energy ball milling, cryo rolling, and equal channel angular extrusion (6 Hours)
Module 5: Thermodynamics of nanomaterials (3 hours)
Module 6: Mechanical property aspects of nano-materials, inverse Hall-Petch relationship (2 Hours)
Module 7: Specific nano materials and their applications such as:
Carbon nano-structures (Nano-tubes, nano-horns, graphene, buckyballs etc.) (6 Hours)
Semiconducting nano-materials – Quantum confinement, Quantum wells, quantum wires and quantum dots. (3 Hours)
Magnetic nanomaterials – super paramagnetism (2 hours),
Ferroelectric, nano ceramics (2 Hours)
Super-plasticity (2 Hours)
Nano-composites (2 Hours)
Module 8: Characterization techniques from the perspective of nanomaterials (4 Hours).

Text / Reference Books:

Introduction to Nanomaterials, Charles Poole and Frank Owens, Wiley 2007.

Metallurgical Engineering			
MLO716	NANOSTRUCTURED MATERIALS	**L**	**T**
		3	**0**

Course Objective:

To develop an understanding of the basic knowledge of Metallurgical and Materials Engineering and gain knowledge on overview of developments in the field of materials over periods; to become familiar with the metals and materials industry

Course Outcomes:

CO1	Define engineering materials technology and understand each stage of the materials cycle, material selection criteria
CO2	Understand the impact of Metallurgical and Materials Engineering solutions in a global, economic, environmental, and societal context
CO3	Become familiar with the science behind the development of metals and materials
CO4	Become familiar with current trends / developments and the prevailing industrial scenario in metals and materials

1.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	-	-	1	-	1	-
CO 4	-	2	1	2	-	-	1	-	-	-	-	-

Course Content

Module 1: Introduction: Types of nanomaterials, Emergence and challenges in nanotechnology. (4 Hours)

Module 2: Synthesis routes for nanomaterials: Bottom-up and top-down approaches, Solid, Liquid, Gas phase synthesis, Hybrid Phase synthesis. (9 Hours)

Module 3: Synthesis of bulk Nanostructured materials: Approaches and challenges. Properties of nanomaterials: Stability of nanomaterials, Mechanical properties, Optical, Electrical and Magnetic properties, nano-diffusion. (8 Hours)

Module 4: Characterization of nanomaterial: Structural characterization by XRD, SEM, TEM, SPM, Chemical characterization by spectroscopy techniques, characterization of mechanical properties by Nano indentation, hot compression testing, Fracture analysis. (10 Hours)

Module 5: Application of nanomaterials: Electronics and optoelectronics applications, Nanobots, Biological applications, Catalytic applications, Quantum devices, Application of carbon nanotubes, Nanofluids. Future of Nanotechnology. (11 Hours)

Text / Reference Books:

1. Yuri Gagotsi (Ed.), Taylor and Francis, *Nanomaterails Handbook*, 2006.
2. G. Cao, *Nanostructures and Nanomaterials*, Imperial College Press, 2006.

Supplementary Reading:

1. R. D. Booker and E. Boyden, *Nanotechnology for Dummies*, Dummies Publishing, 2005.
2. C. Deere and M. Llano, *Nanostructures,* Springer, 2004.
3. C. P Poole and F. T. Owe, *Introduction to Nanotechnology*, Willey Press, 2003.

Foundry Laboratory

List of experiment

1. Effect of Moisture content on strength, hardness, permeability of molding sand.
2. Effect of Charcoal on strength, molding sand.
3. Study of the effect of clay content on the permeability green compressive strength on molding sand.
4. To study the effect of milling time as various properties of molding sand
5. Molding practice e in the foundry;

    5.1 Molding practice.

    5.2 Inspection of moulding and core.

CSE / IT

Computer Science & Engineering and Information Technology					
Code: CSC701	**Artificial Intelligence**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOME

CO.1: Discuss basic concepts of Artificial Intelligence, AI(Artificial Intelligence) principles, AI Task domains and application.
CO.2: Explain various searching techniques, constraint satisfaction problem, game playing techniques and **Apply** these techniques in applications which involve perception, reasoning and learning.
CO.3: Explain various searching techniques, constraint satisfaction problem, game playing techniques and **Apply** these techniques in applications which involve perception, reasoning and learning.
CO.4: Explain working of uncertainty management, decision making and learning methods.
CO.5: Apply different knowledge representation, reasoning, and learning techniques to real-world problems.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO.1	3	-	-	-	-	-	-	-	-	-	-	3
CO.2	3	2	2	2	-	-	-	-	-	-	-	-
CO.3	3	2	2	2	-	-	-	-	-	-	-	-
CO.4	3	-	-	-	-	-	-	-	-	-	-	2
CO.5	-	2	2	2	-	-	-	-	-	-	-	-

**3: high, 2: moderate, 1 low*

MODULE 1:

Introduction

Overview of AI, Problems of AI, AI techniques, Problem Solving, Problem Space and Search, Defining the problem as state space search, Problem characteristics; Tic,Tac,Toe Problem

AI languages

Basic knowledge of AI programming languages like Prolog and Lisp .

MODULE 2:

Basic Search Techniques

Solving Problems by searching; Uniform search strategies; Breadth first search, depth first search, depth limited search, bidirectional search, Best First search, comparing search strategies in terms of complexity.

MODULE 3:

Special Search Techniques
Heuristic Search, greedy best,first search, A* search; Hill climbing search, Simulated Annealing search; Genetic Algorithm; Constraint Satisfaction Problems; Adversarial search, Games, Optimal decisions and strategies in games, Minimax search, Alpha,beta pruning.
Symbolic Logic
Syntax and semantics for propositional logic, Syntax and semantics of FOPL, Properties of WFF, Clausal form, Unification, Resolution.

MODULE 4:

Reasoning Under Inconsistencies and Uncertainties :
Non,monotonic reasoning, Truth Maintainace System, Default Reasoning & closed world assumption, Predicate completion and circumscription, Fuzzy Logic.
Probabilistic Reasoning
Bayesian probabilistic inference, Representation of knowledge in uncertain domain, Semantics of Bayesian networks, Dempster, Shafer theory.

MODULE 5:

Structured Knowledge
Associative networks, Conceptual graphs, Frames structures.
Expert Systems
Rule based systems, Non production systems : decision tree architectures, black board system architecture, neural network architecture.
Learning
Types of learning, general learning model, Learning by induction; generalization, specialization, example of inductive learner.
Text book:

1. Elaine Rich, Kevin Knight and Shivashankar B Nair, “Artificial Intelligence”, Mc Graw Hill Publication, 2009.
2. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert System”, Pearson Publication,2015.

References:

1. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning, 2011.

Computer Science & Engineering and Information Technology					
CSP702	**Machine Learning**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcome: At the completion of the course a student will be able to –

1. Discuss fundamental of machine learning, design and its application.
2. Differentiate various learning approaches, and to interpret the concepts of different learning.
3. Illustrate and apply clustering algorithms and identify its applicability in real life problems.
4. Discuss basics of neural network and its different model.
5. Describe different optimizations algorithm.

CO-PO Mapping-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**3**	**1**	**2**							
CO2	**3**	**2**	**3**	**1**					**1**			**2**
CO3	**3**	**3**	**2**	**2**	**1**							
CO4	**3**	**2**	**2**		**2**							
CO5	**2**	**2**	**3**	**1**	**2**							

MODULE 1: What is Machine learning, Basic principal, Utility of ML Well defined learning system, Designing learning system, Challenges in ML, Application of ML.

MODULE 2: Linear Regression (with one variable and multiple variables), Gradient Descent, Classification (Logistic Regression, Over fitting, Regularization, Support Vector Machines), Decision Trees and issue in decision tree, Bayesian Learning – Bayes Theorem, Concept Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, EM Algorithm.

MODULE 3:

Clustering (K-means, Hierarchical, etc.), Dimensionality reduction, Principal Component Analysis, Anomaly detection, Feasibility of learning, Reinforcement learning.

MODULE 4:

Artificial Neural Networks, Artificial Perceptron's, Gradient Descent and The Delta Rule, Adaline, Multilayer Networks, Back-propagation Rule back-propagation Algorithm-Convergence.

MODULE 5:

Evolutionary algorithm, Genetic Algorithms – An Illustrative Example, Hypothesis Space Search, Genetic Programming, Swarm intelligence algorithm.

Text Book:

1. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press.

2. Tom Mitchell. Machine Learning (McGraw Hill)

3. Artificial Neural Network, B. Yegnanarayana, PHI, 2005

Reference Book:

1. Christopher M. Bishop. Pattern Recognition and Machine Learning (Springer)

Computer Science & Engineering and Information Technology					
CSP703	**MULTIMEDIA SYSTEMS AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcome:

After Completion of this course, the students will be able to:

1. Developed understanding of technical aspect of Multimedia Systems.
2. Understand various file formats for audio, video and text media.
3. Develop various Multimedia Systems applicable in real time.
4. Design interactive multimedia software.
5. Apply various networking protocols for multimedia applications.
6. To evaluate multimedia application for its optimum performance.

Syllabus:

MODULE 1:

Introduction to Multimedia System: Architecture and components, Multimedia distributed processing model, Synchronization, Orchestration and Quality of Service (QOS) architecture.

MODULE 2:

Audio and Speech: Data acquisition, Sampling and Quantization, Human Speech production mechanism, Digital model of speech production, Analysis and synthesis, Psycho-acoustics, low bit rate speech compression, MPEG audio compression.

MODULE 3:

Images and Video: Image acquisition and representation, Composite video signal NTSC, PAL and SECAM video standards, Bilevel image compression standards: ITU (formerly CCITT) Group III and IV standards, JPEG image compression standards, MPEG video compression standards.

MODULE 4:

Multimedia Communication: Fundamentals of data communication and networking, Bandwidth requirements of different media, Real time constraints: Audio latency, Video data rate, multimedia over LAN and WAN, Multimedia conferencing.

MODULE 5:

Multimedia Information Systems: Operating system support for continuous media applications: limitations is usual OS, New OS support, Media stream protocol, file system support for continuous media, data models for multimedia and hypermedia information, content based retrieval of unstructured data.

Text / Reference Books

1. Ralf Steinmetz and Klara Nahrstedt, Multimedia Systems, Springer.
2. J. D. Gibson, Multimedia Communications: Directions and Innovations, Springer.
3. K. Sayood, Introduction to Data Compression, Morgan-Kaufmann.
4. A. Puri and T. Chen, Multimedia Systems, Standards, and Networks, Marcel Dekker.
5. Iain E.G. Richardson, H.264 and MPEG-4 Video Compression, John Wiley.
6. Borivoje Furht, Handbook of Multimedia Computing, CRC Press.

Computer Science & Engineering and Information Technology					
ITP705	**Data Mining and Data Warehousing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes

1. Establish the relation between data warehousing and data mining.
2. Able to comprehend multi-dimensional structure of data model.
3. Able to identify the need for analysis of large, complex, information-rich data sets.
4. Identify the goals and primary tasks of the data mining process.
5. Recognize the iterative character of a data process and specify its basic steps.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	1	2	3	2	-	-	-	-	-	1	-	-
CO 2												
CO3	3	3	1	-	3	3	3	2	3	-	-	2
CO4	2	3	2	-	-	-	-	-	-	-	-	1
CO5	1	2	3	-	-	-	-	-	-	-	-	-

Syllabus

MODULE 1:

Introduction :

Data warehousing-definitions and characteristics, Multi-dimensional data model, Warehouse schema.

Data Marts : Data marts, types of data marts, loading a data mart, metadata, data model. Maintenance, nature of data, software components; external data, reference data, performance issues, monitoring requirements and security in a data mart.

MODULE 2:

Online Analytical Processing: OLTP and OLAP systems, Data Modeling, LAP tools, State of the market, Arbor Essbase web, Microstrategy DSS web, Brio Technology, star schema for multi dimensional view, snowflake schema, OLAP tools.

MODULE 3:

Developing a Data Warehousing : Building of a Data Warehousing, Architectural strategies & organizational issues, design considerations, data content, distribution of data, Tools for Data Warehousing.

MODULE 4:

Data Mining : Definitions; KDD (Knowledge Discovery database) versus Data Mining; DBMS versus Data Mining, Data Mining Techniques; Issues and challenges; Applications of Data Warehousing & Data mining in Government.

Association Rules: Apriori algorithms. Partition algorithm, Dynamic itemset counting algorithm, FP- tree growth algorithm, Generalized association rule.

MODULE 5:

Clustering Techniques :Clustering paradigm, Partition algorithms, CLARA, CLARANS, Hierarchical clustering, DBSCAN, BIRCH, CURE; Categorical Clustering, STIRR, ROCK, CACTUS.

Decision Trees : Tree construction principle, Best split, Splitting indices, Splitting criteria, Decision tree construction with presorting.

MODULE 6:

Web Mining: Web content Mining; Web structure Mining; Web usage Mining; Text mining.

MODULE 7:

Temporal and Spatial Data Mining: Basic concepts of temporal data mining, The GSP algorithm, SPADE, SPIRIT, WUM.

Books

1. Data Warehousing, Reema Thareja
2. Data mining - Concepts & Techniques, Jiawei Han, Micheline Kamber, Morgan Kaufmann ,2nd Ed.2006.
3. Oracle 8i Data Warehousing, Michale Corey, Michale Abbey, Tata McGraw Hill
4. Fundamentals of Database Systems, Navathe and Elmasry, Addison Wesley, 2000
5. Data Mining, Arun Pujari Orient Longman, 2003

Computer Science & Engineering and Information Technology					
ITP706	**INFORMATION SECURITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes: At the end of the course the student will be able to:

CO1	Recognize propensity of errors and remedies in processes involving information technology
CO2	Consummate knowledge of risk and controls in IT operation in industry
CO3	Determine IT security guidelines for various type of industries
CO4	Evaluate asset safeguarding, data integrity, system effectiveness and system effici ency.
CO5	Understand software security auditing including database security audit, network security audit and micro-computer security audit.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1		2		3		1		2	
CO2		2		3		1		2	
CO3		2		3		1		2	
CO4		2		3		1		2	
CO5		2		3		1		2	

Detailed syllabus:

Module1

Computer Auditing- System Access control, Data Access Control, Security Administration, System Design.

Module 2

Hardware Security Controls - The Total System Needs Securing, Levels of Hardware Controls, Operating System Controls , Access Controls, General-Purpose Operating Systems Security , Sources of Additional Information

Module 3

Software Controls - Software Security and Controls, Types of Software Intrusions, Configuration Management , Modularity and Encapsulation, Protecting Information, Selecting Security Software, Analysis of Software Products Database Security - Introduction to Databases, Security Requirements of Databases, Designing Database Security.

Module 4:

Methods of Protection, Security of Multilevel Databases,The Future of Databases. Network and Telecommunication Security - Telecommunications and Networks, Security Considerations, Cases in Point, Special Communications, Security Considerations.

Module 5:

Microcomputer Security - Microcomputer Problems and Solutions , The Microcomputer Environment , Security of Microcomputers, Internal Data Security, The Threats to Micros, Developing a Micro Security Plan, Establishing a Micro-to-Mainframe Link , Portable Microcomputer Security , Password Protection, Security of Special Micro Applications.

Reading:

1. Deborah Russell, *Computer Security Basics*, O'Reilly & Associate, 1991.
2. Karen A. Forcht, *Computer Security Management*, Boyd & Fraser Publishing Co., 1994.
3. Donald A. Watne, Peter B.B. Turney, *Auditing EDP Systems*, 2nd Edition, PH 1990

Computer Science & Engineering and Information Technology			
Code: CSP707	**Computer Vision**	**L**	**T**
		3	**0**

Objectives:

Computer Vision focuses on development of algorithms and techniques to analyze and interpret the visible world around us. This requires understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis visual geometric modeling, stochastic optimization etc. Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision. Applications range from biometrics, medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

Course Outcomes

After completion of the course students will be able

COs	Course outcome description
CO1	To apply mathematical modeling methods for low-, intermediate- and high-level image processing tasks.
CO2	To design new algorithms to solve recent state of the art computer vision problems.
CO3	To perform software experiments on computer vision problems and compare their performance with the state of the art.
CO4	To develop a broad knowledge base so as to easily relate to the existing literature.
CO5	To gather a basic understanding about the geometric relationships between 2D images and the 3D world.
CO6	To build a complete system to solve a computer vision problem.

Detail Syllabus:

MODULE-I

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc.; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

MODULE-II

Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

MODULE-III

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

MODULE-IV

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

MODULE-V

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

MODULE-VI

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Textbook

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, March 2004.

Reference book

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

Computer Science & Engineering and Information Technology					
CSO709	**Values and Ethics in Profession**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

CO1 Identify the effects of technological growth on the society and the limited natural resources.

CO2 Identify the essence of sustainable development, and will be able to apply approaches to handle energy crisis and environment protection.

CO3 Analyze the impact of technology transfer and the problems of man machine interaction for the human operators in engineering projects and industries.

CO4 Apply industrial standards, code of ethics and role of professional ethics in engineering field.

CO5 Assess the possible values crisis at different levels and the way out with the help of the constitution and moral, and ethical values.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
IT6105.1	-	-	2	-	-	2	3	-	-	-	-	-
IT6105.2	-	-	3	-	-	-	3	-	-	-	-	-
IT6105.3	-	-	1	-	2	-	2	2	-	-	-	-
IT6105.4	-	-	3	-	2	3	-	3	-	-	-	-
IT6105.5	-	-	1	-	2	3	-	3	-	-	-	-
Average			2		1.2	1.6	1.6	1.6				

#3 highly, #2 moderate and #1 low

Module-1

Science, Technology and Engineering as Knowledge and as Social and Professional Activities, Effects of Technological Growth: Rapid Technological growth and depletion of resources. Reports of the Club of Rome. Limits of growth; sustainable development, Energy Crisis; Renewable Energy Resources.

Module-2

Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations. Environmental Ethics, Appropriate Technology Movement of Schumacher: later developments

Module-3

Technology and developing nations. Problems of Technology transfer. Technology assessment, impact analysis. Human Operator in Engineering projects and industries. Problems of man machine interaction. Impact of assembly line and automation. Human centered Technology.

Module-4

Ethics of Profession

Engineering profession: Ethical issues in engineering practice. Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond. Case studies.

Module-5

Profession and Human Values

Value Crisis in contemporary society, Nature of values: Value Spectrum of a ‘good’ life, Psychological values: Integrated personality; mental health, Societal values: The modern search for a ‘good’ society, justice, democracy, secularism, rule of law; values in Indian Constitution, Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity - Moral and ethical values: Nature of moral judgments; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

Suggested Text Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Edition)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Suggested Reference Books:

1. Mike Martin and Ronald Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York, 2005.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, “Engineering Ethics Concepts and Cases”, Thompson Learning, 2000.
3. Govindarajan M, Natarajan S., Senthil Kumar V. S., “Engineering Ethics”, Prentice Hall of India, New Delhi 2004.
4. Charles D Fledderman, Engineering Ethics”, Prentice Hall, New Mexico, 1999.
5. Edmund G Seebauer and Robert L Barry, Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
6. David Ermann and Michele S Shauf, “Computers, Ethics and Society”, Oxford University Press, 2003.

Computer Science & Engineering and Information Technology					
ITO708	Software Engineering	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

- Ability to identify the minimum requirements for the development of application.
- Ability to develop, maintain, efficient, reliable and cost effective software solutions
- Ability to critically thinking and evaluate assumptions and arguments**.**

MODULE- I: Introduction to Software Engineering:The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI).

MODULE 2: Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, Specialized process models, The Unified process.

MODULE 3: Software Requirements:Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis.

MODULE 4
Requirements validation, Requirements management. System models: Context Models, Behavioral models, Data models, Object models, structured methods.

MODULE 5: Design Engineering:Design process and Design quality, Design concepts, the design model, pattern based software design. Creating an architectural design: software architecture, Data design, Architectural styles and patterns, Architectural Design, assessing alternative architectural designs, mapping data flow into a software architecture. Modeling component-level design: Designing class-based components, conducting component-level design, object constraint language, designing conventional components. Performing User interface design: Golden rules, User interface analysis, and design, interface analysis, interface design steps, Design evaluation.

TEXT BOOKS:

- Software engineering A practitioner's Approach, Roger S Pressman, sixth edition McGraw Hill International Edition.
- Software Engineering, Ian Sommerville, seventh edition, Pearson education.

REFERENCE BOOKS:

- Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India, 2010.
- Software Engineering : A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008
- Fundamentals of Software Engineering, Rajib Mall, PHI, 2005
- Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.
- Software Engineering1: Abstraction and modeling, Diner Bjorner, Springer International edition, 2006.
- Software Engineering2: Specification of systems and languages, Diner Bjorner, Springer International edition 2006.
- Software Engineering Foundations, Yingxu Wang, Auerbach Publications, 2008.
- Software Engineering Principles and Practice, Hans Van Vliet, 3rd edition, John Wiley &Sons Ltd.
- Software Engineering 3: Domains, Requirements, and Software Design, D. Bjorner, Springer International Edition.
- Introduction to Software Engineering, R. J. Leach, CRC Press.

Computer Science & Engineering and Information Technology					
CSO712	**CRYPTOGRAPHY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcome:

.1 Explain the basics of network security and compare various encryption techniques.
.2 Summarize the functionality of public key cryptography
.3 Apply various message authentication functions and secure algorithms
.4 Demonstrate different types of security systems and describe different levels of security and services.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
IT6103.1	-	-	-	-	2	-	-	-	-	1	-	1
IT6103.2	-	2	-	-	2	-	-	-	-	-	-	-
IT6103.3	3	2	-	-	2	1	-	-	-	-	1	-
IT6103.4	-	3	1	-	-	2	-	3	-	-	-	-
Average	0.75	1.75	0.25	0	1.5	0.75	0	0.75	0	0.25	0.25	0.25

Course Description:

MODULE 1:

Conventional Encryption and Message Confidentiality: Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution

MODULE 2:

Public key cryptography and Message Authentication: Approaches to Message Authentication, SHA-1, MD5, Public key cryptography Principles, RSA, Digital Signatures, Key Management

MODULE 3:

Network Security Applications: Kerberos Motivation, Kerberos version 4, PGP Notation, PGP Operational Description

MODULE 4:

IP Security: IP Security Overview, IP Security Architecture, Authentication Header

Web Security: Web Security Threats, Web Traffic Security Approaches, Overview of Secure Socket Layer and Transport Layer Security, Overview of Secure Electronic Transaction

MODULE 5:

Intruders and Viruses: Intruders, Intrusion Techniques, Password Protection, Password selection Strategies, Intrusion Detection, Malicious Programs**,** Nature of viruses, Types of viruses, Macro viruses, Antivirus Approaches

Firewalls: Firewall characteristics, Types of Firewalls, Firewall configuration

Suggested Text Books:

1. **"Cryptography and Network Security Principles and Practices", Fourth Edition, William Stallings. Publisher: Prentice Hall**
2. **"Cryptography And Network Security", McGraw Hill, Behrouz A *Forouzan***

Computer Science & Engineering and Information Technology					
ITO713	**Knowledge Driven Development (KDD)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course objective:

Managing knowledge in a software project is a challenge. Waterfall methodology places emphasis on exhaustive documentation, which is difficult to be kept updated with the dynamics project delivery environment. Agile relies mostly on user stories and acceptance criteria for knowledge management which is flexible but may not be exhaustive.

KDD digitises the knowledge currently contained in the project documents into a specified number of building blocks represented in inventory relationship format. For the implementation aspects, it follows Agile way of working. By digitising knowledge, KDD brings in the next level of maturity in the project delivery that takes it closer to effective implementation of digital transformation programmes using enablers such as Machine Learning, Artificial Intelligence, Data Analytics, Cloud.

Course outcome:

After completing this course, students will acquire:

1. A general understanding of how IT projects are delivered by IT companies.
2. Details of a new project delivery methodology (Knowledge driven development – KDD) based on digitisation of project knowledge.
3. How KDD may assist Waterfall, Agile and DevOps methodologies.
4. The potential contribution of KDD in the current wave of digitisation that industry is undergoing.
5. Application of KDD in digitising domain knowledge and enterprise knowledge.

Course syllabus:

MODULE 1: Project delivery and supporting methodologies (4 hrs)

- IT Industry from technology and domain perspective
- Information technology – a knowledge-based industry
- IT project delivery – An introduction
- IT project delivery methodology landscape

MODULE 2 : Project delivery pain areas and the way forward (4 hrs)

- IT project failures
- Project delivery pain areas
- Project knowledge

MODULE 3. Project knowledge model – context and definition (5 hrs)

- Traditional project knowledge management
- Project delivery activities and project knowledge
- Project knowledge model – Definition
- Project knowledge model – An example

MODULE 4: Extending project knowledge model to cover end to end project delivery – KDD (10 hrs)

- KDD focus area and core value
- End to end project delivery using quality gate
- Tracking project delivery quality through Key process indicators (KPI)
- Fitment for different types of Domains and Projects
- KDD Differentiator
- Contrasting KDD with Agile and Waterfall methodologies

MODULE 5: KDD Compliance with standards of project delivery (10 hrs)

- Quality assurance framework
- Project management framework
- Service management framework
- Enterprise architecture framework
- Test management framework
- Addressing contemporary concerns of project delivery
- Assisting Waterfall, Agile and DevOps
- Positioning of KDD in the digital era

6. Global relevance of KDD (8 hrs)

- KDD and generic knowledge management framework
- Examples of generic knowledge management framework
- Generic knowledge management framework – its potential usage in skill development
- Towards another ontology framework

Recommended text-book:

Knowledge Driven Development – Bridging Waterfall and Agile Methodologies, Published jointly by Cambridge University Press and IISc Press.

References:

1. Agile Manifesto: http://agilemanifesto.org/

2. Scrum guide: https://www.scrumalliance.org/learn-about-scrum/the-scrum-guide

Computer Science & Engineering			
CSO710	**Data Mining**	**L**	**T**
		3	**0**

Course Outcomes
The students shall able to:
CO1.**Analyze** different data models used in data warehouse.
CO2. **Apply** different preprocessing techniques for different attributes.
CO3. **Determine** frequent item set using association rules.
CO4**. Apply** different classification techniques to classify the given data set.
CO5. **Analyze** different clustering techniques.

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1	1	1					
CO2	3	2	2		1	1		1				1
CO3	3	2	2		1			1	1			
CO4	3	2	2		1		1		1			
CO5	3	2	2		1		1	1	1		1	1
	3	2	2		1	1	1	1	1		1	1

Module - 1
Data warehousing and online analytical processing: Data warehousing: Basic concepts, Data warehouse modeling: Data cube and OLAP, Data warehouse design and usage, Data warehouse implementation, Data generalization by attribute-oriented induction.

Module – 2
Introduction and Data Preprocessing :Why data mining, What is data mining, What kinds of data can be mined, What kinds of patterns can be mined, Which Technologies Are used, Which kinds of Applications are targeted, Major issues in data mining .Data Preprocessing: An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization.

Module – 3
Classification: Basic Concepts: Basic Concepts, Decision tree induction, Bays Classification Methods, Rule-Based classification, Model evaluation and selection, Techniques to improve classification accuracy.

Module– 4
Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods: Basic Concepts, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Pattern Mining in Multilevel, Multidimensional Space, Constraint-Based Frequent Pattern Mining.

Module – 5

Cluster Analysis: Basic concepts and methods: Cluster Analysis, Partitioning methods, Hierarchical Methods, Density-based methods, Grid-Based Methods, Evaluation of clustering.

Text Book:

1. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining Concepts and Techniques, ELSEVIER (MK) 3rd edition 2012.

Reference Books:

1.Arun K Pujari: Data Mining Techniques 2nd Edition, Universities Press, 2009.
2. Jiawei Han and Micheline Kamber: Data Mining - Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publisher, 2006.
3.Alex Berson and Stephen J. Smith: Data Warehousing, Data Mining, and OLAP Computing, Mc GrawHill Publisher, 1997.
4. Insight into Data Mining – Theory and Practice – K.P.Soman, Shyam Diwakar, V.Ajay, PHI, 2006.

Computer Science & Engineering			
CSP704	**Human Computer Interaction**	**L**	**T**
		3	**0**

COURSE OUTCOMES

CO. 1: Explain the capabilities of both humans and computers from the viewpoint of human information processing.
CO. 2: Understand the design technologies for individuals and persons with disabilities
CO. 3: Analyze and Design real time application in mobile HCI and Web Interface.
CO. 4: Describe typical human–computer interaction (HCI) models and styles, as well as various historic HCI paradigms.

Module I : FOUNDATIONS OF HCI

The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

Module II : DESIGN & SOFTWARE PROCESS

Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Module III : MODELS AND THEORIES

Cognitive models –Socio-Organizational issues and stake holder requirements – Communication and collaboration models-Hypertext, Multimedia and WWW.

Module IV : MOBILE HCI

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Module V : WEB INTERFACE DESIGN

Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.

TEXT BOOKS:

- Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004 (UNIT I , II & III)
- Brian Fling, "Mobile Design and Development", First Edition , O"Reilly Media Inc., 2009 (UNIT –IV)
- Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O"Reilly, 2009.(UNIT-V)

ITO711 INFORMATION SECURITY L3 –T0 –P 0 Credit 3

Course Outcomes: At the end of the course the student will be able to:

CO1	Recognize propensity of errors and remedies in processes involving information technology
CO2	Consummate knowledge of risk and controls in IT operation in industry
CO3	Determine IT security guidelines for various type of industries
CO4	Evaluate asset safeguarding, data integrity, system effectiveness and system efficiency.
CO5	Understand software security auditing including database security audit, network security audit and micro-computer security audit.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1		2		3		1		2	
CO2		2		3		1		2	
CO3		2		3		1		2	
CO4		2		3		1		2	
CO5		2		3		1		2	

Detailed syllabus:

Module1

Computer Auditing- System Access control, Data Access Control, Security Administration, System Design.

Module 2

Hardware Security Controls - The Total System Needs Securing, Levels of Hardware Controls, Operating System Controls , Access Controls, General-Purpose Operating Systems Security , Sources of Additional Information

Module 3

Software Controls - Software Security and Controls, Types of Software Intrusions, Configuration Management , Modularity and Encapsulation, Protecting Information, Selecting Security Software, Analysis of Software Products Database Security - Introduction to Databases, Security Requirements of Databases, Designing Database Security, Methods of Protection, Security of Multilevel Databases,The Future of Databases. Network and Telecommunication Security - Telecommunications and Networks, Security Considerations, Cases in Point, Special Communications, Security Considerations.

Module 4

Microcomputer Security - Microcomputer Problems and Solutions , The Microcomputer Environment , Security of Microcomputers, Internal Data Security, The Threats to Micros, Developing a Micro Security Plan, Establishing a Micro-to-Mainframe Link , Portable Microcomputer Security , Password Protection, Security of Special Micro Applications.

Reading:

1. Deborah Russell, *Computer Security Basics*, O'Reilly & Associate, 1991.
2. Karen A. Forcht, *Computer Security Management*, Boyd & Fraser Publishing Co., 1994.
3. Donald A. Watne, Peter B.B. Turney, *Auditing EDP Systems*, 2nd Edition, PH 1990

COMPUTER SCIENCE & ENGINEERING AND INFORMATION TECHNOLOGY					
COURSE CODE: CSE 701P & IT 701P	**ARTIFICIAL INTELLIGENCE LAB**	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

EXP No.	EXPERIMENT NAME	COURSE OUTCOME
1	Write LISP Program to define a function for i. Converting Centigrade temperature to Fahrenheit ii. Finding maximum among three numbers iii. Finding factorial of a number iv. Finding n^{th} power of m (m^n) using recursive function	CO1
2	Write PROLOG program i. To find maximum among three numbers ii. To find factorial of a number iii. To add/remove nth element in a list iv. To implement reverse of a list	CO1
3	Write a PROLOG Program about family relations and checking the relation between different family members by using facts and rules.	CO1
4	Write a PROLOG Program for Missionaries and Cannibal problem.	CO2
5	Write a PROLOG Program for Water Jug problem.	CO2
6	Write a LISP program to perform Breadth-first search	CO2
7	Write a LISP program to perform Depth-first search	CO2
8	Write a PROLOG Program for 8 puzzle problem.	CO2
9	Write a PROLOG Program for an expert course advisor system.	CO4
10	Write a program for TIC-TAC-TOE game using python.	CO3

Chemical Engineering

CHEMICAL ENGINEERING

Syllabus
SEMESTER VII

CHEMICAL PLANT MANAGEMENT

University Examination: 3 hours. ***Sessional Marks: 30***
University Examination Marks: 70

Course objective:

To understand the basic concepts of flow sheeting, material and energy balances and process development, to gain knowledge of estimation of capital investment, total product costs, depreciation, cash flows, and profitability, to carry out process optimization based on economic profitability by connecting economics with design principles for real chemical engineering processes

Module 1: ECONOMIC STUDY **Lecture 8**

Simple, Compound and continuous interest, calculation of equivalence involving interest, present worth, capitalized cost. Common methods of depreciation-their comparison, Formation of business organization, source of Finance and their formulation.

Module 2: MANAGEMENT **Lecture 8**

Functions of management of execution. Managerial activities in planning, organization staffing-direction and control. Authority span of control and coordination. Line staff and functional relations of authority in an organization. Morale building and leadership qualities. Personnel management, principles and functions.

Module 3: FINANCIAL AND COST ESTIMATIONS **Lecture 8**

Cost of production, inventory control, Balance sheets, income statement cost and financial ratios to study profits, returns, earnings. Investments etc. cost benefit ratio, Economic optimum production unit and incremental costs. Profits, break oven point etc. and the relation with production. Pay back period, internal rate of return. Financial and economic analysis.

Module 4: PROFITABILITY TECHNIQUES **Lecture 8**

Different profitability techniques for analysis, financial proposals like cumulative cash, discount cash, payment time, present worth, capitalized cost comparison, Alternate investments and replacements, Inflation and investments.

Module 5: QUALITY AND STANDARDS **Lecture 8**

Quality Assurance plan, staged final inspection standards, and standardization cost. Quality control techniques, comparison.

Course outcome:

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

CO1: Determine costs involved in process plants.

CO2: Analyze alternative processes and equipment for manufacturing a product.

CO3: Evaluate project profitability.

CO4: Perform economic analysis and optimum design of processes.

Reference Book:

1. Plant Design and Economics for Chemical Engineering by Max S. Psters, Klaus D. Timmerhaus and Ronald E. West, Mc Graw Hill, 5th Edition.

2. R. Panneerselvam, Engineering Economics, Prentice Hall India, 2013.

3. James R. Couper, W. Roy Penny, James R. fair, Stanley M. Walas, Chemical Process Equipment: Selection and Design, Elsevier Butterworth-Heinemann, 2012.

COMPUTER AIDED DESIGN IN CHEMICAL ENGINEERING

Sessional Marks: 30

University Examination: 3 hours. **University Examination Marks: 70**

Objective: Introduction to basic concepts for chemical process equipment, piping design, heat exchanger, distillation column and reactor used in chemical industries.

Syllabus

UNIT I Lectures 8

Software development for design of various chemical equipment. Introduction of computer aided design (CAD) a review of tools for CAD (computer systems: file and data management). Scope of computer aided design of process equipment.

UNIT II Lectures 8

Design of minimum energy heat exchanger network by using pinch technology and energy integration in distillation column.

UNIT III Lectures 8

Design of Mass Integration in separation process. Determination of bubble point, Dew point of binary phase by using for ideal and Non-Ideal Solutions. Calculation of volume of a gaseous system by using viral equation of state.

UNIT IV Lectures 8

Calculation of equilibrium compositions of a set of simultaneous reactions, Performance calculation for batch reactor, plug flow reactor and CSTRs, homogeneous and heterogeneous flow reactors.

UNIT V Lectures 8

Determination of dirt factor of a given shell and tube heat exchanges.

Course Outcome:

At the end of course students able to understand the

CO1: Understand the basic design concept of chemical process equipment

CO2: Design the distillation column and adsorption column

CO3: Design the heat exchanger

CO4: Apply various design in process plant.

Text Books:

1. Chemical Process Computations, Raghu Raman, Elsevier Applied Science Publishers

2. Computer Aided Process Plant Design, M.E.Leesley, Gulf Publishing Co.,

Reference Books:

1. Computer Applications in chemical Engineering: Process Design & simulation, Robert G. Squires.

2. Fortran programs for Chemical Process Design, Analysis and Simulation, Coker A.K, Gulf

Publishing Co.

3. Catalytic Reactor Design, OrhanTarhan, McGraw Hill.

PROCESS MODELING AND SIMULATION

Sessional Marks: 30
University Examination: 3 hours. ***University Examination Marks: 70***

Course Objectives: To make the students understand physical systems in chemical engineering and to develop their mathematical models and solutions for these models. The students will also learn to use the commercial process simulators

UNIT-1: **Lecture 8**
Introduction to modeling and simulation, classification, Uses of mathematical models, Principles of model formulation, Fundamental laws- continuity equation, energy equation, equations of motion, Transport equations, equations of state, equilibrium and kinetics, Introduction to process simulators and mathematical tools.

UNIT-2: **Lecture 8**
Numerical solution of model equations with Linear and non linear algebraic, Equations in one and more than one variables, ordinary differential equations in one and more than one variables

UNIT-3: **Lecture 6**
Numerical solution of model equations with partial differential equations using finite difference method. Model Parameters Estimation: Introduction, method of least squares, curve fitting, etc.

UNIT-4: **Lecture 8**
Lumped Parameter Models: Formulation and solution techniques for vapor-liquid equilibrium models, batch and continuous distillation column, mixing tank, stirred tank with heating, CSTR with multiple reactions. N- CSTRs in series, Non-isothermal CSTR, Non-ideal CSTR models.

UNIT-5: **Lecture 12**
Steady State Distributed Parameter Models: Formulation and solution of split boundary value problems - shooting technique, quasi-linearization techniques, counter current heat exchanger, tubular reactor with axial dispersion. Unsteady State Distributed Parameter Models: convective problems, diffusive problems, combined convective and diffusive problems.

Course Outcomes:

At the end of the, student able to understand

CO1: Understand the important physical phenomena from the problem statement
CO2: Develop model equations for the given system
CO3: Demonstrate the model solving ability for various processes/unit operations
CO4: Demonstrate the ability to use a process simulation

Text & Reference Books:

1. K. M. Hangos and I. T. Cameron, “Process Modeling and Model Analysis”, Academic Press, 2001.
2. W.L. Luyben, “Process Modelling, Simulation and Control for Chemical Engineers”, 2nd Edn., McGraw Hill Book Co., New York, 1990.

3. W. F. Ramirez, “Computational Methods for Process Simulation”, Butterworths, 1995.
4. Process Dynamics: Modeling, Analysis and Simulation, B Wayne Bequette, Prentice Hall. International Inc.
5. Computational Methods for Process Simulation, 2nd ed., W F Remirez, Butterworth-Heinemann.
6. Roger E. Franks, “Modeling and Simulation in Chemical Engineering”, JohnWiley and Sons, 1972.

FLUID DYNAMICS

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Unit I
Lectures 18

Flow Dynamics:

Continuity equation in linear and curvilinear coordinates, Momentum, equations, idea flow, Euler's equations of motion, Velocity potential, rotational and irrotational flow; Naiver-Stokes equation, Poiseuille flow, creep flow and Couette flow. Boundary layer theory: integral momentum analysis. Turbulent boundary layer: turbulence and mixing. Universal velocity profile. Stability analysis of laminar flow, Orr-Somerfield Solution, modeling of turbulent flow. Laminar and turbulent flow of non-Newtonian fluid. Rheological characteristics, consistency measurement, viscometric flow, pipeline design equation.

Unit II
Lectures 18

Fluidization:
The phenomena of fluidization and its industrial application.
Characteristics of particles. Principle of fluidization and mapping of various regimes. Two phase theory of fluidization. Liquid-solid and gas solid fluidized beds, entertainment and Elutriation. Fast circulating and semi-fluidized bed. Mixing and segregation. Introduction to three phase fluidizations. Heat and Mass transfer in fluidized bed. Design of fluidized bed reactors.

Suggested Books:

1. Fluid Dynamics & Heat Transfer – J.G. Kundsen & D.L. Katz, McGraw Hill Book Co.Inc.
2. Fluidization Engineering – D. Kunil & O. Levenspiel, Willey International Education.

COMPUTATIONAL FLUID DYNAMICS

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course Objectives:

1. Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems
2. Provide the essential numerical background for solving the partial differential equations governing the fluid flow
3. Develop students' skills of using a commercial software package to solve problems in Chemical Engineering

Course Outcomes:

On successful completion of the course, students will be able to:

1. **Understand** solution of aerodynamic flows. Appraise & compare current CFD software (Ansys Fluent). Simplify flow problems and solve them exactly
2. **Define** and **setup** flow problem properly within CFD context, performing solid modeling using CAD package and producing grids via meshing tool.
3. **Understand** both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.
4. **Use** CFD software to model relevant engineering flow problems. Analyse the CFD results. Compare with available data, and discuss the findings.

UNIT I **Lectures 6**

Basic ideas of CFD: Introduction to CFD, role of CFD and its applications, future of CFD. Governing equations (GE's) of Fluid dynamics: Modeling of flow, control volume concept, substantial derivative, physical meaning of the divergence of velocity. Continuity equation, momentum equation, energy equation and its conservation form. Equations for viscous flow (Navier-Stokes equations), equations for inviscid flow (Euler equation). Different forms of GE's, initial and boundary conditions.

UNIT II **Lectures 6**

FVM for Diffusion Problems: FVM for 1D steady state diffusion, 2D steady state diffusion, 3d steady state diffusion. Solution of discretised equations **-** TDMA scheme for 2D and 3D flows.

UNIT III **Lectures 6**

FVM for Convection-Diffusion Problems: FVM for 1D steady state convection-diffusion, Central differencing scheme, Conservativeness, Boundedness, Transportiveness, Upward differencing scheme, Hybrid differencing scheme for 2D and 3D convection-diffusion, Power-law scheme, QUICK scheme.

UNIT IV **Lectures 6**

Solution Algorithm for Pressure-velocity Coupling in Steady Flows: Concept of staggered grid, SIMPLE, SIMPLER, SIMPLEC, PISO algorithm.

UNIT V **Lectures 8**

Grid Generation: General transformation of the equations. Metices and Jacobians.Types of grids-structured and unstructured grids, grid generation methods- algebraic, differential and hybrid methods. Coordinate stretching, boundary-fitted coordinate systems. Elliptic and hyperbolic grid generation methods, orthogonal grid generation for Navier-Stokes equations, Multi-block grid generation.

Text & References:

1. "An Introduction to Computational Fluid Dynamics: the Finite Volume Method", H.K. Versteeg and W. Malalasekera, Longman Scientific & Technical, 1995/Addison-Wesley,1996.

2. "Computational Fluid Flow and Heat Transfer" (2ndedition), K. Muralidhar and T. Sundararajan, Narosa Publishing, 2004.

3. "Numerical Heat Transfer and Fluid Flow", S.V. Patankar, McGraw-Hill, New York, 1980.

4. "Computational Methods for Fluid Dynamics" (3rdedition), J.H. Ferziger and M. Peric, Springer, 2001.

5. "Fundamentals of Computational Fluid Dynamics", T. K. Sengupta, Universities Press, Hyderabad, 2004.

CHEMICAL PLANT OPERATION AND SAFETY

Sessional Marks: 30

University Examination: 3 h *University Examination Marks: 70*

Semester VII **Elective II**

Pre-requisites: A-level physics and mathematics.

Syllabus

UNIT I **Lectures 4**

1. Identification, classification and assessments of various types of hazards, safety audits.

UNIT II **Lectures 7**

2. Reactivity, instability and explosively, hazard indices, hazard assessment and operability (HAZOP), studies – case studies.

UNIT III **Lectures 12**

3. Consequences analysis: Discharge model, flash and evaporation, dispersion models.
4. Explosion and fires: Unconfined vapour cloud explosion and flash fires, physical explosion, BLEVE and fireball, confined explosion, pool fire & jet fire.

UNIT IV **Lectures 10**

5. Effect models: Toxic gas effects, thermal effects, explosion effects, evasive actions.
6. Risk estimates: Risk indices, Individual risk, and societal risk.

UNIT V **Lectures 8**

7. Emergency planning and disaster management plan: work emergency planning, works emergency procedures, disaster management planes.

Text books/ References books:

- Chemical process safety, Fundamentals with applications, Daniel A Crowl, and Joseph F. Louvar, 2nd Ed, Prentice Hall, 2002.
- HAZOP Guide to Best Practice, Frank Crawley, Malcolm Preston, and Brian Tyler, 2nd Edition, IChemE, 2008.
- Basic Guide to system safety, Jeffrey W. Vincoli, John Wiley & Sons, Inc., Hoboken, New Jersey, 2014.
- Health, Safety and Accident Management in the Chemical Process Industries, Ann Marie Flynn and Louis Theodore, Marcel Dekker, Inc. NW, 2002.
- Guidelines for Chemical Process Quantitative Risk Analysis. 2nd edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2000.

Course outcomes (COs)

<u>On successful completion of this course students will be able to:</u>

CO1: Identify the typical sources of risk in a process plant by hazard identification and examination of case studies.

CO2: Perform a chemical process safety analysis on a proposed process.

CO3: Able to conduct assessment and produce safe operational working procedure in industries and research laboratories.

CO4: Describe and apply the principles and approach of inherently safer design to reduce and eliminate hazards and thereby lower the risk of new or currently operating chemical systems.

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	3	3		2		2	2					2
CO2	3	3	3	3			2					2
CO3	3	3	2	2		2	2	2				2
CO4	3	3	3	3		3	2	2				2

ENERGY CONSERVATION METHODOLOGY

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

UNIT I **Lectures 10**

1. Energy Scenario: Primary and Secondary Energy, Commercial, Non-commercial, renewable and non-renewable energy, global primary energy reserves, energy pricing in India, energy sector reforms, energy and environment, energy conservation act 2001.
2. Energy Management & Audit: Definition & objective, type and methodology, energy audit reporting, bench marking and energy performance, maximizing system efficiency, energy audit instruments.

UNIT II **Lectures 10**

1. Boilers: Boiler system, types and classification, performance evaluation of boilers, energy conservation opportunities.
2. Steam System: Properties of steam, steam distribution, steam pipe sizing, design, proper selection, operation and maintenance of steam traps, performance assessment methods for steam traps, energy saving opportunities.

UNIT III **Lectures 10**

1. Furnaces: Types and classification, performance evaluation, fuel economy measures.
2. FBC Boilers: Mechanism, retrofitting of FBC systems to conventional boilers, merits.

UNIT IV **Lectures 10**

1. Co-generation: Principle, technical options, classification, factors influencing cogeneration choice, Prime movers for cogeneration.
2. HVAC and Refrigeration System: Types, common refrigerants and properties, selection of suitable refrigeration system, performance assessment of refrigeration plant, factor affecting performance and energy efficiency of refrigeration plants, energy saving opportunities.

Text Books:

1. Conventional Energy technology, S.B.Pandy, Tata McGraw Hill
2. Fuel Science, Harker and Allen, Oliver & Boyd.
3. Energy conversion, Culp, Mc Graw Hill.

Reference Books:

1. Hand book of energy technology, Considine D. M.
2. Fuels and energy, Harker and Backhusst, Academic press
3. Solar Energy Thermal Process, John A Duffie.

Interfacial Science and Engineering

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Unit I **Lectures 6**

Introduction to the engineering of interfaces; Definitions of fluid-fluid and fluid-solid interfaces; Occurrence of interfaces in science and engineering; Overview of industrial applications of various interfacial phenomena; Colloidal materials; Properties of colloidal systems.

Unit II **Lectures 10**

Surface and interfacial tension; Theoretical methods for the calculation of surface and interfacial tension; Experimental techniques for the determination of equilibrium and dynamic tension; Shape of the surfaces: curvature and radius of curvature; Young-Laplace equation; Characterization of fluid-solid interfaces; Contact angle and wetting phenomena; Young-Dupré equation; Measurement of equilibrium and dynamic contact angles.

Unit III **Lectures 10**

Introduction to intermolecular and surface forces; van der Waals forces; Electrostatic double layer force, Adsorption at fluid-fluid and fluid-solid interfaces; Adsorption of surfactants; Gibbs and Langmuir monolayers; Gibbs adsorption equation; Surface equation of state; Surface pressure isotherm; Langmuir-Blodgett films and their applications

Unit IV **Lectures 10**

Emulsions: Preparation, characterization and applications; Ostwald ripening; Flocculation and coalescence; Microemulsions: characterization and properties; Stability of microemulsions; Foams: preparation, characterization and stability; Structure of foams.

Unit V **Lectures 6**

Application: General applications, Enhanced petroleum recovery, Novel fabrication of nanostructured particles, engineering surfaces and interfaces, Self-assembled and nanostructured biomimetic interfaces

Name of Text Books and References

- Adamson, A. W. and Gast, A. P., Physical Chemistry of Surfaces, John Wiley, New York, 1997.
- Ghosh, P., Colloid and Interface Science, PHI Learning Pvt. Ltd., New Delhi, 2009.
- Hiemenz, P. C. and Rajagopalan, R., Principles of Colloid and Surface Chemistry, Marcel Dekker, New York, 1997.
- Stokes, R. J. and Evans, D. F., Fundamentals of Interfacial Engineering, Wiley-VCH, New York, 1997.
- Baszkin, A. and Norde, W., Physical Chemistry of Biological Interfaces, Marcel Dekker, New York, 2000.
- Edwards, D. A., Brenner, H. and Wasan, D. T., Interfacial Transport Processes and Rheology, Butterworth-Heinemann, Boston, 1990.
- Hunter, R. J., Foundations of Colloid Science, Oxford University Press, New York, 2005.
- Israelachvili, J., Intermolecular and Surface Forces, Academic Press, London, 1992.
- Slattery, J. C., Interfacial Transport Phenomena, Springer-Verlag, New York, 1990.

Polymer Science Engineering

Sessional Marks: 30

University Examination: 3 hours. *University Examination Marks: 70*

Semester VII

Prerequisite: None

Unit I **Lectures 8**

Classification of polymers. Thermosets and thermoplastics. Physical states and transition. Glass transition and its measurements. Crystallization and measurement of crystalline.

Unit II **Lectures 8**

Polymer synthesis and step growth polymerization with examples: Chain growth including free radicals. Anionic and cationic polymerization.

Unit II I **Lectures 8**

Polymer Kinetics molecular weight and its distribution. Copolymers and copolymerization. Polymerization systems including bulk solution, suspension and emulsion.

Unit IV **Lectures 8**

Rubber elasticity. Flow of polymer techniques for processing of polymer. Properties of commodity and engineering polymers. end Application, polymer-based industries.

Unit V **Lectures 8**

Polymer additives, blends and composites: Additives – plasticizers, fillers and reinforcements, other important additives. Polymer blends and interpenetrating networks **-** polymer blends, toughened plastics and phase-separated blends, interpenetrating network. Introduction to polymer composites – Mechanical properties, composite fabrication.

Text Book:

1. Polymer science, Gowarikar R.A., New Age publishers.

Reference Books:

1. Polymer science and technology, Joel R. Fried, PHI publishers.

2. Polymer science and technology of plastics and rubbers, Premamoy Ghosh, Tata McGraw Hills, New Delhi

3. Text Book of polymer science, Fred Billmayer.Jr., John Wiley & Sons,

Course outcomes (COs)

<u>At the end of the course, the students will be able to:</u>

CO1: Identify the polymer based upon its behavior, mechanism and its occurrence.

CO2: Calculate different states of polymer.

CO3: Understand the kinetics of polymerization process and evaluate the rate constants

CO4: Apply the polymer processing relevant to Engineering polymers

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2		2	2					3
CO2	2	3	1	2								3
CO3	3	3	1	1								3
CO4	3	3	3	1		2						3

Mineral Beneficiation

Sessional Marks: 30

University Examination: 3 h *University Examination Marks: 70*

Pre-request:
Basic Science, Process Calculation.

Syllabus:

Unit 1: **Lectures 5**

Exploitable Characteristics or Minerals, Economics of Mineral Beneficiation.

Unit 2: **Lectures 10**

Principles of Crushing and Grinding, Grind Ability, Power Law, Evaluation of Particle Size, Size Distribution curves and their significance. Mechanism of breakage of Material classification design and application of crushers and grinders.

Unit 3: **Lectures 10**

Industrial Screening, Classification and Performance of Screens. Dry and wet classifiers.
Thickeners, hydro cyclone. Filtration, Tabling, Jigging, Magnetic and electrostatic

Unit 4: **Lectures 9**

Separation, Surface Behavior and flotation Principles. Flotation Machines, Differential Flotation and Flotation Circuit Design.

Unit 5: **Lectures 7**

Elements of hydrometallurgy, Microbial Leaching etc.
Important Beneficiation Circuits of Minerals like Chalcopyrite, Sphalerite, Galena, Buxite etc.

Text Books

- Tim Napier-Munn, Barry A. Wills, Mineral Processing Technology, 7th Edition, Elsevier Science & Technology Books.
- Maurice C Fuerstenau, Kenneth N Han, Principles of Mineral Processing, Society for Mining, Metallurgy, and Exploration, Inc. USA.
- A. M. Gaudin, Principles of Mineral Dressing, Tata McGraw-Hill Publishing Company, 1980.
- S K Jain, Mineral Processing Technology, CBS Publisher.
- D.V. Subba Rao, Textbook of Mineral Processing, Scientific Publishers (India)

Course outcomes:

At the end of the course, the students would be able to:

CO1: Understand the operation of beneficiation units for mineral.

CO2: Analyze basic element of machine e.g. crushers, mills jigs, tables etc.

CO3: Apply knowledge of mineral dressing for understanding, formulating and solving problems related with mineral beneficiation.

CO4: Explain the principles governing a range of processes applied in the minerals industry;

CO5: Describe commonly used metallurgical processes in industries and the major drivers for mineral processing.

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	3	2					2					2
CO2	3	2										2
CO3	3	3	2	2		2	2					2
CO4	3	1	3	3		2	2	2				2
CO5	3	2	2	2		2	2	2				2

Fuel Cell Technology

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course Objective: To provide detail knowledge in theory, analysis, performance, design and operational principles of various fuel cell components.

Unit I **Lectures 5**

Fundamentals and classification of fuel cells; Thermodynamic efficiency.

Unit II **Lectures 8**

Electromotive force of fuel cells: Standard electrode potentials; Effect of concentration; Nernst equation. Rate of electrode processes: Types of polarization; Surface reactions; Oxygen electrodes; Hydrogen electrodes; Overall performance.

Unit III **Lectures 10**

Low temperature fuel cells: Hydrogen–oxygen fuel cells– alkaline and polymeric membrane types; Active catalyst and its dispersion; Heat and mass transfer; Construction and design; Limiting problems; Low temperature fuel cells of other types – methanol fuel cell, hydrocarbon fuel cell.

Unit IV **Lectures 8**

High temperature fuel cells: Advantages; Molten electrolyte fuel cell; Solid electrolyte fuel cell; Construction. Air depolarised cells; Biochemical fuel cells; Regenerative cells; Micro fuel cells.

Unit V **Lectures 10**

Fuel cell operation: Supply of fuel; Electrical arrangement; Removal of products; Materials for battery construction; Production and purification of fuels. Application of fuel cell systems: Large scale power generation; Power plant for vehicles; Domestic power; Fuel cells in space. Fuel cell economics; Future trends in fuel cells.

Text/Reference Books:

1. O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel CellFundamentals, Wiley, NY (2006).

2. Bard,A. J. , L. R., Faulkner,Electrochemical Methods,Wiley, N.Y.(2004) Ref Book.

3. Basu,S.(Ed) Fuel Cell Science and Technology,Springer,N.Y.(2007).

4. Liu, H.,Principles of fuel cells, Taylor & Francis, N.Y.(2006).

5. M.M. MENCH, Fuel Cell Engines, Wiley, 2008.

6. M.T.M.Koper (ed.), Fuel Cell Catalysis, Wiley, 2009.

7. J.O'M.Bockris,A.K.N. Reddy, Modern Electrochemistry, Springer 1998.

8. Larminie J., Dick A., Fuel Cell Systems Explained,2nd Ed. Wiley, 2003.

Course Outcomes: After completion of this course students will able to

CO1: Classify different kinds of fuel cells used in process industries.

CO2: Describe the application of fuel cells in power generation.

CO3: Explain the construction and design procedure of fuel cells.

CO4: Demonstrate the components of fuel cells.

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	1	1	1	-	-	-	-	2
CO2	3	3	2	1	2	1	2	-	-	-	-	3
CO3	3	2	3	2	3	2	1	-	-	-	-	3
CO4	3	2	2	1	2	1	1	-	-	-	-	3

Food Processing Technology

Sessional Marks:30

University Examination Marks: 70
University Examination: 3 hours

Course objective: To provide knowledge about food preservation, storage, handling, processing and packaging methods used in food industry.

Syllabus:

UNIT I **Lectures 10**

Cold preservation:

Freezing: Requirements of refrigerated storage controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, progressive freezing, changes during freezing concentration effect and ice crystal damage, freezer burn, Refrigeration load.

Freezing- Mechanism and freezers: Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.

UNIT II **Lectures 8**

Dehydration: Normal drying curve , effect of food properties on dehydration , change in food during drying ,drying methods and equipments air convection dryer, tray dryer, tunnel dryer ,continuous belt dryer , fluidized bed dryer, spray dryer, drum dryer, vacuum dryer ,freeze drying ,foam mat drying.

UNIT III **Lectures 6**

Food Irradiation and Microwave Heating: Ionizing radiation and sources, unit of radiations, direct and indirect radiation effects, safety and wholesomeness of irradiated food. Microwave heating and application.

UNIT IV **Lectures 10**

Packaging of foods: Packaging: Properties of packaging material, factors determining the packaging requirements of various foods and brief description of packaging of frozen products, dried products, fats and oils and thermally processed foods.

Material handling: Elementary concept of material handling in food industry, equipment and functioning of belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor.s

UNIT V **Lectures 5**

Thermal processing: Introduction, classification of Thermal Processes, Principles of thermal processing, Thermal resistance of microorganisms, Thermal Death Time, Lethality concept, characterization of heat penetration data, Thermal process Calculations.

Text/Reference Books:

1. Potter NH, Food Science, CBS Publication, New Delhi, 1998
2. Paine FA and Paine HY, Handbook of Food Packaging, Thomson Press India Pvt Ltd, New Delhi- 1992
3. Desrosier NW and Desrosier JN, The Technology of Food Preservation, CBS Publication, New Delhi, 1998
4. Ramaswamy H and Marcott M, Food Processing Principles and Applications CRC Press, 2006
5. Rao PG, Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi, 2010 6. Toledo Romeo T, Fundamentals of Food Process Engineering, Aspen Publishers, 1999

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

CO1: Understand different methods of food preservation.

CO2: Recognize the heating method used in food industry.

CO3: Select appropriate packing materials for food packaging

CO4: Describe the methodology for thermal processing of food.

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	-	-	-	-	-	-	3
CO2	3	2	3	2	1	-	-	-	-	-	-	2
CO3	3	3	2	2	3	-	-	-	-	-	-	3
CO4	2	2	1	3	2	-	-	-	-	-	-	1

Biochemical Engineering Fundamentals

Sessional Marks: 30

University Examination: 3 hours. *University Examination Marks: 70*

Course objective: To introduce the engineering principles of bioprocesses including characteristics of different microbial cells, enzymes, microbial kinetics and develop design considerations for bioreactors and fermenter.

Syllabus:

UNIT I **Lectures 8**

1. Introduction to biochemical process Industries-Industrial alcohols antibiotics acids, alcoholic beverages, enzymes, vitamins single cell protein.
2. Food processing and biological waste treatment.

UNIT II **Lectures 8**

1. Interaction of chemical engineering principles with biological sciences Life processes, unit of living system.
2. Microbiology, reaction in living systems, Biocatalysts, model reactions.

UNIT III **Lectures 8**

1. Fermentation mechanism and kinetic models of microbial growth and product formation
2. Fermenter types, modeling of batch and continuous fermenter.

UNIT IV **Lectures 8**

1. Bioreactor design, mixing phenomena in bioreactors sterilization of media and air sterilization equipment 2.
2. Batch and continuous sterilizer design.

UNIT V **Lectures 8**

Biochemical product recovery and separation, membrane separation process reverse osmosis dialysis, ultra-filtration, chromatographic methods, absorption, chromatography gel filtration, affinity chromatography etc Electro kinetic separation electro dialysis electrophoresis waste water treatment activated sludge process anaerobic digestion trickling filter.

Text Books recommended:

1. Biochemical Engineering fundamentals, J.B.Bailey and D.F.Ollis, McGraw Hill

Reference Books:

1. Biochemical Engineering, 2nd edition, A.Aiba, E.Humphrey and N.R.Milli.

2. Bio process Engineering Basic Concepts, 2nd edition, Michel L. Shuler, Fikeet Kargi.

Course Outcomes:

After completion of this course, the student will be able to:

CO1: Explain the fundamental concepts of biochemical processes.

CO2: Describe the functions of various biopolymers and their importance.

CO3: Analyze the fermentation mechanism and kinetic models of microbial growth.

CO4: Design bioreactors and batch/continuous fermenter.

CO5: Distinguish between different membrane separation processes used in product recovery.

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

PETROCHEMICAL TECHNOLOGY

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

COURSE OBJECTIVE:

The objective of this course is to learn the advancements in petrochemical technologies.

COURSE OUTCOMES:

1. Understand organic chemical technologies.
2. Draw process flow diagrams.
3. Identify the effect of chemical technologies on the health, safety and environment.
4. Understand engineering problems in chemical processes and equipments.
5. List chemical reactions and their mechanism involved.

UNIT I **Lectures 8**

1. Introduction: Composition of petroleum, laboratory tests, refinery products, characterization of crude oil.
2. Indian petrochemical Industries: A review.
3. Feed stocks for petrochemical Industries and their sources.

UNIT II **Lectures 10**

1. A brief introduction to catalytic reforming.
2. Delayed coking Hydrogenation and Hydro cracking Isomerization. Alkylation and polymerization, Purification of gases.
3. Separation of aromatics by various Techniques.

UNIT III **Lectures 8**

1. Petrochemicals from Methane.
2. Petrochemicals from Ethane-Ethylene-Acetylene,
3. Petrochemicals from C_3, C_4, and higher hydrocarbons synthetic gas chemicals.

UNIT IV **Lectures 6**

1. Polymers from Olefins.
2. Petroleum Aromatics, synthetic Fibers, Rubber, Plastics and Synthetic Detergents

UNIT V **Lectures 10**

1. Energy conservation in petrochemical Industries.
2. Pollution control in petrochemical industries.
3. New Trend in petrochemical industry.

Text books and references:

1. W.L. Nelson, "Petroleum Refinery Engineering", 4th Edn., McGraw Hill , New York 1985.
2. B. K. BhaskaraRao, "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing
Company, New Delhi, 1990.Khanna Publishers.
3. G. D. Hobson and W. Pohl., “Modem Petroleum Technology", Gulf Publishers 2nd. Edn., 1990.

4. R. A. Meyers, "Handbook of Petroleum Refining Processes", McGraw Hill , 1st Edn., 1980.
5. F. Hatch md Sumi Malar, "From Hydrocarbons to Petrochemicals", Gulf Publishing Company, 1st Ed.
1981.

PETROLEUM REFINERY ENGINEERING

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Objective: This course is to provide students a thorough understanding in the area of crude oil refining, hydrocarbon processing and trends in refinery operations which is the current need of the country. The physical and chemical properties of petroleum and petroleum products will be described, along with major refining processes.

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

CO1	Understand the physical properties of petroleum.
CO2	Explain the unit operations involved in petroleum refining.
CO3	Analyzed the technologies for conversion of crude oil to chemical products.
CO4	Explain the different process for petroleum industries.
CO5	Understand the methods of hazard identification and preventive measures.

Detailed Syllabus:

UNIT I **Lectures 8**

History and growth of petroleum Industry in India. Crude oil and their characteristics. Composition, classification and evaluation of different crudes. Physical properties: - Specific gravity, characterization factor, viscosity. viscosity index, viscosities gravity consent Reid vapor pressure, aniline point, flash & fire point, pour and cloud points, octane and cetane nun hers, ASTM TBP and Diesel index, smoke point.

UNIT II **Lectures 8**

Primary Refining: - Dehydration, distillation, desulphurization, stabilization. Atmospheric & vacuum distillations, naphtha. Diesel and furnace oils, their specification and characteristics.

UNIT III **Lectures 8**

Secondary Refining: Thermal and catalytic cracking, Dubbs method of thermal cracking. Fluidized thermal and fixed bed catalytic cracking & their products. Tube still heater and its design. Hydro-cracking, Hydro-treating.

UNIT VI **Lectures 6**

Principle of multicomponent extraction. Edeluane process. Due sol process. odex process, propane and furfural extraction & refining.

UNIT V **Lectures 6**

Blending storages, fire protection, waste disposal, air pollution etc. in petroleum industry. Energy conservation in petroleum Industry.

Reference Books:

- Austin G.T., Shreve's Chemical Process Industries - International Student Edition, 5th Edition, McGraw Hill Inc., 1998.
- Sittig M. and GopalaRao M., Dryden's Outlines of Chemical Technology for the 21st Century, 3rd Edition, WEP East West Press, 2010.
- B.K. BhaskaraRao, Modern Petroleum Refining Processes, 4th Edition, Oxford&IBH Publishing Co. Pvt. Ltd., 2008.
- B.K. Bhaskara Rao, A Text Book of Petrochemicals, 2nd edition, Khanna Publications, 2002.
- W.L. Nelson, Petroleum Refinery Engineering, McGraw Hill Book Company, 1969.

Mapping of course outcomes (CO's) with program outcomes (PO's):

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	-	-	-	-	-	-	-	-
CO2	2	3	1	1	-	-	-	-	-	-	-	-
CO3	2	3	2	1	-	-	-	-	-	-	-	-
CO4	1	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	3	2	2	-	3	-	-	-	-	-

Petroleum Refinery Engineering Lab

Pre-requisites: Process Engineering II (CL5112)

Course outcomes: At the end of the lab, student will be able to

CO1	Investigate the characteristics of petroleum products.
CO2	Analyse the flow behaviour of petroleum product.
CO3	Examine the flammability of petroleum products
CO4	Understand the storage and handling of petroleum hazardous materials

Mapping of course outcomes (CO's) with program outcomes (PO's):

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	3	-	-	1	-	1	-	-	-
CO2	2	2	1	2	-	-	1	-	1	-	-	-
CO3	2	2	1	1	-	-	2	-	1	-	-	-
CO4	2	1	1	-	-	1	2	-	1	-	-	1

List of experiments:

1. Determine the flash point of the given sample of oil using PENSKY MARTIN's apparatus.
2. Determine the flash and fire points of the given sample of oil using CLEVELAND open-cup apparatus.
3. Determine the kinematic viscosity and dynamic viscosity of a given sample of oil at different temperatures using SAYBOLT UNIVERSAL viscometer.

4. Determine the cloud and pour points of the given sample of oil.
5. Determine the viscosity in Engler's seconds of the given samples of oil and to plot the variation of Engler's seconds, kinematic and dynamic viscosity with temperature.
6. Determination of smoke point of light petroleum products.
7. Study of vapour pressure of petroleum products using Reid's vapour pressure method.