दिल्ली प्रौद्योगिकी विश्वविद्यालय

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
(Estd. By Govt. of NCT of Delhi vide Act 6 of 2009)

SCHEME OF TEACHING AND EXAMINATIONS
BACHELOR OF TECHNOLOGY
POLYMER SCIENCE & CHEMICAL TECHNOLOGY
W.E.F 2015

DEPARTMENT OF APPLIED CHEMISTRY

Scheme of Teaching and Examinations

B. Tech. (Polymer Science & Chemical Technology)

W.E.F. 2015

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

CONTENTS

VISION

To be a world class university through education, innovation and research for the service of humanity.

MISSION

1. To establish centres of excellence in emerging areas of science, engineering, technology, management and allied areas.

2. To foster an ecosystem for incubation, product development, transfer of technology and entrepreneurship.

3. To create environment of collaboration, experimentation, imagination and creativity.

4. To develop human potential with analytical abilities, ethics and integrity.

5. To provide environment friendly, reasonable and sustainable solutions for local & global needs.

DEPARTMENT OF APPLIED CHEMISTRY

VISION

To be a Centre of Excellence in the area of Applied Chemistry, Polymer Science & Chemical Technology.

MISSION

1. Be a world class centre for Education, Research and Innovation in the field of Applied Chemistry and Polymer Technology, focus on cutting edge Technologies for Education delivery and foster Environment of seamlessness between Academics and Industries.

2. Meet the need for Engineers and Scientists at all levels of tertiary education, UG, PG and Doctoral levels.

Program Educational Objectives (PEOs)

PEO-1   To equip students with strong knowledge of chemical, physical, mathematical and engineering concepts, managerial and communication skills, environmental issues and ethics & human values.

PEO-2   To provide an in-depth knowledge of polymer science and principles of chemical engineering to address the challenges of chemical and plastic industries

PEO-3   To develop an understanding of machines and tools related to manufacturing, processing, quality assurance and testing of chemicals and polymers.

PEO-4   To bring out creative and innovative abilities of students by incorporating Academia – industrial interactions, project activities as essential component of curriculum.

PEO-5   Enabling graduates to pursue higher studies in India and abroad

PEO-6   Enabling graduates to become entrepreneurs.

DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF TECHNOLOGY (POLYMER SCIENCE & CHEMICAL TECHNOLOGY)

I Year: Odd Semester

S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
								Contact Hours/Week		Exam Duration (h)		Relative Weights (%)		
Group A														
1	MA101	Mathematics - I	ASC	4	3	1	0	3	0	25	-	25	50	-
2	AP101	Physics – I	ASC	4	3	0	2	3	0	15	15	30	40	-
3	AC101	Chemistry	ASC	4	3	0	2	3	0	15	15	30	40	-
4	ME101	Basic Mechanical Engineering	AEC	4	4	0	0	3	0	25	-	25	50	-
5	ME103	Workshop Practice	AEC	2	0	0	3	0	3	-	50	-	-	50
6	HU101	Communication Skills	HMC	3	3	0	0	3	0	25	-	25	50	-
		Total		**21**	**16**	**1**	**7**							
Group B														
1	MA101	Mathematics - I	ASC	4	3	1	0	3	0	25	-	25	50	-
2	AP101	Physics – I	ASC	4	3	0	2	3	0	15	15	30	40	-
3	EE101	Basic Electrical Engineering	AEC	4	3	0	2	3	0	15	15	30	40	-
4	CO101	Programming Fundamentals	AEC	4	3	0	2	3	0	15	15	30	40	-
5	ME105	Engineering Graphics	AEC	2	0	0	3	0	3	-	50	-	-	50
6	EN101	Introduction to Environmental Science	AEC	3	3	0	0	3	0	25	-	25	50	-
		Total		**21**	**15**	**1**	**9**							

I Year: Even Semester

S. No.	Subject Code	Course Title	Subject Area	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
		Teaching Scheme						Contact Hours/ Week		Exam Duration		Relative Weights (%)		
Group A														
1	MA102	Mathematics-II	ASC	4	3	1	0	3	0	25	-	25	50	-
2	AP102	Physics – II	ASC	4	3	0	2	3	0	15	15	30	40	-
3	EE102	Basic Electrical Engineering	AEC	4	3	0	2	3	0	15	15	30	40	-
4	CO102	Programming Fundamentals	AEC	4	3	0	2	3	0	15	15	30	40	-
5	ME102	Engineering Graphics	AEC	2	0	0	3	0	3	-	50	-	-	50
6	EN102	Introduction to Environmental Science	AEC	3	3	0	0	3	0	25	-	25	50	-
		Total		21	15	1	9							
Group B														
1	MA102	Mathematics – II	ASC	4	3	1	0	3	0	25	-	25	50	-
2	AP102	Physics – II	ASC	4	3	0	2	3	0	15	15	30	40	-
3	AC102	Chemistry	ASC	4	3	0	2	3	0	15	15	30	40	-
4	ME104	Basic Mechanical Engineering	AEC	4	4	0	0	3	0	25	-	25	50	-
5	ME106	Workshop Practice	AEC	2	0	0	3	0	3	-	50	-	-	50
6	HU102	Communication Skills	HMC	3	3	0	0	3	0	25	-	25	50	-
		Total		21	16	1	7							

II Year: Odd Semester

S.No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	EC271	Basic Electronics Engg.	AEC	4	3	0	2	3	0	15	15	30	40	-
2.	PT201	Principles of Polymerization	DCC	4	3	0	2	3	0	15	15	30	40	-
3.	PT203	Elements of Chemical Engg.	DCC	4	3	0	2	3	0	15	15	30	40	-
4.	PT205	Chemical Engineering Thermodynamics	DCC	4	3	0	2	3	0	15	15	30	40	-
5.	PT207	Engineering Analysis and Design	DCC	4	3	0	2	3	0	15	15	30	40	-
6.	MG201	Fundamentals of Management	HMC	3	3	0	0	3	-	25	-	25	50	-
		Total		23										

II Year: Even Semester

S.No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	EE282	Instrumentation and Control	AEC	4	3	0	2	3	0	15	15	30	40	-
2.	PT202	Fluid Mechanics	DCC	4	3	0	2	3	0	15	15	30	40	-
3.	PT204	Polymer Processing	DCC	4	3	0	2	3	0	15	15	30	40	-
4.	PT206	Polymer Structure and Properties	DCC	4	3	0	2	3	0	15	15	30	40	-
5.	PT208	Chemical Reaction Engg.	DCC	4	3	0	2	3	0	15	15	30	40	-
6.	HU202	Engineering Economics	HMC	3	3	0	0	3	-	25	-	25	50	-
		Total		23										

III Year: Odd Semester

S.No..	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	PT301	Heat Transfer	DCC	4	3	0	2	3	0	15	15	30	40	-
2.	PT303	Polymer Processing Techniques	DCC	4	3	0	2	3	0	15	15	30	40	-
3.	PT3xx	Departmental Elective Course-1	DEC/ GEC	4	3	0/1	2/ 0	3	0	15/ 25	15/-	30 /25	40/ 50	-
4	PT3xx	Departmental Elective Course-2	DEC/ GEC	4	3	0/1	2/ 0	3	0	15/ 25	15/-	30 /25	40/ 50	-
5.	UE	OpenElective Course	OEC	3	3	0	0	3	0	25	-	25	50	-
6.	HU301	Technical Communication	HMC	2	2	0	0	3	-	25	-	25	50	-
		Total		21										

III Year: Even Semester

S.No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	PT302	Rubber Technology	DCC	4	3	0	2	3	0	15	15	30	40	-
2.	PT304	Mass Transfer	DCC	4	3	0	2	3	0	15	15	30	40	-
3.	PT306	Plastic Technology	DCC	4	3	0	2	3	0	15	15	30	40	-
4.	PT3xx	Departmental. Elective Course-3	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	15/-	30 /25	40/ 50	-
5.	PT3xx	Departmental. Elective Course-4	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	15/-	30 /25	40/ 50	
6.	HU304	Professional Ethics and Human values	HMC	2	2	0	0	3	-	25	-	25	50	-
		Total		22										

IV Year: Odd Semester

S. No	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	PT401	B. Tech Project-I	DCC	4										
2.	PT403	Training Seminar	DCC	2										
3.	PT405	Fibre Technology	DCC	4	3	0	2	3	0	15	15	30	40	-
4.	PT407	Chemical Process Technology	DCC	4	3	0	2	3	0	15	15	30	40	-
5.	PT4xx	Departmental. Elective Course - 5	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	15/-	30 /25	40/ 50	
6.	PT4xx	Departmental. Elective Course - 6	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	15/-	30 /25	40/ 50	
		Total		**22**										

IV Year: Even Semester

S. No.	Code	Title	Area	Cr	L	T	P	TH	PH	CWS	PRS	MTE	ETE	PRE
1.	PT402	B. Tech Project-II	DCC	8										
2.	PT404	Polymer Product and Die Design	DCC	4	3	0	2	3	0	15	15	30	40	-
3.	PT4xx	Departmental. Elective Course-7	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	15/-	30 /25	40/ 50	
4.	PT4xx	Departmental Elective Course-8	DEC/ GEC	4	3	0/1	2/0	3	0	15/ 25	15/-	30 /25	40/ 50	
		Total		**20**										

List of Departmental Electives Courses

S. No.	Sub. Code	Course Title	DEC detail
1.	PT-305	Process Equipment Design	DEC – 1 & 2
2.	PT-307	Optimization Techniques	
3.	PT-309	Petroleum Refining Engineering	
4.	PT-311	Renewable & Non-renewable energy	
5.	PT-313	Combustion Engineering	
6	PT-315	Packaging Technology	
7	PT-317	Polymer Coatings & Adhesives	
8	PT-319	Biomaterials	
9	PT-321	Biosensor Technology	
10	PT-323	Biochemical Engineering	
11	PT-308	Advanced Chemical Reaction Engineering	DEC – 3 & 4
12	PT-310	Chemical Process Simulation	
13	PT-312	Numerical Methods in Chemical Engineering	
14	PT-314	CAD in Chemical Engineering	
15	PT-316	Corrosion Engineering	
16	PT-318	Polymer Blends and Composite	
17	PT-320	Polymer Rheology	
18	PT-322	Non-Woven Technology	
19	PT-324	Application of Nanotechnology in Polymer	
20	PT-326	Polymer Reaction Engineering	

21	PT-409	Tyre Technology	DEC – 5 & 6
22	PT-411	Thermoplastic Elastomers	
23	PT-413	Resins Technology	
24	PT-415	Paint Technology	
25	PT-417	Footwear Technology	
26	PT-419	Plastic and Environment	
27	PT-421	Industrial Waste Management	
28	PT-423	Polymer Degradation	
29	PT-425	Energy Conservation & Recycling	
30	PT-427	Safety & Hazards in Chemical Industry	
31	PT-406	Speciality Polymers	DEC – 7 & 8
32	PT-408	Colouration Technology	
33	PT-410	Membrane Technology	
34	PT-412	Inorganic Polymer	
35	PT-414	Food Technology	
36	PT-416	Process Design and Engineering Economics	
37	PT-418	Fertilizer Technology	
38	PT-420	Fuel Cell Technology	
39	PT-422	Pharmaceutical Technology	
40	PT-424	Rocket Propulsion and Explosives	

List of Open Elective Courses

S.No.	SUBJECT CODE	SUBJECTS
1.	CO351	Enterprise & Java Programming
2.	CO353	E-commerce & ERP
3.	CO355	Cryptography & Information Security
4.	CO357	Operating System
5.	CO359	Intellectual Property Rights & Cyber Laws
6.	CO361	Database Management System
7.	EC351	Mechatronics
8.	EC353	Computer Vision
9.	EC355	Embedded System
10.	EC 357	Digital Image Processing
11.	EC359	VLSI Design
12.	EE351	Power Electronics Systems
13.	EE353	Electrical Machines and Power Systems
14.	EE355	Instrumentation Systems
15.	EE357	Utilization of Electrical Energy
16.	EE359	Non-conventional Energy Systems
17.	EE361	Embedded Systems
18.	EN351	Environmental Pollution & E- Waste Management
19.	EN353	Occupational Health & Safety Management
20.	EN355	GIS & Remote Sensing
21.	EP351	Physics of Engineering Materials
22.	EP353	Nuclear Security
23.	HU351	Econometrics
24.	MA351	History Culture & Excitement of Mathematics
25.	ME351	Power Plant Engineering
26.	ME353	Renewable Sources of Energy
27.	ME355	Combustion Generated Pollution
28.	ME357	Thermal System

29.	ME359	Refrigeration & Air Conditioning
30.	ME361	Industrial Engineering
31.	ME363	Product Design & Simulation
32.	ME365	Computational fluid dynamics
33.	ME367	Finite Element Methods
34.	ME369	Total Life Cycle Management
35.	ME371	Value Engineering
36.	MG351	Fundamentals of Financial Accounting and Analysis
37.	MG353	Fundamentals of Marketing
38.	MG355	Human Resource Management
39.	MG357	Knowledge and Technology Management
40.	PE351	Advance Machining Process
41.	PE 353	Supply Chain Management
42.	PE355	Work Study Design
43.	PE357	Product Design & Simulation
44.	PE359	Total Life Cycle Management
45.	PE361	Total Quality Management
46.	PT361	High Performance Polymers
47.	PT363	Separation Technology
48.	PT365	Non-Conventional Energy
49.	PT367	Polymer Waste Management
50.	PT369	Nanotechnology in Polymers
51.	PT371	Applications of Polymer Blends and Composite
52.	IT 351	Artificial Intelligence and Machine Learning
53.	IT 353	Data Structures and Algorithms
54.	IT 355	Communication and Computing Technology
55.	IT 357	Internet and Web Programming
56.	IT 359	Java Programming
57.	CE351	Geoinformatics and its applications

SYLLABUS

1. Subject Code: **ME 101/104**   : Course Title: **Basic Mechanical Engineering**

2. Contact Hours   : L: 04   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 04

6. Semester   : I / II

7. Subject Area   : AEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the concepts of thermodynamics, fluid mechanics, power plants, engineering materials, manufacturing processes and metrology.

10. Details of Course   :

S. No.	Contents	Contact Hours
PART A		
1	**Introduction:** Introduction to Thermodynamics, Concepts of systems, control volume, state, properties, equilibrium, quasi-static process, reversible & irreversible process, cyclic process. Zeroth Law and Temperature, Ideal Gas. Heat and Work.	05
2	First Law of Thermodynamics for closed & open systems. Non Flow Energy Equation. Steady State, Steady Flow Energy Equation. Second Law of Thermodynamics-Kelvin and Plank's Statements, Clausius inequality, Definition of Heat Engines, Heat pumps, Refrigerators. Concept of Energy and availability. Carnot Cycle; Carnot efficiency, Otto, Diesel, Dual cycle and their efficiencies.	12
3	Principles of power production, basic introduction about thermal power plant, hydroelectric power plant and nuclear power plant.	04

4	Properties & Classification of Fluids, Ideal & real fluids, Newton's law of viscosity, Pressure at a point, Pascal's law, Pressure variation in a static fluid, General description of fluid motion, stream lines, continuity equation, Bernoulli's equation, Steady and unsteady flow.	07
PART B		
5	Introduction to engineering materials for mechanical construction. Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.	12
6	Introduction to Manufacturing processes for various machine elements. Introduction to Casting & Welding processes. Sheet metal and its operations. Introduction to machining processes – turning, milling, shaping, drilling and boring operations. Fabrication of large and small assembles – examples nuts and bolts, turbine rotors etc.	12
7	Introduction to quality measurement for manufacturing processes; standards of measurements, line standards, end standards, precision measuring instruments and gauges: vernier calliper, height gauges, micrometer, comparators, dial indicator, and limit gauges.	04
Total		**56**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
TEXT BOOKS:		
1	Engineering Thermodynamics, P. K. Nag, Tata McGrawa-Hill	2005
2	Fundamentals of Classical Thermodynamics, G. J. Van Wylen and R. E. Santag.	1994
3	Manufacturing Processes, Kalpakjian	2013
4.	Basic Mechanical Engineering,1/e, Pravin Kumar, Pearson Education, Delhi	2013

	REFERENCE BOOKS:	
1	Introduction to Fluid Mechanics and Fluid Machines, S. K. Som and G. Biswas	2013
2	Fluid Mechanics and Hydraulic Machines, R. K. Bansal	2010
3	Workshop Practices, K. Hazara Chowdhary	2007
4	Workshop Technology, W. A. J. Chapman	1972
5	Production Engineering, R. K. Jain, Khanna Publishers	2001

1. Subject Code: **AC 101/102**   :   Course Title: **Chemistry**

2. Contact Hours   :   L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   :   Theory: 03   Practical: 00

4. Relative Weight   :   CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   :   04

6. Semester   :   I / II

7. Subject Area   :   ASC

8. Pre-requisite   :   NIL

9. Objective   :   To familiarize the students with the concepts of Engineering Chemistry, Material characterization and green Chemistry.

10. Details of Course   :

S. No.	Contents	Contact Hours
1.	**Conventional Analysis**: Volumetric Analysis, Types of Titrations, Theory of Indicators.	06
2.	**Spectral Methods of Analysis**: UV-visible, IR, NMR & MS: Principles and Applications.	08

3.	**Thermal Methods of Analysis**: Thermo-gravimetry, Differential thermal analysis and Differential Scanning Calorimetry: Principles and Applications.	04
4.	**Polymers & Plastics**: Functionality and Degree of Polymerization, Mechanism of Polymerization, Molecular Weights of Polymers, Methods of polymerization, Functional Polymers, Industrial applications of Polymers.	06
5.	**Electrochemistry**: Electrochemical cells, components, characteristics of batteries. Primary and Secondary battery systems, Zinc-Carbon cells, Lead storage and lithium batteries. Fuel Cells, Electro-deposition, Electrical and chemical requirements. Electroplating bath and linings. Agitation, Circulation and filtration equipment.	08
6.	**Phase Equilibrium**: Definitions of Phase, component and degree of freedom, Gibb's phase rule. One component systems: Water and sulphur. Two component systems: Pb-Ag and Cu-Ni.	06
7.	**Green Chemistry**: Principles of Green Chemistry, Examples of Green Methods of Synthesis, Reagents and Reactions, Evaluation of feedstocks, Future trends in Green Chemistry.	04
Total		**42**

11. Suggested Books:

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Introduction to Thermal Analysis/ Michael E. Brown/ Springer Netherlands	2001
2	Vogel's Quantitative Chemical Analysis/ J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas / Prentice Hall/6 edition	2000
3	Green Chemistry: Theory & Practice/P.T. Anastas & J.C. Warner/ Oxford Univ Press	2000
4	Polymer Science and Technology/ Fried Joel R./ PHI; 2 edition	2005
5	Electrochemistry/ Philip H. Rieger / Springer	2009

1. Subject Code: **AP 101**   :   Course Title: **Physics – I**

2. Contact Hours   :   L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   :   Theory:03   Practical: 00

4. Relative Weight   :   CWS: 15 PRS: 15   MTE: 30 ETE: 40   PRE: 00

5. Credits   :   04

6. Semester   :   I

7. Subject Area   :   ASC

8. Pre-requisite   :   NIL

9. Objective   :   To impart knowledge of basic concepts in applied
                                            physics and make the students familiar with topics
                                            like interference, diffraction, polarization, fiber
                                            optics, lasers, wave mechanics, etc. This course is
                                            also aimed at enhancing the analytical capability of
                                            the engineering students.

10. Details of Course   :

S. No.	Contents	Contact Hours
1.	**RELATIVITY**: Review of concepts of frames of reference and Galilean transformation equation, Michelson – Morley experiment and its implications, Einstein's special theory of relativity, Lorentz transformation equations, Law of addition of velocities, Mass variation with velocity, Concept of energy and momentum, Mass energy relation.	08
2.	**OSCILLATIONS & WAVES:** Damped and forced oscillations, Resonance (amplitude and power), Q – factor, Sharpness of resonance. Equations of longitudinal and transverse waves and their solutions, Impedance, Reflection and transmission of waves at a boundary, Impedance matching between two medium.	07

3.	**PHYSICAL OPTICS:** Interference by division of wave front and amplitude, Multiple beam interference and Fabry-Perot interferometer, Fresnel diffraction through a straight edge, Zone plate, Fraunhoffer diffraction, single slit and N-slit / grating, Resolving power of telescope, prism and grating. Polarization by reflection and by transmission, Brewster's law, Double refraction, elliptically and circularly polarized light, Nicol prism, Quarter and half wave plates.	12
4.	**OPTICAL INSTRUMENTS:** Cardinal points of co-axial lens systems, spherical and chromatic aberrations and their removal, Huygens and Ramsden's eyepiece.	05
5.	**Lasers:** Coherence and coherent properties of laser beams, Brief working principle of lasers, Spontaneous and stimulated Emission, Einstein's co-efficient, Ruby laser, He-Ne laser.	06
6.	**Optical Fiber:** Classification of optical fibers, Refractive index profile, Corecl adding refractive index difference, Numerical aperture of optical fiber, Pulse dispersion in optical fiber (ray theory).	04
Total		**42**

11. Suggested Books:

S.No.	Name of Books/Authors	Year of Publication/ Reprint
1.	Physics of Vibrations and Waves, by H.J. Pain.	2005/ John Wiley & Sons Ltd
2.	Vibrations and Waves, by A.P. French.	1971/CRC Press
3.	Perspective of Modern Physics, by Arthur Beiser	1981/ McGraw-Hill
4.	Optics, by A. Ghatak.	2006/Tata McGraw-Hill
5.	Berkley Physics Course Vol – 1.	2009/ Tata McGraw-Hill

1. Subject Code: **AP 102**   : Course Title: **Applied Physics-II**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6.	Semester	:	II
7.	Subject Area	:	ASC
8.	Pre-requisite	:	NIL
9.	Objective	:	This course gives a balance account of the fundamentals of Physics as well as some of recent developments in this area best suited to the Engineering applications in different branches and to provide the knowledge and methodology necessary for solving problems in the field of engineering.

10. Details of Course   :

S.No.	Contents	Contact Hours
1.	**Quantum Physics :** Failure of classical physics ,Compton effect , Pair production, de-broglie relation, wave function, Probability density, Schrodinger wave equation, operators, expectation values and eigen-value equation, particle in a box, simple harmonic oscillator problem, concept of degeneracy.	10
2.	**Classical Statistics:** Microscopic-macroscopic systems, concept of phase space, basic postulates of statistical mechanics, Maxwell—Boltzmann distribution law.	05
3.	**Quantum Statistics:** Fermi—Dirac and Bose–Einstein Distribution, Fermi- Dirac probability function, Fermi energy level.	05
4.	**Nuclear Physics:** Nuclear properties, constituent of the nucleus, binding energy, stable nuclei, radioactive decay law (alpha and beta spectrum), Q-value of nuclear reaction , nuclear models: liquid drop and shell model, nuclear fission and fusion, elementary ideas of nuclear reactors.	06
5.	**Electrodynamics:** Maxwell's equations, concept of displacement current, Derivation of wave equation for plane electromagnetic wave, Poynting vector. Poynting theorem, Energy density, wave equation in dielectric & conducting media.	09

6	**Semiconductor Physics:** Concept of intrinsic and extrinsic semiconductors, Fermi level, characteristics of PN Junction, static and dynamic resistance, zenar diode and LED, diode as a rectifier, transistor (PNP and NPN) characteristics, current and voltage gain.	07
	Total	**42**

11. Suggested Books:

S.No.	Name of Books/Authors	Year of Publication/ Reprint
1.	Nuclear Physics, by Erwin Kaplan	2002/Narosa
2.	Concept of Nuclear Physics, by Bernard Cohen	2001/ McGraw-Hill
3.	Perspective of Modern Physics, by Arthur Beiser	1969/ McGraw-Hill US
4.	Electrodynamics, by Griffith	2012/PHI Learning
5.	Electricity & magnetism, by Rangawala& Mahajan.	2012/ McGraw-Hill

1. Subject Code: **EE-101/102** : Course Title: **Basic Electrical Engineering**

2. Contact Hours : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.) : Theory: 03   Practical: 00

4. Relative Weight : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits : 04

6. Semester : I / II

7. Subject Area : AEC

8. Pre-requisite : NIL

9. Objective : To familiarize the students with the concepts of electrical circuits, magnetic circuits, transformer and measuring instruments.

10. Details of Course   :

S. No.	Contents	Contact Hours
1	**Introduction:** Role and importance of circuits in Engineering, concept of fields, charge, current, voltage, energy and their interrelationships. V- I characteristics of ideal voltage and ideal current sources, various types of controlled sources, passive circuit components, V-I characteristics and ratings of different types of R, L, C elements. DC Network: Series and parallel circuits, power and energy, Kirchhoff's Laws, delta-star transformation, superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, Tellgen's theorem.	10
2	**Single Phase AC Circuits:** Single phase emf generation, average and effective values of sinusoids, complex representation of impedance, series and parallel circuits, concept of phasor, phasor diagram, power factor, complex power, real power, reactive power and apparent power, resonance in series and parallel circuits, Q-factor, bandwidth and their relationship, half power points.	10
3	**Three-Phase AC Circuits:** Three phase emf generation, delta and star connection, line and phase quantities, solution of three phase circuits: balanced supply and balanced load, phasor diagram, three phase power measurement by two wattmeter method.	05
4	**Magnetic Circuits and Transformers:** Amperes circuital law, B-H curve, concept of reluctance, flux and mmf, analogies between electrical and magnetic quantities, solution of magnetic circuits, hysteresis and eddy current losses, mutual inductance and dot convention, single phase transformer – construction and principle of working, auto transformer and their applications.	12
5	**Measuring Instruments:** Analog indicating instruments, PMMC ammeters and voltmeters, damping in indicating instruments, shunt and multipliers, moving iron ammeter and voltmeters, dynamometer type instruments, multimeters, AC watt-hour meters. digital voltmeters, ammeters and watt meters.	05
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1	Basic Electrical Engineering, A.E. Fitzgerald , David Higginbotham , Arvin Grabel, Tata McGraw-Hill Publishing Company; 5th Edition.	2009
2	Electrical and Electronic Technology, Edward Hughes, Ian Mckenzie Smith, John Hiley, Pearson Education, 10th edition.	2010
3	Linear Circuit Analysis: Time, Domain, Phasor and Laplace Transform Approaches Raymond A. De Carlo, Pen-Min Lin, Oxford University Press, 2nd Edition.	2001
4	Hayt, Kemmerly & Durbin, "Engineering Circuit Analysis", Tata McGraw Hill Publishing Company Ltd.	2007
5	Electrical Engineering Fundamental V. Del Toro, Prentice-Hall, 2nd Edition.	1989
6	Basic Electrical Engineering, C.L. Wadhwa, New Age International Pvt Ltd Publishers	2007
7	Introduction to Electrical Engineering, Mulukutla S. Sarma, Oxford University Press Inc.	2001

1. Subject Code: **ME-102/105**   : Course Title: **Engineering Graphics**

2. Contact Hours   : L: 00   T: 00   P: 03

3. Examination Duration (Hrs.)   : Theory: 0 Practical: 03

4. Relative Weight   : CWS: 00 PRS: 50 MTE: 00 ETE: 00 PRE: 50

5. Credits   : 02

6. Semester   : I / II

7. Subject Area   : AEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with drafting and engineering drawing practices.

10. Details of Course :

S. No.	Contents	Contact Hours
	PART A	
1	**General:** Importance, Significance and scope of engineering drawing Lettering, Dimensioning, Scales, Sense of Proportioning, Different types of Projections, B.I.S. Specification, line symbols, rules of printing.	03
2	**Projections of Points and Lines:** Introduction of planes of projection, Reference and auxiliary planes, projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance, intersecting and non-intersecting lines.	03
3	**Planes Other than the Reference Planes:** Introduction of other planes (perpendicular and oblique), their traces, inclinations etc., projections of points lines in the planes, conversion of oblique plane into auxiliary plane and solution of related problems.	03
4	**Projections of Plane Figures:** Different cases of plane figure (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.	03
5	**Projection of Solids:** Simple cases when solid is placed in different positions, Axis, faces and lines lying in the faces of the solid making given angles.	03
6	**Isometric and Orthographic Views:** First and Third angle of system of projection, sketching of Orthographic views from pictorial views and vice –versa, Sectional views.	09
7	Principles of dimensioning.	03
8	Development of lateral surfaces of simple solids.	06
9	Introduction to available drafting softwares like AutoCAD	09
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
TEXT BOOKS:		
1	Engineering Graphics, Narayana, K.L. and Kannaiah, P, Tata McGraw Hill	2005
REFERENCE BOOKS:		
1	Engineering Graphics, Naveen Kumar and S C Sharma	2013
2	Engineering Graphics, Chandra, A.M. and Chandra Satish, CRC Press	2003

1. Subject Code: **EN-101/102** : Course Title: **Introduction to Environmental Science**

2. Contact Hours : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.) : Theory: 03   Practical: 0

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 03

6. Semester : I / II

7. Subject Area : AEC

8. Pre-requisite : NIL

9. Objective : To introduce basic fundamentals of Environmental Science.

10. Details of Course   :

S. No.	Contents	Contact Hours
1.	**Introduction to Environment** Definition, Scope, and importance of environmental studies; need for public awareness; Segments of environment- lithosphere, hydrosphere, atmosphere, and biosphere; Environmental degradation; Role of individual in environmental conservation; sustainable lifestyle.	06
2.	**Natural Resources** Forest Resources : Deforestation, mining, dams and their effects on forest and tribal people; Water resources: over-utilization, floods, drought, conflicts over water, dams-benefits and problems; Mineral resources: Use and exploitation, environmental effects; Food resources : World food problems, changes caused by modern agriculture, fertilizer-pesticide problems, water logging, salinity; Energy resources : Growing energy needs, renewable and non renewable energy sources; Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.	09
3.	**Ecosystems and Biodiversity** Concept of an ecosystem, Structure and function, Energy flow, Ecological succession, ecological pyramids; Types, characteristic features, structure and function of the Forest, Grassland, Desert, and Aquatic ecosystems Concept of Biodiversity, definition and types, Bio-geographical classification of India; Value of biodiversity; Biodiversity at global, national and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity, Endangered and endemic species of India, Conservation of biodiversity.	09
4.	**Environmental Pollution** Definition, Cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards Solid waste Management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides.	09

5.	**Social Issues and Environment** Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation, Consumerism and waste products, Environment Laws and Acts, Issues involved in enforcement of environmental legislation, Public awareness. Population growth, variation among nations, Family Welfare Programme.	09
	Total	**42**

1. Subject Code: **MA-101**   : Course Title: **Mathematics – I**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : I

7. Subject Area   : ASC

8. Pre-requisite   : NIL

9. Objective   : To acquaint the students with the knowledge of series & sequence, single & multiple variable calculus, knowledge of vector calculus and their applications.

10. Details of Course   :

S. No.	Contents	Contact Hours
1.	**Infinite series**: Tests for convergence of series (Comparison, Ratio, Root, Integral, Raabe's, logarithmic), Alternating series, Absolute convergence, Conditional convergence.	06
2.	**Differential & Integral Calculus of single variable:** Taylor's & MaClaurin's expansion, Radius of curvature, Tracing of some standard curves, Applications of definite integral to Area, Arc length, Surface area and volume (in cartesian, parametric and polar co-ordinates).	07
3.	**Calculus of several variables**: Partial differentiation, Euler's theorem, Total differential, Taylor's theorem, Maxima-Minima, Lagrange's method of multipliers, Application in estimation of error and approximation.	07
4.	**Multiple Integrals**: Double integral (Cartesian and polar co-ordinates), Change of order of integration,Triple integrals (Cartesian, cylindrical and spherical co-ordinates), Beta and Gamma functions, Applications of multiple integration in area and volume.	08
5.	**Vector Differential Calculus**: Continuity and differentiability of vector functions, Scalar and Vector point function, Gradient, Directional Derivative, Divergence, Curl and their applications.	07
6.	**Vector Integral Calculus**: Line integral, Surface integral and Volume integral, Applications to work done by the force, Applications of Green's, Stoke's and Gauss divergence theorems.	07
Total		**42**

11. Suggested Books:

S. No.	Name of Books/Authors Publishers	Year of Publication/ Reprint
1.	Advanced engineering mathematics: Kreyszig; Wiley-India. 9th Edition ISBN : 978-81-265-3135-6	2011
2.	Advanced engineering mathematics: Jain/Iyenger; Narosa. 2nd Edition. ISBN: 81-7319-541-2	2003

3.	Advanced engineering mathematics: Taneja; I K international ISBN: 978-93-82332-64-0	2014
4.	Advanced engineering mathematics: Alan Jeffery; Academic Press ISBN: 978-93-80501-50-5	2010
5.	Calculus and analytic geometry: Thomas/Finney; Narosa. ISBN : 978-81-85015-52-1	2013

1. Subject Code: **MA-102**   : Course Title: **Mathematics – II**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : II

7. Subject Area   : ASC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge of matrices and applications closed form and series solutions of Differential equations, Laplace Transform, Fourier series, Fourier Transform & their applications.

10. Details of Course   :

S. No.	Contents	Contact Hours
1.	**Matrices**: Rank of a matrix, Inverse of a matrix using elementary transformations, Consistency of linear system of equations, Eigen-values and Eigenvectors of a matrix, Cayley Hamilton theorem, Diagonalization of matrix.	07

2.	**Ordinary differential equations:** Second & higher order linear differential equations with constant coefficients, General solution of homogenous and non - homogenous equations, Method of variation of parameters, Euler-Cauchy equation, Simultaneous linear equations, Applications to simple harmonic motion.	08
3.	**Special Functions**: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.	08
4.	**Laplace Transforms**: Basic properties, Laplace transform of derivatives and integrals, Inverse Laplace transform, Differentiation and Integration of Laplace transform, Convolution theorem, Unit step function, Periodic function, Applications of Laplace transform to initial and boundary value problems.	08
5.	**Fourier series** : Fourier series, Fourier Series of functions of arbitrary period, Even and odd functions, half range series, Complex form of Fourier Series, Numerical Harmonic analysis.	06
6.	**Fourier Transforms**: Fourier Transforms, Transforms of derivatives and integrals, Applications to boundary value problem in ordinary differential equations (simple cases only).	05
Total		**42**

11. Suggested Books:

S. No.	Name of Books/Authors Publishers	Year of Publication/ Reprint
1.	Advanced engineering mathematics: Kreyszig; Wiley. ISBN : 978-81-265-3135-6	2011
2.	Advanced engineering mathematics: Jain/Iyenger; Narosa. ISBN: 81-7319-541-2	2003
3.	Advanced engineering mathematics: Taneja; I K international ISBN: 978-93-82332-64-0	2014
4.	Advanced engineering mathematics: Alan Jeffery; Academic Press ISBN: 978-93-80501-50-5	2010

5.	Advanced engineering mathematics: Peter V. O'Neil Cengage Learning. ISBN : 978-81-315-0310-2	2007

1. Subject Code: **HU 101/102** : Course Title: **Communication Skills**

2. Contact Hours : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.) : Theory: 03   Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 03

6. Semester : I / II

7. Subject Area : HMC

8. Pre-requisite : NIL

9. Objective : To impart essential skills required for effective communication in English language.

10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Communication Communication: Process, Features, Barriers Language, Technology and Communication	02
2	Unit II: Grammar and Usage Vocabulary-Words/Word Formation, Confusing Word Pairs Sentence Construction, Sentence Types, Direct/Indirect Speech Punctuation, Error Spotting, Idioms and Phrases	06
3	Unit III: Oral Communication Phonetics of English, Vowels, Consonants, syllables, transcription of words and simple sentences using IPA: Speech Sounds and their articulation; phonemes, Syllable, Stress, Transcription of words and Simple Sentences Language Lab Practice for Oral Communication: Project Presentations, Group Discussions, Debates, Interviews etc.	12

4	Unit IV: Written Technical Communication Composition- Descriptive, Explanatory, Analytical and Argumentative Writing Paragraphs (Essay, Summary, Abstract) Reading and Comprehension, Providing working mechanism of instruments, appliances, description of processes, their operations and descriptions; Drawing Inferences from graphs, charts, Diagrams etc.	12
5	Unit V: Texts for Appreciation and Analysis Improve your Writing by V. N. Arora and Lakshmi Chandra (OUP) Vijay Seshadri. *3 Sections* (2014) **or** *Gestures: Poetry from SAARC Countries* Ed. K. Satchidanandan. Sahitya Akademi: New Delhi ISBN- 81-260-0019-8 Ursula K. Leguin. *The Telling*, Harcourt Inc. 2000 **or** *Animal Farm* by George Orwell (1945) ISBN: 9781502492791 **or** *Frankenstein* by Mary Shelley (1818) Harper Collins India Ltd.: NOIDA ISBN: 9780007350964	10
Total		**42**

Text Books:

Sl.No.	Name of Books, Authors, Publishers	Year of Publication/ Reprint
1.	*Improve your Writing* by V.N.Arora and Lakshmi Chandra OUP: Delhi ISBN 13: 978-0-19-809608-5	1981, 2013 (Revised Edition)
2.	*Technical Communication: Principles and Practice* by Meenakshi Raman and Sangeeta Sharma OUP: Delhi. ISBN-13: 9780-19-806529-6	2011, Reprinted in 2014
3.	*English Phonetics and Phonology: A Practical Course*. By Peter Roach. Cambridge: Cambridge University Press. (Fourth Edition) ISBN: 978-0-521-14921-1	2009, 2014 (Reprinted)
4.	Vijay Seshadri. *3 Sections*, Harper Collins India Ltd.: India. ISBN: 9789351367734. **or** *Gestures: Poetry from SAARC Countries* Ed. K. Satchidanandan. Sahitya Akademi: New Delhi ISBN- 81-260-0019-8	2014 1996, Reprint 2007

| 5. | Ursula K. Leguin. *The Telling*, Harcourt Inc. 2000 **or**
 Animal Farm by George Orwell (1945) ISBN: 9781502492791 **or**
 Frankenstein by Mary Shelley (1818) Harper Collins India Ltd.: Noida
 ISBN: 9780007350964 | 2000
 1945/ 2014 Reprint
 1818/ Latest Reprint 2012 |

11. Suggested Books

Sl.No.	Name of Books, Authors, Publishers	Year of Publication / Reprint
1.	Maison, Margaret M. *Examine Your English.* Orient Blackswan: Delhi,	2009
2.	Sharma, Sangeeta & Binod Sharma. *Communication Skills for Engineers & Scientists*, PHI.	2012
3.	Swan, Michael, Catherine Walter. *Oxford English Grammar Course. OUP: Delhi,*	2011
4.	Kumar, E Suresh & P Sreehari *A Handbook for English Language Laboratories*, 2nd Edition, Cambridge University Press,Foundation Books,	2014
5.	Dutt, P Kiranmai, Geetha Rajeevan & CLN Prakash *A Course in Communication Skills. Cambridge University Press (*Foundation Books).	2013
6.	Mitra, Barun K. *Personality Development and Soft Skills*.OUP: Delhi.	2011
7.	Apps for Phonetics- Advanced English Dictionary for Windows phone & OALD for Android phone	Latest

1. Subject Code: **CO 101/102**   : Course Title: **Programming Fundamentals**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory : 3   Practical : 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40   PRE: 00

5. Credits   : 04

6.	Semester	:	I / II
7.	Subject Area	:	AEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To introduce fundamentals of Programming using C and C++, concepts of program development and object Oriented Programming.

10. Details of Course   :

S.No.	Contents	Contact Hours
1.	Introduction: Concepts of algorithm, flow chart, Introduction to different Programming Languages like C, C++, Java etc. Elementary Programming in C: Data types, assignment statements, Arithmetic, unary, logical, bit-wise, assignment and conditional operators, conditional statements and input/output statements.	06
2.	Iterative programs using loops- While, do-while, for statements, nested loops, if else, switch, break, Continue, and goto statements, comma operators. Concept of subprograms.	06
3.	Array representation, Operations on array elements, using arrays, multidimensional arrays. Structures & Unions: Declaration and usage of structures and Unions. Defining and operations on strings.	06
4.	Pointers: Pointer and address arithmetic, pointer operations and declarations, using pointers as function argument. File: Declaration of files, different types of files. File input/ output and usage-, File operation: creation, copy, delete, update, text file, binary file..	08
5.	Concept of macros and pre-processor commands in C, Storage types: Automatic, external, register and static variables. Sorting and searching algorithms: selection sort, bubble sort, insertion sort, merge sort, quick sort and binary search.	08
6.	Introduction to Object Oriented Programming: OOPS concepts: class, encapsulation, inheritance, polymorphism, overloading etc. C++ introduction, Concept of class, methods, constructors, destructors, inheritance.	08
	Total	**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	The C Programming Language, 2nd Edition, Brian W. Kernighan, Dennis M. Ritchie, PHI, (ISBN-978-8120305960)	1988
2.	Let Us C, 13th Edition, YashavantKanetkar, BPB Publications, (ISBN: 978-8183331630)	2013
3.	Mastering C, Venugopal K R, Sudeep R Prasad, Edition 1,McGraw Hill Education. (ISBN- 9780070616677)	2006
4.	Programming in ANSI C , Sixth Edition, McGraw Hill Education (India) Private Limited E Balagurusamy (ISBN: 978-1259004612)	2012
5.	Object Oriented Programming with C++, Sixth edition , E. Balagurusamy, McGraw Hill Education (India) Private Limited (ISBN: 978-1259029936)	2013

1. Subject Code: **ME 103/106**   : Course Title: **Workshop Practice**

2. Contact Hours   : L: 00   T: 00   P: 03

3. Examination Duration (Hrs.)   : Theory : 00   Practical : 03

4. Relative Weight   : CWS: 00 PRS: 50 MTE: 00 ETE: 00 PRE: 50

5. Credits   : 02

6. Semester   : I / II

7. Subject Area   : AEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with manufacturing shops like Carpentry, Foundry, Welding, Machining, Fitting and Smithy.

10. Details of Course :

Sl. No.	Shop	Description	Contact Hours
1.	Carpentry	Study of Different Carpentry Tools and Pattern Making of a given job (pulley/screw jack body)	03
2.	Foundry	Study of Different Foundry Tools and Furnaces Making a green sand mould of a given pattern (pulley/ screw jack body) and its casting	06
3.	Welding	Arc welding of butt joint, T-joint and lap joint Study of other welding/ joining Techniques	09
4.	Machining	Study of lathe, milling, drilling machine, shaper, planer and grinding machine. Demonstration of a job on lathe	09
5.	Fitting	Study of various fitting hand tools, marking and measuring devices Preparation of a given job (box / funnel)	09
6.	Smithy	Study of different forming tools and power press Preparation of a given job (bolt / chisel)	06
Total			**42**

1. Subject Code: **EC271**   Course Title: **Basic Electronics Engineering**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.) : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40   PRE: 00

5. Credits   : 04

6. Semester   : III

7. Subject Area   : AEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the concepts of basic electronics and instrumentation.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to semiconductor physics: Classification of materials (conductors, insulators and semiconductor), Intrinsic and extrinsic semiconductors, drift and diffusion currents, p-n Junction diode: Physical operation, diode current equation and I-V characteristic and piecewise linear model, concept of load line, Breakdown in p-n diodes, Zener diode; Diode applications: Rectifiers Zener regulators, clipping and clamping circuits.	9
2	Bipolar Junction Transistor (BJT): Physical structure and modes of operation, BJT current components, BJT characteristics, large-signal equivalent circuit and concept of load line, small-signal equivalent. Basic single- stage BJT amplifiers (CE, CB, CC) and frequency response of an RC coupled amplifier. JFET/MOSFET characteristics and amplifiers.	9
3	Concept of positive and negative feedback, merits and demerits of negative feedback, Principle of oscillation, LC and RC oscillators; Power Amplifiers (Class A and Class B), operational Amplifier and basic applications; Operational amplifiers: Ideal characteristics, basic Applications: Inverting and non-inverting amplifier Integrator, Differentiator, voltage follower, Summing and difference circuit.	8

S. No.	Contents	Contact Hours
4	Introduction to Digital Circuits: Digital and analog signals, number systems, Boolean algebra, Logic Gates, minimization of switching function: Karnaugh map method.	8
5	Combinational and Sequential Circuits: Binary half and full adder and subtractor, muliplexer and decoder, flip flops, Counters, Shift Registers.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Electronic Devices and Circuit Theory/ Robert L. Boylestad and Louis Nashelsky/ Pearson	2013
2	Electronics: Analog and Digital/ I. J. Nagrath	2013
3	Modern Digital Electronics/ R. P. Jain/ Tata McGraw-Hill	2010

1. Subject Code: **PT201**   Course Title: **Principles of Polymerization**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : III

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge of polymerization process, chemistry and kinetics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	General introduction to polymer structure: Classification and nomenclature of polymers, Monomer and functionality, Polymerization and degree of polymerization, high polymers and associated polymers, Concept of stereo-chemistry of polymers, Molecular Weights determination, Auto-acceleration, Factors affecting molecular weight and molecular weight distribution, Chain-transfer reactions, retarders, inhibitors. Photo and bio-degradation of polymers.	10

2	Polymerization: Classification of polymerization mechanism, Stepwise polymerization, Kinetics and statistics of linear stepwise polymerization, Radical chain (Addition) polymerization: Chain polymerization, Laboratory methods in vinyl polymerization, Absolute reaction rates, Steady state kinetics.	9
3	Chemistry of Polymerization: Chemistry of radical and non-radical chain polymerization, Coordination polymerization, Ring opening polymerization. Catalytic polymer systems.	8
4	Co-polymerization: Kinetics of co-polymerization, composition of co-polymers, chemistry of co-polymerization, block and graft co-polymerization, Alternate, Random Copolymerization, Polymerization Conditions and polymer reactions,	9
5	Techniques of Polymerization: Bulk, Solution, Suspension & Emulsion, Industrial methods of polymerization, polymerization in homogenous systems, polymerization in heterogeneous systems.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Textbook of Polymer Science/ F.W. Billmeyer/ John Wiley	2008
2	Polymer Science/ V.R. Gowarikar/ New Age International	2016
3	Polymer Chemistry/ M.P. Stevens/ Oxford University Press	1999
4	Principle of Polymerization/ G Odian/ Wiley	2004

1. Subject Code: **PT203**   Course Title: **Elements of Chemical Engineering**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : III

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart basic knowledge of chemical engineering.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Concepts of chemical engineering, Modern concept of unit operations and processes, Introduction to co-current, counter current processes, flow and drag reduction, batch, semi-batch and continuous reactors.	10
2	Stoichiometry: Material and energy balance, Flow sheets for single and multi-stage operations with and without chemical reactions, Thermo-chemical calculations.	9
3	Mechanical operations: Particle size and its importance, Size reduction and separations, Concept of mixing and agitation, Settling, Centrifugation, Filtration, Various types of conveyers and their uses in processing.	9
4	Reactors, Materials of construction, Physical and mechanical properties, Selection of materials for different conditions of processes like high and low temperatures, pressure and vacuum applications, chemical composition of materials to be selected, properties and performance of newer plastics and metals towards economic selection, Corrosion and its control.	14

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Elements of Chemical Reaction Engineering/ H. Scott Fogler/ Prentice Hall	2005
2	Outlines of Chemical Technology/ C.E. Dryden/ East West Press	2010
3	Encyclopedia of Chemical Technology/ Kirk-Othmer/ Wiley	2014
4	Principles of Unit Operations/ A.S. Foust e al / Wiley India	2008

1. Subject Code: **PT205**   Course Title: **Chemical Engineering Thermodynamics**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4.	Relative Weight	:	CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00
5.	Credits	:	04
6.	Semester	:	III
7.	Subject Area	:	DCC
8.	Pre-requisite	:	NIL
9.	Objective	:	To familiarize the students with concepts of chemical engineering thermodynamics.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Fundamental concepts and definitions, Temperature and zeroth law of thermodynamics, Equation of states, P-V-T- relationships and application, First law of thermodynamics: Application of first law to different processes in close and open systems, Limitations of first law	8
2	Second law of thermodynamics, entropy concept, entropy and lost work calculations, Microscopic interpretation of entropy, Mathematical statement of second law, Carnot cycle for an ideal gas, Refrigeration cycle, criterion of irreversibility, Third law of thermodynamics and its applications, free energy functions and their significance in phase and chemical equilibria.	9
3	Thermodynamic property relations: Maxwell relations, Joule-Thomson coefficient, Clasius-Clapeyron equation, Thermodynamic diagrams; Partial Molar Properties, Fugacity, Activity and activity coefficients, Variation of activity coefficient with temperature and composition, Fugacity of liquid and solid, fugacity coefficient for pure species and solution, Generalized correlations for fugacity coefficient, Dependence of fugacity on temperatures and pressure.	9
4	Phase Equilibria: Predicting VLE of systems, VLE at low to moderate pressures, Calculation of the VLE data for a binary mixture, VLE at high pressures. Gibbs-Duhem equation and its application to vapour liquid equilibria, Thermodynamic consistency.	8
5	Chemical Reaction Equilibria: Criterion of chemical reaction equilibrium, Application of Equilibrium Criteria to Chemical Reactions, the standard Gibbs Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Equilibrium Conversions for single Reactions.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Introduction to Chemical Engineering Thermodynamics / J.M. Smith, H.C. Van Ness, M.M. Abbott / 7th Ed / McGraw Hill	2005
2	Chemical Engineering Thermodynamics/ Rao/ University Press	1997
3	A Textbook of Chemical Engineering Thermodynamics/ K.V. Narayanan/ Prentice – Hall of India Pvt. Ltd.	2001

1. Subject Code: **PT207** Course Title: **Engineering Analysis and Design**

2. Contact Hours : L: 03 T: 00 P: 02

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits : 04

6. Semester : III

7. Subject Area : DCC

8. Pre-requisite : NIL

9. Objective : To familiarize the students with characterization of monomers and polymers

10. Details of Course:

S. No.	Contents	Contact Hours
1	Structural Analysis of monomer and polymer: Principles, theories and applications to monomeric and polymeric systems with suitable illustration of the techniques like FTIR, NIR, UV-Vis, NMR and Raman spectroscopy.	10
2	Molecular weight distribution, Significance, and fractionation, Methods of determination of different molecular weights.	8

3	Polymer structure analysis: Configuration and conformation of polymers, structure of amorphous phase, two phase structure of semi crystalline polymers, crystal morphologies, crystallization, unit cell structure, extended chain crystal, lamellar, spherulites.	8
4	Static stress and strain measurements, tensile machines, extensiometry environmental cabinets, flexural properties and compressive properties. Hardness, durometers, dead load instruments and other indentation tests. Load analysis on polymer structures.	8
5	Dynamic stress and strain properties, Forced vibration machines, Free vibration machines, Rebound resilience, Impact strength, Falling weight, Charpy and Izod, Load analysis on polymer structures.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Handbook of Plastic Testing & Failure Analysis/ V. Shah/ Wiley Inter-science	2006
2	Testing & Evaluation of Plastics/ Mathur & Bhardwaj/ Allied Publishers Pvt Ltd	2003
3	Handbook of Plastics Technology/ Allen & Baker/ CBS Publishers	2004
4	Introduction to Plastics & Composites/ E. Miller/ Marcel Dekker	1996

1. Subject Code: **MG 201**   Course Title: **Fundamentals of Management**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : III

7. Subject Area   : HMC

8. Pre-requisite   : NIL

9. Objective   : The basic objective of this paper is to acquaint the students with the basic concepts of management necessary to deal with emerging business environment besides sensitizing them about societal challenges.

10. Details of Course:

S.No.	Detail Contents	Contact Hrs.
1	Definition of management, importance of management, management principals, managerial roles, managerial ethos, management vs administration, managerial functions, task and responsibilities, organizational structure, motivation: meaning, theories and techniques.	8
2	Concept of business environment, corporate social responsibility and corporate governance, managerial values and ethics.	8
3	Objectives and importance of financial management, basics of capital budgeting, cost of capital, emerging sources of funds for new projects, introduction to stock market.	9
4	Functions of marketing, marketing Vs sales, interface of marketing with other departments, customer life time value, new product development, unethical issues in marketing.	8
5	Introduction to knowledge management, knowledge society, knowledge economy, building knowledge assets, sources of knowledge, technology innovation process, E-governance: definition, objectives and significance; challenges in Indian context, Digital India programme.	9
	Total	42

11. Suggested Books

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education, (ISBN:9780273755869)	2011
2	Financial Accounting, 4 ed, S.N. Maheshwari and S.K. Maheshwari, Vikas Pulication, (ISBN: 8125918523)	2005
3.	Management, James A F Stonner, Pearson Education, (ISBN: 9788131707043)	2010
4.	Marketing Management, 14th ed., Philip Kotler , Kevin Lane Keller, Abraham Koshy and MithileswarJha, Pearson Education (ISBN: 9788131767160)	2013
5	Knowledge Management in Organizations: A Critical Introduction, Donald Hislop, Oxford University Press, ISBN: 9780199691937.	2013

1. Subject Code: **EE282** Course Title: **Instrumentation and Control**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits : 04

6. Semester : IV

7. Subject Area : AEC

8. Pre-requisite : NIL

9. Objective : To familiarize the students with fundamentals of instruments and control system

10. Details of Course:

S. No.	Contents	Contact Hours
1	Op-Amp. applications: Op-Amp fundamentals (brief review of differential amplifier, ac and dc characteristics) basic building blocks using Op-Amps, inverting non inverting Amplifiers, integrators, differentiators, Instrumentation amplifiers.	8
2	Instrumentation: Transducers, measurement of nonelectrical quantities like pressure, temperature, displacement, velocity, acceleration etc, strain gauge & applications. Telemetry, CRO principles & applications.	8
3	Basic control system theory: Linear, non linear, time varying and linear time invariant system, servomechanism, historical development of automatic control, Control loop & its components, mathematical models of physical systems, differential equations of physical systems, transfer functions, block diagram algebra and signal flow graphs.	9
4	Feedback Characteristics, Time Response Analysis, Performance Indices: Characteristics of feedback, Standard test signals, time response of first-order systems, time response of second-order systems, steady-state error and error constants, performance indices.	9
5	Process control: P, PI and PID control actions and their effect, choice of proportional derivative & integral control, working mechanism of pneumatic & electronic PID controller, on-off controller, limit switches, solenoid valves, simple control schemes for level, flow, temperature etc as applied to reactor and heat exchangers.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Process Control Instrumentation Technology/ Curtis D. Johnson/ Pearson Publications.	2006
2	Operational Amplifiers and Linear Integrated Circuits/ Robert F. Coughlin and Frederick F. Driscoll/ Prentice Hall	1982
3	Modern Control Engineering, 5th Ed/ K. Ogata/ Pearson	2010
4	Instrumentation for Process Measurement & Control, 3rd Ed./ Norman A Anderson/ CRC Press	1997

1. Subject Code: **PT202**   Course Title: **Fluid Mechanics**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : IV

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge to the students about fluid mechanics and their applications

10. Details of Course:

S. No.	Contents	Contact Hours
1	Units and dimensions, Normal forces in Fluids, Principles governing Fluid flow, Newtonian and Non-Newtonian Fluids, Laminar and Turbulent flows; Pressure drop and friction factor; Velocity profiles, Nature of turbulence, eddy Viscosity.	9

2	Flow in Boundary Layers. Basic Equation of Fluid Flow, Conservation of mass, momentum and energy - integral and differential approaches, Bernoulli's Equations.	9
3	Derivation of Navier-Stokes Equation, Dimensional analysis; Dimensionless numbers and their physical significance, Drag force and drag coefficient; Terminal and settling velocities; Hindered settling, Forces on submerged bodies, Buoyancy and stability.	10
4	Techniques of flow Measurement: Pitot tube, Orifice meter, Venture meter, Rota meter, Notches, Wet gas meter, Fluid Machinery: Pumps, blowers and compressors.	8
5	Mixing of fluids: Types of mixers and their selection; Power requirements.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ reprint
1	Unit Operations in Chemical Engineering 7th Ed./McCabe, W.L., Smith J.C., and Harriot, P./ McGraw Hill.	2004
2	Fluid mechanics for chemical Engineers/ 3rd edition/ Nevers Noel de/ McGraw Hill.	2004
3	Fox & McDonald Introduction to Fluid Mechanics/ 8th ed/ PJ Pritcard/John Wiley and sons.	2011

1. Subject Code: **PT204**   Course Title: **Polymer Processing**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : IV

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge of polymer processing to the students

10. Details of Course:

S. No.	Contents	Contact Hours
1	Plastics additives and compounding: Antioxidants, metal deactivators, stabilizers, plasticizers, lubricants, processing aids, impact modifiers, fillers and reinforcements, colorants, flame retardants, anti-static agents, blowing agents, nucleating agents, compound development and compounding of plastics.	10
2	Principle of mixing and mixers: Introduction, mechanism of mixing, practical mixing variables. Types of mixers: roll mills, internal batch mixers, sigma mixers, high speed mixer, blending, kneading and granulating equipment.	9
3	Calendaring and Milling: Introduction, calendar roll, calendar configuration and operations.	5
4	Extrusion: Principle of extrusion, Screw design, Qualitative and quantitative aspects of mechanism of screw extrusion and effects of screw and die design, breaker plates and screens, screw speed and temperature on output and quality of extrudate.	9
5	Extrusion Dies: Constructional features of dies, equipment for extrusion, tubes, rods, pipes, blown film, cast film, Oriented film, Sheet extrusion, coating and lamination; processing parameters; Trouble shooting of processing techniques; twin screw extruder, types of twin screw extruder; process parameters in twin screw extruder.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Handbook of Plastic Processes/ Harper/ Wiley Interscience	2006
2	Principles of Polymer Processing/ Tadmor & Gogos/ Wiley Interscience	2013
3	Plastics Engineering/ R J Crawford/ Butterworths	2013
4	Handbook of Plastic Technology/ Allen & Baker/ CBS Publications	2004
5	Plastic Materials/ J A Brydson/ Butterworth-Heinemann	1999

1. Subject Code: **PT206**   Course Title: **Polymer Structure and Properties**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : IV

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To familiarize students about the structure and properties of polymers

10. Details of Course:

S. No.	Contents	Contact Hours
1	Thermal properties: Transition temperature in polymers, T_g and T_m - other transitions like β-transitions, crystallization temperatures, Prediction of T_c, T_g and T_m of polymers by group contributions. Calorimetric properties, Calculation of heat capacities of polymers, Thermal analysis of polymers by TGA, DTG, DTA, DSC, DMA.	9
2	Viscoelastic properties of Polymer: Experimental determination, mechanical models, polymer rheology, creep, stress relaxation and set, stress relaxation, tensile stress relaxation, compress stress relaxation and set, fatigues, dynamic fatigue of polymeric materials.	8
3	Electrical properties: Resistivity, Insulating and conducting materials, electric strength, resistance to surface discharges and tracking, surface charge and discharge measurements, permittivity and power factor, Effect of polymer structure on dielectric constant, power factor, dissipation factor and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment, Factors affecting the electrical conductivity of polymers.	9
4	Surface characterization: Microscopy, SEM, TEM, AFM, Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, absorbance, reflectance, and gloss - Prediction of refractive indices of polymers, Permeability: Vapor permeability, Gas permeability.	8

| 5 | Chemical and Weathering properties: Prediction of solubility parameter, Effect of polymer structure on solubility in solvents and oils, Chemical resistance of polymers, Accelerated weathering tests, outdoor weathering of plastics, Resistance of plastic materials to fungi and Bacteria and limitations of accelerated microbial growth resistance testing. | 8 |

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Polymer Science & Technology/ P. Ghosh/ Tata McGraw Hill	2001
2	Thermal Analysis of Polymeric Materials/ Wunderlich/ Springer	2005
3	Handbook of Plastic Testing & Failure Analysis/ V. Shah/ Wiley Inter-science	2006
4	Testing & Evaluation of Plastics/ Mathur & Bhardwaj/ Allied Publishers Pvt Ltd	2003

1. Subject Code: **PT208**   Course Title: **Chemical Reaction Engineering**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : IV

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge to the students about chemical reaction engineering

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Reaction rate; Kinetics of homogeneous reaction: Concentration-dependent term of a rate equation, single and multiple reaction, Elementary & Non-elementary reactions, kinetic view of equilibrium for elementary reactions, Molecularity, order of reaction, Representation of an elementary reaction, Kinetics for non-elementary reactions, related problems, Temperature dependent term of a rate equation: Arrhenius law, Collision theory, Transition-state Theory, related problems;	12
2	Interpretation of batch reactor data: Constant-volume batch reactor, Integral method of data analysis: General Procedure, Irreversible unimolecular-type First-order Reaction, Irreversible Bimolecular-type Second-order Reactions, Empirical Rate Equations of nth Order, Zero-order Reactions, Overall Order of Irreversible Reactions from the Half-life, Irreversible Reactions in Parallel, Autocatalytic reactions, Irreversible reactions in series, First-order Reversible Reactions, Differential method of Analysis of data: Analysis of the Complete Rate Equation, Partial analysis of rate equation, Varying-Volume Batch Reactors	12
3	Material balance equation for ideal batch reactor & its use for kinetic interpretation of data and isothermal reactor design for single reactions (simple & complex rate equation), Analysis of CSTR & PFR and their use for kinetic interpretation and design, Comparison of batch reactor, CSTR & PFR, Multiple reaction in a batch reactor, CSTR & PFR, concept of yield & selectivity	10
4	Concept of adiabatic & non-isothermal operations; Non Ideality: Basics of non-ideal flow, residence time distribution, States of segregation, Measurement and application of RTD, Conversion in non-ideal reactors.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Chemical Reaction Engineering/ Levenspiel O./ Wiley Eastern Ltd. 3rd Ed.	2006
2	Essentials of Chemical Reaction Engineering/ Fogler/ Pearson	2014
3	Introduction to Chemical Engineering Kinetics and Reactor Design/ Charles G. Hill, Thatcher W. Root/ Wiley	2014

1. Subject Code: **HU202**   Course Title: **Engineering Economics**

2. Contact Hours   : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 03

6. Semester   : IV

7. Subject Area   : HMC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to understand the economic theories which may be applied to maximize return and economic environment in which they have to operate.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Nature and significance of economics, Goods and Utility, Basic Concept of Demand and Supply, Elasticity of Demand- Price elasticity of Demand, Cross elasticity of Demand, Production - Production Function, Production Process and Factors of Production, Market – Introduction to Monopoly, Perfect Competition, Oligopoly and Monopolistic Competition, Cost Concepts- Opportunity Cost, Total Cost, Average Cost; Marginal Cost; Life Cycle cost, Sunk Cost; Preparation of Cost Sheet Profit Maximisation- numerical problem.	10
2.	Money- its evaluation and function, Bank- Commercial Bank and Central Bank and brief idea about function of banking system:. Tax and Subsidy, Type of Tax- Direct and Indirect, Monetary and fiscal policy, Inflation and Business cycle, International trade, terms of Trade, Gain from International Trade, Free Trade vs. Protection, Dumping, Balance of Payment.	10
3.	Role of Science, Engineering and Technology in Economic Development: Seven salient Feature of the Indian Economy; Inclusive Growth; relevance for the Indian Economy; Globalisation & opening up of the Indian Economy; GDP- definition and Its measurement; How knowledge of engineering and technology may be used to improve life at slum; Green Revolution and White revolution. Reasons for their success and can we replicate them. Appropriate Technology & Sustainable Development. Entrepreneurship: Macro environment for promotion of entrepreneurship: How environment has changed after advent of IT and Globalisation.	12

4.	Elementary Economic Analysis: Interest formulas and their Applications; Calculations of economic equivalence, Bases for Comparison of Alternatives: Present Worth Method, Future worth method, Annual equivalent, Internal Rate of Return; Business Risk; Factors which should be taken care while deciding price of the product in the market.	10
	TOTAL	**42**

11. Suggested books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Engineering Economy, Engi G.J. Thuesen, & W.J. Fabrycky, Prentice-Hall of India Private Limited.	(2007)
2.	Engineering Economy, William G. Sullivan, James A. Bontadelli & Elin M. Wicks, Pearson Education Asia,(First Indian reprint).	2009
3.	Engineering Economic Analysis, Donald G. Newman, Jerome P. Lavelle & Ted G. Eschenbach, , Engineering Press.	2001
4.	Economics for Engineering Students, Seema Singh, , IK International Publishing House Pvt. Ltd	2014

Vth SEMESTER

1. Subject Code: **PT301**   Course Title: **Heat Transfer**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : V

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge to the students about conduction, convection and heat radiation.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to heat transfer and involved basic equations.	4
2	Conduction: Review of Fourier's law, thermal conductivity of materials, steady and unsteady state conduction, steady state conditions, equation of planes, cylinders, hollow spheres, and problems related to these cases. Lagging of pipes and other equipment, optimum lagging thickness, heat transfer from extended surfaces (fins).	9
3	Convection: Free and forced convection, Concept of thermal boundary layer, concept of Individual and overall heat transfer coefficients, laminar and turbulent flow, Heat transfer inside & outside tubes with significance of Nusselt, Prandlt, Reynold, Biot, Fourier and Peclet number. Condensation and Boiling: Definition, film wise and drop wise condensation, Nucleate & Film boiling, Different Boiling regimes.	9
4	Radiation: Distribution of radiant energy, Definition of emissivity, absorpitivity, Reflectivity and Transmissivity, concept of Black and Grey bodies, Planck's law of monochromatic radiation, Kirchhoff's law, Wein's displacement law, Stefan-Boltzmann Law, Heat exchange by radiation between two simple bodies, two parallel surfaces and between any source and receiver, Salient features of shape factor.	10
5	Heat Exchangers: Classification of heat exchangers, the construction, specification and applications, LMTD in single pass, parallel and counter flow arrangements, cross-flow arrangements, use of correction factor. Evaporation: Heat transfer to vaporization processes, single and multiple effect evaporations. Various types of evaporators	10

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Fundamentals of Heat & Mass Transfer/ Bergman et al/ Wiley India	2011
2	Heat Transfer: Principles & Applications/ Dutta/ Prentice Hall	2000
3	Process Heat Transfer: Principles, Applications and Rules of Thumb, 2nd/ R.W. Serth, T. Lestina/ Academic Press	2014
4	Heat Transfer/ Holman/ McGraw Hill	2010

1. Subject Code: **PT303** Course Title**: Polymer Processing Techniques**

2. Contact Hours L: 03 T: 00 P: 02

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits : 04

6. Semester : V

7. Subject Area : DCC

8. Pre-requisite : NIL

9. Objective : To impart knowledge to the students about molding machines and other processing methods.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Injection molding Machine-Machine description study, Types and limitations, working principles, constructional features, specifications, maintenance, types of clamping, temperature control, types of cylinder nozzles, ejection systems, starting and shutdown procedures, press capacity. Hydraulics, basic principles, hydraulic systems as used in injection molding machine; Process variables, Trouble shooting.	10
2	Gas assisted injection molding, structural foam molding, reaction injection molding process, their industrial applications; Trouble shooting.	8
3	Blow molding process, Principles and Description of blow mold, Extrusion & Injection stretch blow molding, Parison control, trouble shooting.	8
4	Compression molding machine: Types, principles of operations, molding cycle, meaning of terms bulk factor and flow properties as applied to molding materials, the interplay of heat, pressure, friction, catalysts etc for thermosetting materials; Trouble shooting.	9
5	Miscellaneous processing methods: casting, rotational molding, decoration of polymers	7

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Injection Molding: An introduction/ Potsch & Michaeli/ Carl Hanser	2008
2	Blow Molding Handbook/ Rosato et al/ Carl Hanser	2004
3	Polymer Processing: Principles & Design/ Baird & Collias/ Wiley	2014
4	Handbook of Plastic Processes, Harper, Wiley Interscience	2006
5	Injection Molds/ Hans Gastrow/ Carl Hanser	2006

1. Subject Code: **HU301**   Course Title: **Technical Communication**

2. Contact Hours   : L: 02   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 02

6. Semester   : V

7. Subject Area   : HMC

8. Pre-requisite   : NIL

9. Objective   : To train students for business communication to enhance employability skills with special emphasis on placement interviews and public speaking.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**English for Professional Purposes:** **A.** Technical Communication- Methods, Strategies and Skills **B.** Communication in Global Contexts- Social, Cultural, Political and Technical, especially in formal set up	1 2

2.	**Communication at the Workplace: Oral and Written:** **A. Written Communication**- Letters, Orders (Sale/Purchase) Report Writing, Technical proposals Resume, SOP, Memo, Notice, Agenda, Minutes, Note Taking/Making, **B. Oral Communication**: Seminars, Conferences, Meetings, Office Etiquettes/ Netiquettes, Presenting Written Material Negotiation, Demonstration, Group Discussion, Interview	6 6
3.	**Group Discussion** and **Report Writing:** i) Group Discussion (Continous assessment through the semester) ii) Minor Report Writing(to be submitted before Mid- Semester Examination) iii) Major Report writing (To be submitted before End Semester Examination)	13
	Total	**28**

11. Suggested Books:

Sl.No.	Name of Books, Authors, Publishers	Year of Publication/ Reprint
1	Technical Communication: Principles and Practice Raman, Meenakshi and Sangeeta Sharma, Oxford University Press, ISBN-13: 978-0-19-806529-6	2011, Reprinted 2014
2	Writing to Get Results, (3rd Ed) Blicq, Ron S., Lisa A. Moretto, John Wiley and Sons, Inc. ISBN 0-7803-6020-6	2001
3	Effective Technical Communication: A Guide for Scientists and Engineers , Mitra, Barun K. OUP: Delhi ISBN-13: 978-0-19-568291-5	2006
4	Personality Development and Soft Skills, Mitra, Barun K. New Delhi: Oxford University Press. ISBN-9780198060017	2014
5	The Essence of Effective Communication**,** Ludlow, Ron and Fergus Panton. Prentice Hall: PHI. ISBN-81-203-0909-X	1996
6	Advanced Technical Communication, Gupta, Ruby. Foundation Books, CUP. ISBN 978-81-7596-733-5	2011
8	Soft Skills: Enhancing Employability, Rao, M.S. Connecting Campus with Corporate ISBN: 978-93-80578-38-5	2011
9	Developing Communication Skills (2nd Ed), Mohan, Krishna and Meera Banerji, Macmillan Publishers India Ltd. ISBN 13: 978=0230-63843-3	2009

1. Subject Code: **PT302**   Course Title: **Rubber Technology**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40   PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge about rubber technology and their applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to rubber, elasticity of rubber chain, elasticity of a network, thermodynamics of rubber elasticity, morphology of rubber, structure property relationship in rubbers, non elastomeric properties, chemical reactivity solution properties.	8
2	Natural Rubber: Source, Chemical Formula, Molecular weight distribution, concept of Sol, Gel, Microgel and Macrogel. Natural rubber from latex, field latex composition, methods of concentration and stabilization of latex, effect of electrolyte and protein, processing of latex into sheet and pale crepe rubber.	8
3	Synthetic Rubbers: preparation, properties and application of styrene butadiene, polybutadiene, polyisoprene, ethylene propylene, thiokol, butyl, nitrile, silicon and polyurethane rubber.	8
4	Rubber additives and compounding: Pre-vulcanized latex, Vulcanizing agents, vulcanization theory, activators, accelerator, fillers, softeners, antioxidants, peptizers, retarders, stiffeners, flame retardants, colors and pigments, tackifying agents, blowing agents, bonding agents, compound development and compounding of rubbers, Principle and working of Mooney viscometer.	9
5	Manufacture of latex products by impregnation and spreading process, casting impregnation, dipping process, latex coatings, latex cement and adhesives, latex thread and coir, latex foam. Manufacture of rubber products. Manufacture of rubber products as Tubes, Hoses, Footwear.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	The Science & Technology of Rubber/ Erman & Ronald/ Academic Press	2013
2	Rubber Technologist's Handbook, Volume 1 / Sadhan K. De, Jim R. White / Smithers Rapra Publishing	2001
3	Handbook of Rubber Technology: Natural, Synthetic Rubber and Technology of Vulcanisation Vol. I (HB)/ Martin; Smith/ CBS Publishers	2004
4	Rubber Compounding: Chemistry and Applications/ Rodgers/ CRC Press	2015

1. Subject Code: **PT304**   Course Title: **Mass Transfer**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To familiarize students about mass transfer.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Mass transfer operations and their classification, molecular diffusion, Fick'law of diffusion, equimolal counter diffusion, diffusion of A through stagnant non-diffusing B, diffusion in gases, molecular diffusion in liquids, measurement and estimation of diffusivity mass transfer between gas and liquid phases, Individual and overall mass transfer coefficients.	9

2	Theories of Mass transfer, Film theory, penetration theory and surface renewal theory. Equipment used in gas-liquid operations, co-current and countercurrent absorption processes, transfer unit: HETP, HTU and NTU concepts.	8
3	Distillation: Vapor liquid equilibria, Raoult's Law, relative velocity, Enthalpy-concentration diagrams, simple distillation, continuous rectification of binary systems. Multistage tray tower design: McCabe and Thiele and PonchonSavarit methods, tray efficiency, Azeotropic, extractive and steam distillation.	9
4	Liquid-liquid extraction: Extraction equipment, equilibrium diagram, Choice of solvent, Single stage and multistage counter-current extraction with/without reflux, Equipments used in liquid-liquid extraction. Solid liquid extraction: Leaching, Leaching equipments, Single stage and multistage cross current and counter current leaching.	10
5	Crystallization: Methods of forming nuclei in solution and crystal growth.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Mass Transfer Operations/ Treybal/ McGraw Hill	1980
2	Mass Transfer/ Sherwood/ McGraw Hill	1989
3	Principles of Mass Transfer, Sharma, Prentice Hall of India	2007
4	Principles of Mass Transfer & Separation Process, Dutta, Prentice Hall of India	2001
5	Elements of Mass Transfer/ Anatharaman & Sheriffa Begum/ Prentice Hall of India	2005

1. Subject Code: **PT306**   Course Title: **Plastic Technology**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40   PRE: 00

S. No.		
5.	Credits	: 04
6.	Semester	: VI
7.	Subject Area	: DCC
8.	Pre-requisite	: NIL
9.	Objective	: To impart knowledge about industrial preparation, properties and application of polymers.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Commodity plastics: Manufacture, properties and applications of polyethylene, polypropylene, polyvinyl chloride polyacrylate, polymethyl methacrylate, polyvinyl acetate, polyvinyl alcohol.	14
2	Engineering plastics: Industrial preparation, properties and applications of polyethylene terephathalate, polybutylene terphthalate, polyamides, polycarbonate, polyacetal, polystyrene.	14
3	Thermosetting polymers: Preparation, properties and applications of phenol formaldehyde, unsaturated polyester, urea and melamine formaldehyde, epoxy resins.	10
4	Recent advancements in polymeric materials.	4

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Principles of Polymerization, 4th Ed./ G. Odion/ Wiley Interscience	2004
2	Polymer Synthesis: Theory and Practice/ Braun et al / Springer International	2013
3	Synthetic Polymers/ Feldman & Barbalate/ Chapman & Hall	1995
4	Synthesis of Polymers/ Schluter et al/ Wiley VCH	2012

1. Subject Code: **HU304**   Course Title: **Professional Ethics and Human Values**

2. Contact Hours   : L: 02   T: 00   P: 00

3. Examination Duration (Hrs.) : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 02

6. Semester   : VI

7. Subject Area   : HMC

8. Pre-requisite   : NIL

9. Objective   : To make students aware of the ethics and codes of conduct required by Engineers and Professionals.

10. Details of Course:

S. No.	Name of Books, Authors, Publishers	Contact Hours
1.	Human Values and Ethics: Morals, Values, Ethics and Integrity, Need for Value Education for Engineers, Happiness, Prosperity, Harmony.	6
2.	Code of Ethics and Professionalism: Professionalism and the Code of Ethics, Technical Education, Human Values and Coexistence, Universal Human Order, Natural acceptance.	6
3.	Professional Ethics and Technology :Science, Technology and Professional Ethics Engineering Ethics, Environmental Ethics, Safety, Responsibility and Rights.	8
4.	Case Studies: Holistic Technologies, Eco-friendly production systems, The role of responsible engineers and technologists, Global Issues concerning Engineers.	8
TOTAL		**28**

11. Suggested Books

S.No.	Name of Books, Authors, Publishers	Year of Publication/ Reprint
1.	Professional Ethics, Subramanian, R, Oxford University Press, ISBN13: 978-0-19-808634-5	2011
2.	Professional Ethics and Human Values, Govindarajan, M. S. Natarajan, V.S. Senthil kumar PHI, **ISBN: 978-81-203-4816-5**	2013
3.	Constitution of India and Professional Ethics, Reddy, G.B. and Mohd. Suhaib, IK International Publishing House. ISBN: 81-89866-01-X	2006
4.	Introduction to Engineering Ethics (2nd Ed.)Martin, Mike W. and Roland Schingzinger McGraw-Hill ISBN 978-0-07-248311-6	2010

VIIth Semester

1. Subject Code: **PT401**   Course Title: **B.Tech Project-I**

2. Contact Hours   : L:0   T:0   P:0

3. Examination Duration (Hrs.)   : Theory: 0   Practical: 0

4. Relative Weight   : CWS: 0 PRS: 0   MTE: 0   ETE: 0   PRE: 0

5. Credits   : 4

6. Semester   : VII

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students to work in group and develop an independent understanding of engineering and analysis of engineering systems. He should also be able to write and present the work done during the course.

1. Subject Code: **PT403**   Course **Title: Training Seminar**

2. Contact Hours   : L: 0   T:0   P:0

3. Examination Duration (Hrs.)   : Theory: 0   Practical: 0

4. Relative Weight   : CWS: 0   PRS: 0   MTE: 0   ETE: 0   PRE: 0

5. Credits   : 2

6. Semester   : VII

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students to work in industry and working culture of the industrial system. He should also be able to write and present the work done during the course.

1. Subject Code: **PT405**   Course Title: **Fibre Technology**

2. Contact Hours: L: 03   T: 00   P: 02

3. Examination Duration (Hrs.):   Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40   PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DCC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge about fibre, their spinning and preparation to the students.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction to fibres and basic terminology, Characteristics of fibre forming polymers, Classification of fibres, Properties and structure of natural fibres.	9
2	Principles of fibre spinning, Melt spinning, Solution spinning, Gel spinning, Electro-spinning, Effect of process parameters of each spinning techniques on structure and properties of fibres.	8
3	Post spinning operations, Principles and effects on properties of fibres, Drawing, Heat setting, Spin finish, Texturing, Top to tow converters.	8
4	Manufacturing, properties and uses of viscose rayon, acetate rayon, polyester, polyamide, polyacrylonitrile and polypropylene fibres.	8
5	Manufacturing, properties and uses of kevlar, nomex, polyurethane, high density polyethylene fibres, bicomponent fibers, hollow fibers.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	A Textbook of Fibre Science and Technology/ SP Mishra/ New Age Publication	2014
2	Manufactured Fibre Technology/ Gupta and Kothari/ Springer	1997
3	Handbook of fiber Science and Technology/ Vol. III/ Lewin and Prestone/ Dekker	1996
4	Progress in Textile Science & Technology/ Vol I & II, Kothari/ Chapman & Hall	1985

1. Subject Code: **PT407**   Course Title: **Chemical Process Technology**

2. Contact Hours   : L: 03   T: 00   P: 02

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 15 PRS: 15 MTE: 30 ETE: 40   PRE: 00

5.	Credits	:	04
6.	Semester	:	VII
7.	Subject Area	:	DCC
8.	Pre-requisite	:	NIL
9.	Objective	:	To familiarize students about oils, fats, agro based products etc.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Representation of steady-state flow sheets for the chemical plant	5
2	Oils and fats: Major oil seeds production in India; Methods of oil extraction, Hydrogenation of oils. Soaps and detergents: cleaning action, soap and detergent manufacturing, recovery of glycerine, Fat-splitting.	9
3	Food processing and agro based Industries: Cane Sugar production and manufacturing technology, cane sugar refining, baggasse utilization, Fermentation of molasses.	9
4	Inorganic chemical industries; sulfuric acid, sodium hydroxide, ammonia and its allied products. Fertilizers: Classification of fertilizers, manufacture of ammonia based fertilizers, manufacture of phosphate fertilizers and potash fertilizers, N-P-K values.	9
5	Pulp and Paper Industries: Kraft pulp process, Sulphite pulp process, Production of paper. Recent advancements in chemical process technology.	10

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Chemical Process Technology 2nd Ed/ Moulijn et al/ Wiley	2013
2	Outlines of Chemical Technology/ Dryden, C. E., and Rao, M.G. (Ed.)/ Affiliated East West Press	1973

3	Sherve's Chemical Process Industries/ Austin/ Mc-Graw Hill	2012
4	Encyclopedia of Chemical Technology; 27 Vol Set/ Kirk & Othmer (Ed.)/ Wiley	2004

VIIIth Semester

1. Subject Code: **PT-402**　　　　Course Title: **B.Tech project-II**

2. Contact Hours　　　　　　　　: L: 0　　T: 0　　P: 0

3. Examination Duration (Hrs.)　: Theory: 0　　　Practical: 0

4. Relative Weight　　　　　　　: CWS: 0　PRS: 0　MTE: 0　ETE: 0　PRE: 0

5. Credits　　　　　　　　　　　: 8

6. Semester　　　　　　　　　　: VIII

7. Subject Area　　　　　　　　: DCC

8. Pre-requisite　　　　　　　　: NIL

9. Objective　　　　　　　　　　: To familiarize the students to work in group and develop an independent understanding of engineering and analysis of engineering systems. He should also be able to write and present the work done during the course.

1. Subject Code: **PT404**　　　　Course Title: **Polymer Product and Die Design**

2. Contact Hours　　　　　　　　: L: 03　　T: 00　　P: 02

3. Examination Duration (Hrs.)　: Theory: 03　　　Practical: 00

4. Relative Weight　　　　　　　: CWS: 15　PRS: 15　MTE: 30　ETE: 40　PRE: 00

5. Credits　　　　　　　　　　　: 04

6. Semester　　　　　　　　　　: VIII

7.	Subject Area	:	DCC
8.	Pre-requisite	:	NIL
9.	Objective	:	To impart knowledge about basic design, mould design and die design.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Basic design theory for product development, Properties of plastic influencing design, Simple structural load analysis and design aspects, Wall thickness, Tolerance, Design limitations of plastic parts based on various processing techniques.	9
2	Basic consideration of designing polymer products with rigid, flexible, static and dynamic loaded parts, Product design based on reinforced plastics.	8
3	Mould Design, Importance of mould & dies, mould types, molding cycle.	7
4	General mould construction, Use of local inserts, 2 & 3 plate moulds, Bolsters, Ancillary items, Guide pillars, Guide bushed, Positioning of guide pillars, sprues, gates and runners, Ejector system, Cooling systems, Venting, Degating devices, Computer aided designs.	9
5	Die design, Classification and construction of die, Rectangular, Ring, Solid, Profile dies, Dies for multi-colour or multi-material extrusion, Cross head dies.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Plastics Design Handbook/ Rosato/ Springer	2001
2	Industrial Design of Plastic Products/ Gordon/ Wiley	2002
3	Plastic Product Design/ R.D. Beck/ Van Nostrand Reinhold	1980
4	Product Design & Manufacturing/ Chitale & Gupta/ Prentice Hall	2007

DEPARTMENTAL ELECTIVE COURSES

1. Subject Code: **PT305** Course Title: **Process Equipment Design**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : V

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To impart knowledge about process equipment design to the students.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Anatomy of a chemical manufacturing process, types of vessels, classification of process equipment, Selection of engineering materials based on process analysis.	8
2	Concept of equilibrium equations, Principal stress, Principal plane and Mohrs circle analysis, Theories of failures, Stress concentration, Fluctuating stress and factor of safety, Design features of the following - Shafts, bearings, belt and chain drives, Types of gear, Law of gearing, Gear trains, Tooth profile and Bolted joints.	11
3	Design of thin cylinders with welded joints, Design of unfired pressure vessel components, Design of reaction vessels, agitators and drive systems, Design of non-pressure storage tanks, High pressure vessels, Tall vertical vessels, Supports for vessels, Bolted flanges.	11
4	Design of end closures, Flat plates, Domed ends, Torri-spherical, Ellipsoidal, Hemispherical and Conical ends.	6
5	Design principles of selected process equipments such as heat exchangers, evaporators, Distillation columns, Reactors.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Materials in Industry/ W J Patton/ Prentice Hall Publication.	1986
2	Introduction to Engineering Materials/ Agrawal/ Tata McGraw Hill	1988
3	Process Equipment Design/ Mahajani & Umarji/ McMillan	2009
4	Process Design of Equipments/ S.D. Dawande, Central Techno Publications	2006

1. Subject Code: **PT307** Course Title: **Optimization Techniques**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : V

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To impart knowledge about optimization, related algorithms etc to the students.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Engineering application of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of chemical engineering, Optimization problems, classification of optimization problems, different optimization algorithms.	9

2	Optimal Point: Local optimal point, global optimal point and inflection point. Single variable, optimization techniques: Optimality criterion; Bracketing method (Bounding phase method); Region elimination methods (Internal halving method, Golden section search method); Point estimation method (successive quadratic estimation methods); Root finding using optimization techniques.	9
3	Multivariable Optimization Techniques: Optimality criterion; Unidirectional search method; Direct search method (Hooke-Jeeves Pattern Search method, Powell's conjugate direction method); Gradient-based methods (Steepest descent method, Newton's method, Marquardt's methods)	9
4	Construined Optimization Algorithms: a. Kuhn - Tucker conditions b. Transformation method (penalty function method) c. Direct search for constrained minimization (variable elimination method, complex search method.)	8
5	Programming: Linear programing problems, Simplex method of linear Programming technique; Quadratic Programming.	7

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Optimization for Engineering Design: Algorithms and Examples/ Deb/ PHI	2004
2	Optimization of Chemical processes/ Edgar & Himmelblau/ McGraw Hill	1987
3	Process Optimization with Applications to Metallurgy & Chemical Engineering/ Ray & Szekely/ Wiley	1973
4	Optimization: Theory & Practice/ Beveridge & Schechter/ McGraw Hill	1970

1. Subject Code: **PT309** Course Title: **Petroleum Refinery Engineering**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight   CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   04

6. Semester   : V

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize students with knowledge of petroleum, its refining and properties.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of oil refining, Composition of crude oil, refinery feedstocks and products, Physical and Chemical properties, Laboratory tests.	6
2	Evaluation of oil stocks, Dehydration and desalting of crude, Crude Assay ASTM TBP distillations evaluation of crude oil properties, API gravity various average boiling points and mid percent curves, Evaluation of properties of crude oil and its fractions, Design concept of crude oil distillation column design.	9
3	Thermal and Catalytic cracking, Coking and Thermal process, Delayed coking, Catalytic cracking, Cracking reactions, Zeolite catalysts, Cracking Feedstocks and reactors, Effect of process variables, FCC Cracking, Catalyst coking and regeneration, Design concepts, New Designs for Fluidized-Bed Catalytic Cracking Units, Hydrocracking, Catalytic Reforming, Reformer feed reforming reactor design continuous and semi regenerative process.	10
4	Isomerization process, Reactions, Effects of process variables, Alkylation process, Feedstocks, reactions, products, catalysts and effect of process variables, Polymerization, Process and reactions, catalysts and effect of process variables.	8

| 5 | Environmental issues and New trends in petroleum refinery operations, Ecological consideration in petroleum refinery, Waste water treatment, control of air pollution, Alternative energy sources, Biodiesel, Hydrogen energy from biomass. | 9 |

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Fundamentals of Petroleum Refining/ **Fahim, Alsahhaf and Elkilani** / Elsevier	2010
2	Handbook of Petroleum Refining Processes; 3rd Ed/ Meyers/ McGraw-Hill	2004
3	Petroleum Refining Processes/ James G. Speight, Baki Ozum/ CRC Press	2001
4	Petroleum Refining Technology/ Indra Deo Mall/ CBS	2015

1. Subject Code: **PT311** Course Title: **Renewable and Non-Renewable Energy**

2. Contact Hours L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : V

7. Subject Area : DEC

8. Pre-requisite NIL

9. Objective : To familiarize students with renewable and non-renewable energy.

10. Details of Course

S. No.	Contents	Contact Hours
1	Energy consumption scenario: Trends and sustainability analysis. Energy economics.	6
2	Non-renewable Energy: Overview of conventional energy sources Coal Mining, Environmental Impacts, Clean coal technologies, Carbon Capture and Storage Oil Reserves: Availability and extraction. Natural gas reserves, Shale gas, Availability and extraction, Hydraulic fracturing. Nuclear Energy: Risks of Nuclear power plants and radioactive waste: Safety and Health concerns.	12
3	Pros & Cons and Environmental concerns of Non-renewable energy	6
4	Renewable energy: Fundamentals of renewable energy sources, Wind, Solar, Geothermal, Tide and Wave Energy, Hydrogen Energy, Fuel Cells, Waste to Energy, Biomass Energy, Hydel Energy.	12
5	Economic Viability: Pros and Cons for using renewable energy, economic viability, sustainability factors, etc.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Energy for the 21st Century: A Comprehensive Guide to Conventional and Alternative Sources/ Roy Nersesian/ Routledge.	2006
2	World Energy Resources/ Charles E. Brown/ Springer.	2002
3	Principles of Sustainable Energy Systems, Second Edition/ Frank Kreith, Susan Krumdieck/ CRC Press.	2013
4	Non-conventional energy sources/ G.D. Rai/ Khanna Publishers.	2004

1. Subject Code: **PT313**   Course Title: **Combustion Engineering**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : V

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize students with combustion, fuels and their thermodynamic studies.

10. Details of Course

S. No.	Contents	Contact Hours
1	Historical perspective of combustion science, perspective of fuels and combustion technology; Types and general characteristics of fuels, proximate and ultimate analysis of fuels. Moisture and heating value determination: gross and net heating values, claorimetry, DuLong's formula for HV estimation, Flue gas analysis, Orsat apparatus.	10
2	Classification of fuels; Solid fuels: Peat, coal, biomass, wood waste, refuse derived solid fuel, testing of solid fuels. Bulk and apparent density storage, washability, coking and caking coals. Liquid fuels: Liquid fuel types and their characteristics, Refining, molecular structure, fuel quality, Liquefaction of solid fuels. Gaseous fuels: Classification and characteristics.	8
3	Thermodynamics and kinetics of combustion: Properties of mixture, combustion stoichiometry, chemical energy, properties of combustion products. First law combustion calculations: adiabatic flame temperature (analytical and graphical methods), Simple second law analysis. Elementary reactions: chain reactions, pre-ignition kinetics, reaction at solid surface.	8

4	Combustion of solid fuels; Drying, Devolatilization, Char combustion, Fixed bed combustion, Suspension burning, Fluidized bed combustion.	6
5	Combustion of liquid and gaseous fuels: Spray formation and droplet behaviour, Oil fired furnace combustion, Direct and indirect injection combustion in IC engines, Energy balance and furnace efficiency, gas burner types: pulse combustion furnace, Premixed charge engine combustion, Detonation of gaseous mixtures..	10

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Principles of Combustion, 2nd Ed/ Kuo/ John Wiley & Sons	2005
2	Combustion science and Engineering/ Annamalai and Puri/ CRC Press	2007
3	Fuels and Combustion, 2nd Ed/ Sarkar/ Orient Longman	2003
4	Fuels and Combustion/ Sharma and Mohan Chander/ Tata Mcgraw Hill.	1984

1. Subject Code: **PT315** Course Title: **Packaging Technology**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits 04

6. Semester : V

7. Subject Area : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize students with packaging materials,
                                             their testing and quality control.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Packaging in production and marketing; Packaging characteristics, Physical properties; Mechanism of spoilage, degradation, corrosion & their prevention; Compatibility: permissible plasticizers and their migration to food products; Package design.	8
2	Packaging Materials: Papers and speciality papers, Cellulosic films and laminates; Plastics in packaging: PE, PP, PS, PVC, PVDC, Nylon, Polyester and their combinations; Expanded PE, PS and bubble films; Glass containers, ampoules and vials; Composite containers, drums and paper tubes; Aluminium foils, laminates and coating; Single layer and multilayer polymer packaging.	8
3	Ancillary materials: Adhesives, Adhesive tapes; Cushioning materials and properties, Reinforcements; Stitching methods; Seals and enclosures; Lining compounds and lacquers; Labels and instant labeling; bar coding	9
4	Graphic design; Printing techniques, Printing inks and print evaluations.	8
5	Testing, Standards and Quality control: Mechanical testing, resistance to light, insect and mould. Barrier testing for air, oxygen etc., shelf life, Seal tests. Standards- basic concepts, standards for rigid and non rigid and ancillary materials, standards for export packages, ISO 9000 and implications. Eco packaging and regulations.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Materials for Advanced Packaging/ Lu/ Springer	2009

2	Encyclopedia of Packaging Technology/ Brody & Marsh/ John Wiley	1997
3	Plastic Packaging Materials for Food: Barrier Function, Mass Transport, Quality Assurance, and Legislation/ Piringer & Baner/ Wiley	2008
4	Understanding Plastics Packaging Technology/ Selke/ Hanser Gardner Pubns	1997

1. Subject Code: **PT317**　　　　　　Course Title: **Polymer Coatings and Adhesives**

2. Contact Hours　　　　　　　　　 :　L: 03　　T: 01　　P: 00

3. Examination Duration (Hrs.)　　 :　Theory: 03　　　　Practical: 00

4. Relative Weight　　　　　　　　 :　CWS: 25　PRS: 00　MTE: 25　ETE: 50　PRE: 00

5. Credits　　　　　　　　　　　　 :　04

6. Semester　　　　　　　　　　　 :　V

7. Subject Area　　　　　　　　　 :　DEC

8. Pre-requisite　　　　　　　　　 :　NIL

9. Objective　　　　　　　　　　　 :　To impart knowledge about polymeric coatings, adhesives and their applications.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction & classification of adhesives, mechanism of adhesion of polymeric coatings on various substrates, chemically reactive adhesives	10
2	Preparation of adhesives, animal glue, protein adhesives, starch adhesives, synthetic resin adhesives, rubber based adhesives, cellulose & silicate adhesives, industrial application of adhesives.	10

3	Solvent based polymeric coatings, Water based polymeric coatings, UV and EB curable coatings, 100% convertible coatings, Selection criteria of coating for various substrates.	10
4	Coating techniques for various substrates	8
5	Health hazards and environmental aspects of coatings during manufacturing and applications.	4

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Coatings Technology Handbook, 3rd Ed/ Tracton/ CRC Press	2005
2	Organic Coatings: Science and Technology, 3rd Ed/ Wicks et al/ Wiley	2007
3	Additives for Coatings/ Bieleman/ Wiley	2000
4	Handbook of Adhesives Technology/ Pizzi & Mittal/ Marcel- Dekker	2003

1. Subject Code: **PT319**   Course Title: **Biomaterials**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : V

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn biomaterials, polymeric implant materials and bioceramics.

10. Details of Course

S. No.	Contents	Contact Hours
1	Biocompatibility, Biomaterials and their requirements, Classification, Effects of physiological fluid on the properties of biomaterials. Biological responses. Surface, physical and mechanical properties, Standards of implant materials.	8
2	Metallic implant materials: Alloys, Importance of corrosion cracking, Host tissue reaction, Importance of passive films for tissue adhesion, Hard tissue replacement implant, Soft tissue replacement implants.	9
3	Polymeric implant materials: Thermoplastics, Thermosetting, biopolymers and biodegradable polymers for implant, Properties of polymeric materials for implant, Controlled release systems, Synthetic polymeric membranes and their biological applications.	9
4	Concepts of bioceramics, Importance of wear resistance and low fracture toughness, Host tissue reactions, Importance of interfacial tissue reaction, Mechanics of improvement of properties by incorporating different elements, Composite theory of fiber reinforcement, Polymers filled with osteogenic fillers, Host tissue reactions.	8
5	Blood and tissue compatibility, Toxicity tests, Acute and chronic toxicity studies, Sensitization, Carcinogenicity, Mutagenicity and related tests. *In vitro* mechanical testing, Corrosion studies, *In vivo* testing, Biological performance of implants.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Biomaterials/ Park and Lakes/ Third edition/ Springer	2007

2	Biomaterials - Science and Engineering/ Park/ Plenum Press	1984
3	Biomaterials/ S.V. Bhat/ Narosa Publishing House	2002
4	Blood compatible materials and devices/ C.P. Sharma & M. Szycher/ Technomic Publishing Co. Ltd.	1991
5	Polymeric Biomaterials (Eds)/ Dordrecht/ Martinus Nijhoff Publishers	1986

1. Subject Code: **PT321**   Course Title: **Biosensor Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : V

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn biological and chemical sensors utilizing new sensing concepts and nanobiosensors.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concept of sensor and biosensor, Types of Biosensors, Measurements and instrumentation principles, Fundamentals and component of biosensor, sensitivity, specificity, linearity and transduction system analysis.	8

2	Transduction principles used in biosensors viz. electrochemical, optical, Surface plasmon resonance, microfluidic sensor and transducers and related technologies.	10
3	Biotechnological components of the sensor based on enzymes, antigen-antibody reaction, DNA biosensor, Organelles, Whole cell, Receptors, DNA probe, Pesticide detection, Methods of immobilization.	9
4	Nanomaterials and its applications in biosensors, Generation of biosensors stability and reusability of sensors.	7
5	Recent applications of biosensor, their selected examples.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Chemical Sensors and Biosensors: Fundamentals and Applications/ Banica Florinel-Gabriel/ John Wiley & Sons	2012
2	Biosensors for Environmental Monitoring/ Bilitewski, U. and Turner, A.P.F./ Academic Publishers	2000
3	Optical Biosensors: Present & Future/ Ligler, F.S. and Rowe Taitt, C.A/ Elsevier	2002
4	Fundamentals of Microfabrication and Nanotechnology (Volume I, II and III)/ Madou. Marc J./ CRC press	2012

1. Subject Code: **PT323**   Course Title: **Biochemical Engineering**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6.	Semester	:	V

7.	Subject Area	:	DEC

8.	Pre-requisite	:	NIL

9.	Objective	:	To enable the students to learn about microbial growth, materials and energy balance in microbial processes, reactor and enzyme kinetics.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction to microbial cell, Growth pattern and kinetic parameters, Monod's growth kinetics, Kinetics of culture in reactors, Substrate and product inhibition on cell growth and product formation, Stoichiometry of microbial growth and chemical process, Elemental balances, Degrees of reduction of substrate and biomass, Available electron balances.	9
2	Thermodynamic preliminaries and system, Mass balance equation. Steady state and unsteady state material balance. Basic energy concept. Energy balance for closed system. Enthalpy change in non-reactive processes.	8
3	Physical & Chemical Methods of Sterilization. Thermal death kinetics of microorganisms, Batch and continuous sterilization, Air Sterilization.	7
4	Enzyme substrate complex and enzyme action, Enzyme kinetics of substrate and multi-substrate reactions, Deactivation kinetics, Molecular folding and defolding of enzyme, Reactors for enzymatic processing, Selection of reactors, Mass transfer in enzyme reactors, Methods of immobilization, External and internal diffusion mass transfer limitation, Effectiveness factor and modulus.	10
5	Diffusion theories, Aeration and Agitation, Analogy between mass, heat and momentum transfer, Mass transfer coefficient, Gas-Liquid Mass Transfer in cellular systems, Gas-Liquid Contacting modes, Oxygen Transfer from Gas bubble to Cell, Determination of volumetric mass transfer coefficient, Factors Effecting volumetric mass transfer coefficient, Rheology of fermentation broth, Scale-up principles	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Enzymes/ Palmer/ Horwood Publishing Series.	2001
2	Biochemical Engineering Fundamentals/ J.E. Baily and D.F. Ollis/ McGraw Hill.	1986
3	Chemical Engineering Design: Fourth edition/ J.M. Coulson and J.F. Richardson/ Publisher: Butterworth Heinemann.	2005
4	Bioprocess engineering principles/ P. Doran/ Publisher-Academic press	1995

1. Subject Code: **PT308**   Course Title: **Advanced Chemical Reaction Engineering**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn advance chemical reaction engineering including biochemical reactions.

10. Details of Course

S. No.	Contents	Contact Hours
1	Basic idea of catalysis, Catalyst properties, Catalytic specificity, Preparation, Testing and characterization of catalysts, Steps in catalytic reaction, Adsorption, Adsorption isotherms, Catalyst poisoning and catalyst regeneration.	9
2	Fluid solid catalytic reaction kinetics, external transport process, Reaction & diffusion within porous catalysts, Effective diffusivity.	8
3	Thermal conductivity and effectiveness factors, Analysis of rate data design outline & selection of fixed bed, Fluid bed and slurry reactions.	8
4	Fluid-fluid reaction rate equations and their application to the design of reactors, Fluid-solid non-catalytic reactors, Rate equations and their applications to the design of reactors.	8
5	Biochemical reactions, Enzyme kinetics; Models of enzyme kinetics, Estimation of kinetics parameters, Competitive and non competitive inhibitors, Fermenters, mixed flow fermenters, Optimum operation of fermenter.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Elements of Chemical Reaction Engineering/ H. Scott Fogler/ Prentice Hall	2005
2	Encyclopedia of Chemical Technology/ Kirk-Othmer/ Wiley	2014
3	The Engineering of Chemical Reactions/ Schmidt/ Oxford University Press	2005
4	Elements of Reaction Engineering/ R.P.S. Srivastava/ Khanna Publishers	2008

1. Subject Code: **PT310** Course Title: **Chemical Process Simulation**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : VI

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To enable the students to learn about mathematical models of chemical reactors, distillation and related columns.

10. Details of Course

S. No.	Contents	Contact Hours
1	Definition of mathematical model, lumped parameter models, distributed parameter models, uses of mathematical models, scope of coverage, principles of formulation.	9
2	Fundamental Laws, Continuity equations, energy equations, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics.	8
3	Mathematical Models of Chemical Reactors, Isothermal/non-isothermal plug-flow reactor, Two heated tanks, Isothermal/Non-isothermal Batch and Continuous Stirred Tank Reactors.	8
4	Mathematical Models of Distillation Columns, Ideal binary and Multi component distillation using short-cut and rigours methods, Batch distillation with holdup.	9

| 5 | Lumped parameter model, Gas absorber, liquid-liquid extraction column and Heat-exchangers. | 8 |

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Process Modelling, Simulation and control for chemical engineers/ Luybean/ McGrawHill	1989
2	Chemical Process Simulation/ Husain/ Wiley Eastern	1986
3	Process Control - Modeling, Design & Simulation/ Bequette/ Prentice Hall Professional	2003
4	Outline of Chemical instrumentation & Process Control/ A. Suryanarayana/ Khanna Publication	2003

1. Subject Code: **PT312**   Course Title: **Numerical Methods in Chemical Engineering**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn errors, equations, curve-fittings and numerical solutions.

10. Details of Course

S. No.	Contents	Contact Hours
1	Error Analysis: Taylor series expansion, Truncation error. Round-off error vs. Chopping-off error. Propagation of Error.	5
2	Solution of simultaneous linear equations: Cramer's rule, Gauss elimination Method, Gauss-Jordon Method, and LU Decomposition, Gauss-Seidel and Relaxation Methods, Iterative method - Jacobi iteration, Application in steady-state solution of isothermal CSTR.	7
3	Solution of Non-linear Algebraic equations: Bisection method, Newton-Raphson method, Secant method, Modified Newton-Raphson method for multiple roots - Application in thermodynamic property calculation, bubble point and dew point calculation. Finding of multiple roots of a polynomial, Solution of a set of non-linear equations - Newton's method, Multivariable Newton-Raphson Technique. Jacobian matrix, characteristics equations and stability.	9
4	Curve-fitting: Least-square method for straight line and polynomial (Linear Regression), Newton's interpolation formulae (equal intervals), Divided Difference (Unequal intervals), differentiation formulae, Integration formulae (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt.	8
5	Numerical Solution of ODE: Initial value problems using Finite difference Techniques; Runge-Kutta methods, Step-size control; Solution of a set of ODEs; Application in chemical and bio-chemical reactions; Stability analysis.	7
6	Numerical Solution of PDE: Eliptical, Parabolic and Hyperbolic using Explicit, Implicit and Crank-Nicholson techniques; Convergence and stability criteria; Application in unsteady-state heat transfer and reactors.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Numerical Methods for Engineers/ S.K. Gupta/ New Age International (P) Limited	1995
2	Applied Numerical Methods with Personal Computers/ Alkis Constantinides/ McGraw Hill	1987
3	Computer Oriented Numerical Methods/ V. Rajaraman/ PHI	1993
4	Numerical Methods for Chemical Engineers with MATLAB Applications/ Alkis Constantinides/ Prentice Hall	1999

1. Subject Code: **PT314**   Course Title: **CAD in Chemical Engineering**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn Computer Aided Design (CAD) and their applications related to polymer science and chemical engineering.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction to Computer Aided Design (CAD); use of computers for physical property evaluation; thermodynamic properties of gases and binary mixtures; methods of calculating vapour liquid equilibrium data for ideal and non-ideal mixture; bubble point and dew point; flash calculations	11
2	Design of pressure vessels; vessels under internal pressure; heads and closures; compensation requirements for openings and flanges; vessels under external pressure; tall vessels; development of CAD modules for design of pressure vessels	10
3	Computer aided design of heat exchanger systems; double pipe and shell and tube heat exchanger design; computer aided design of evaporators; design of single effect evaporator and multiple effect evaporator systems	11
4	Computer aided design of packed bed absorbers and strippers; computer aided mechanical design of bubble; cap distillation column	10

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Computer Aided Design of Chemical Process Equipment/ Bhattacharya & Narayanan/ New Central Book Agency	2008
2	Chemical Engineers Handbook, 8th Ed/ Perry & Chilton/ McGraw Hill	2008
3	Process Equipment Design, 3rd Ed/ Joshi/ McMillan	1994
4	Heat Exchanger Design, 2nd Ed/ K. Thulukannan/ CRC Press	2013

1. Subject Code: **PT316** Course Title: **Corrosion Engineering**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : VI

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To enable the students to learn about the electrochemistry, chemical and biological aspects of corrosion.

10. Details of Course

S. No.	Contents	Contact Hours
1	Corrosion, Classification of corrosion, Electrochemistry of corrosion, Galvanic and electrolytic cells, Potential measurements, EMF and Galvanic series, Galvanic corrosion and bimetallic contacts, Eh-pH diagrams, Copper, Aluminium and general corrosion diagrams.	10
2	Electrode kinetics and polarization phenomena, Exchange current density, Polarization techniques to measure corrosion rates, Mixed potential theory, Activation and diffusion controlled mixed electrodes.	9
3	Methods of corrosion prevention and control, Design, coatings and inhibition, Cathodic protection, Stray current corrosion, Passivity phenomena and development of corrosion resistant alloys, Anodic control.	9

4	Biological aspects of corrosion, Microbially Induced Corrosion (MIC), Principles, Types, environments and microbiology, Biofilms, Corrosion by aerobic and anaerobic bacteria, Depolarization theory, Case studies, Failure analyses, Prevention of MIC, Corrosion of medical implants, Biocorrosion of concrete.	9
5	Metallurgical properties influencing corrosion.	5

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Corrosion Control/ Unling/ John Wiley & Sons	1971
2	Microbiologically Influenced corrosion/ B. J. Little/ Wiley-Intersciene	2007
3	Chemical Materials for construction/ Maslow, P./ Structures publishing Co.	1974
4	Corrosion Engineering/ Fontance, & Gtretrnee/ McGraw Hill	1967

1. Subject Code: **PT318**   Course Title: **Polymer Blends and Composites**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite : NIL

9. Objective : To impart knowledge about the polymer, blends and composites to the students.

10. Details of Course

S. No.	Contents	Contact Hours
1	Polymer blends classification, Principles of polymer compatibility, Different theories of predicting compatibility, Factors governing compatibility, Compatibilizers, Property achieved by blending, Methods of blending, Characterization of blends, Commercial polyblends and their properties, Morphology of blends and its determination.	10
2	Introduction to rheology of polymer blends, Its relevance in processing, Rheology phase morphology relationships and their relevance.	8
3	Classification of composite, particulate and fibrous composite, Introduction to reinforcing material.	8
4	Properties of composites, Fabrication of continuous and short fiber composites and particulate composites, Mechanical and physical properties.	8
5	Environmental effect on composites, Test methods and applications of composites.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Polymer Blends, Vol. I & II/ D.R. Paul/ Academic Press	1978

2	Composite Materials: Science & Engineering/ Chawla/ Springer India	2012
3	Handbook of Polymer Blends & Composites, vol 1/ Kulshreshtha & Vasile/ Rapra Tech Ltd	2002
4	Polymer composites: From nano to macro scale/ Friedrich et al/ Springer	2005

1. Subject Code: **PT320**   Course Title: **Polymer Rheology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn about polymer rheology and their importance.

10. Details of Course

S. No.	Contents	Contact Hours
1	Linear viscoelastic model, stress relaxation and creep, non-linear viscoelasticity - normal stress difference in shear, shear thinning, interrelations between shear functions, extensional thickening, differential-type constitutive equations - single mode differential constitutive equations and multimode constitutive equations for viscoelastic fluids, integral type constitutive equations, rate-type constitutive equations for viscoelastic fluids, material functions for steady state shear flow, oscillatory shear flow, material functions for steady state extensional flow.	10

2	Shear rheometer: sliding plates, falling ball rheometer, concentric cylinder rheometer, cone and plate rheometer, parallel disks, capillary rheometer, slit rheometer and squeezing flow behavior.	8
3	Extensional rheometry: simple extension - end clamps, rotating clamps, buoyancy bath, spinning drop, lubricated compression, planner squzeeing, sheet stretching, multiaxial extension, fiber spinning, tubeless siphon, bubble collapse, stagnation flow.	8
4	Rheology of polymeric liquids: polymer chain conformation, zero shear viscosity, rheology of dilute polymer solutions, entanglement, Repetition Model, effect of long chain branching, effect of molecular weight distribution, temperature dependence.	8
5	Rheology in polymer processing operations: Calendaring and two roll mill, Twin screw extruders, Blow molding, Wire coating, Thermoforming, Sheet extrusion, Internal mixers, Rubber extrusion	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Rheology, Principles, Measurements and Applications/ Christopher W. Macasko/ Wiley VCH	1994
2	Rheology and Processing of Polymeric Materials Vol. 1/ Oxford University Press	2007
3	Rheology: Concepts, Methods, and Applications/ A.Y. Malkin, A.I. Isayev/ ChemTec Publishing	2006
4	Melt Rheology and its Role in Plastic Processing: Theory and applications/ Dealy & Wissbrun/ Chappman and Hall	1999

1. Subject Code: **PT322**   Course Title: **Nonwoven Technology**

2. Contact Hours: L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To enable the students to learn about Non-wovens, bonding processes, finishing process etc.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of nonwovens, Elements of nonwovens, Fibre geometry, Structure of fibrous webs, Basic nonwoven processes and their sequences.	8
2	Staple-fibre based processes, Fibre opening and mixing processes, Staple fibre web formation processes, Carding process, Parallel-lay process, Cross-lay process, Perpendicular-lay process, Air-lay process, Wet-lay process.	8
3	Web and Mechanical bonding processes, Needle-punch and Hydro entanglement process, Principle and processes of thermal bonding, Calendar, Through-air, Infra-red, Ultrasonic and Chemical bonding processes, Chemical binders, Methods of binder applications, Saturation, Foam, Spray and Print bonding process, Methods of drying.	10

4	Polymer-extrusion based technologies, Spun bond technology, Melt-blown technology, Key process factors.	8
5	Mechanical and chemical finishes and their method of applications.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Nonwoven/ Madhavamoorthy and Shetty/ Mahajan Publishers Pvt. Ltd.	2005
2	Handbook of Nonwovens/ S.J. Russell (Ed.)/ Woodhead Publishing, CRC Press, Washington DC.	2007
3	Nonwoven Fabrics: Raw Materials, Manufacture, Applications, Characteristics, Testing Process/ Albrecht, Fuchs and Kettelmann/ Wiley-VCH.	2003

1. Subject Code: **PT324**   Course Title: **Application of Nanotechnology in Polymers**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with nanotechnology and their polymeric applications.

10. Details of Course

S. No.	Contents	Contact Hours
1	Importance and emergence of nanotechnology, Size dependence of properties, crystal structure, energy bands, insulators, semiconductors and conductors, gaps of semiconductors, Fermi surfaces, localized particles.	6
2	Improvements in solar energy conversion and storage; better energy-efficient lighting; stronger and newer materials to improve energy transportation efficiency; use of low-energy chemical pathways to break down toxic substances for remediation and restoration; Device applications, Use in hydrogen Storage and Production, Fuel Cells, Battery, Carbon Nanotubes for energy storage.	10
3	Polmeric Nanoelectronics, Molecular Electronics Components, Concepts of nanopolymer based switches and complex molecular devices, Molecular rectifying diode switches, Polymeric nanophotonics, Photonic Properties of Nanomaterials; Photon Absorption, Emission & Scattering, Band gap of Nanoscale Semiconductors, Laser & uses of Quantum Dots, Lasers based on Quantum Confinement Near Field Light, Optical Tweezers, Photonic Crystals, Semiconductor nanowires, Basics of Nanoelectronic & Nanocomputer architectures	12
4	Nanopolymers in Medicines, Nanomedicine, Molecular design using biological selection, DNA and protein based nanocircuitry, Neurons for network formation, DNA based nanomechanical devices, Drug Delivery, Therapeutic action of nanoparticles and nanodevices, Targeted, Non-targeted delivery, Controlled drug release; exploiting novel delivery routes using nanoparticles; gene therapy using nanoparticles.	10
5	Recent applications of polymeric nanoparticles.	4

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Biomedical Nanostructures/ Gonsalves, Halberstadt, Laurencin & Nair (Eds.)/ Wiley-Interscience	2008

2	Biomaterials Fabrication and Processing Handbook/ Chu and Liu (Eds.)/ CRC Press	2008
3	Handbook of Nano structured Biomaterials and Their Applications in Nanobiotechnology/ H.S. Nalwa/ ASP	2005
4	Nanotechnology Understanding Small Systems/ Rogers et al/ CRC Press	2014

1. Subject Code: **PT326**   Course Title: **Polymer Reaction Engineering**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VI

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with kinetics of polymerization.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of polymer reaction engineering, Fundamental concepts, Study of molecular weight distribution, Distinctive features of polymers and polymerization reactors, Changes in viscosity, density and rate constant with conversion.	10

2	Kinetics of polymerization, MW/MWD obtained for chain-growth, step-growth polymerization in batch reactor, Plug-flow reactor and continuous stirred tank reactor, kinetic studies of cationic, anionic and free radical polymerization reactions, Ziegler-Natta catalyst in stereo-regular polymerization, kinetics mechanism in heterogeneous and stereo-regular polymerization reactions, rates of Ziegler-Natta polymerization, average chain length of polymer in stereo-regular polymerization	10
3	Kinetics of emulsion and suspension polymerization, Introduction to bulk, solution, suspension and emulsion polymerization techniques, aqueous emulsifier solution, kinetic aspects of suspension and emulsion polymerization (Smith-Ewart Model), determination of total number of particles, molecular weight in emulsion polymerization, emulsion polymerization in homogenous CSTR, kinetics of dispersion polymerization.	11
4	Kinetics at High Degree of Conversion, Verification of the kinetic model and the gel effect in radical polymerization, equilibrium of radical polymerization, temperature effects in radical polymerization, role of inter phase mass transfer in the selection and the design of polymerization reactor (especially step-growth polymerization reactors), diffusion effects in Ziegler-Natta polymerization and metallocene catalyst for olefin polymerization.	11

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Fundamentals of Polymer Engineering/ Kumar and Gupta/ Marcel Dekker.	2003
2	Polymerization Process Modeling/ Datson, Galvan, Laurence and Tirrel/ VCH Publishers, Inc.	1996
3	Control of polymerization Reactors/ Schork, Deshpande and Leffew/ Marcel Dekker	1993
4	Reaction Engineering of Step Growth Polymerization/ Gupta and Kumar/ Plenum Press.	1987

1. Subject Code: **PT409**   Course Title: **Tyre Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with tyre, its design and manufacturing.

10. Details of Course

S. No.	Contents	Contact Hours
1	Importance of tyres, Functions and desirable properties of tyres, Classification of tyres, Sizing & Designation, Tyre components, Problems associated with tyres and their remedies.	9
2	Aspects of tyre design, Analysis of motive forces, Types of bonding, Set of service conditions, Tyre size requirements, Safety requirements, Tread design, Role of foot print area and factors affecting tread life, Various types of tread pattern, Carcass design, Role of various fibres used in carcass, Estimation of number of plies, Bead design, Various configurations of wires in bead assembly.	10
3	Compound design, Role of various mixing ingredients, various recipes, Compound mixing, Mixing equipments.	7
4	Extrusion of components, Tyre and wire cord manufacture, Component preparation, Green tyre building, Pre- and post-curing operations/ treatments.	8

5	Tyre Testing and evaluation, Carcass strength, Resistance to bead unseating, Machine simulation tests, Indoor laboratory testing, Field test on road, Proving grounds, Latest testing techniques.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Tyre Technology 3rd Ed/ T. French/ Adam Hilger	1989
2	Encyclopedia of Chemical Technology/ Kirk & Othmer/ Wiley	2000
3	Rubber Technologists Handbook vol 1/ De et al/ Rapra publishing	2001
4	Science and Technology of Rubber/ Mark et al/ Elsevier	2005

1. Subject Code: **PT411**   Course Title: **Thermoplastic Elastomers**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with thermoplastic elastomers, types and their properties.

10. Details of Course

S. No.	Contents	Contact Hours
1	Thermoplastic Elastomers (TPEs), Elastomers, Thermodynamics of elasticity, Thermoplastic elastomers, Classification, structure and synthesis of TPEs.	8
2	Polyolefin based thermoplastic elastomers, Synthesis, Properties, Processing and Applications, PVC based TPE-PVC/Nitrile rubber blends, PVC/PU blends, PVC/Co-polyester elastomers blends, Styrenic TPEs.	9
3	Thermoplastic polyurethane elastomers, Synthesis, Properties, Processing and Applications, Polyamide based TPE, Structure-property relationship, Thermoplastic polyether ester elastomers.	9
4	Preparation of dynamically vulcanized thermoplastic elastomer blends, Properties and applications, Synthesis of ionomeric TPE, Ionic interactions in polymer blends, Applications of ionomeric elastomers.	8
5	Secondary manufacturing processes technology of TPEs, process simulation, 3D printing, product development and testing; Recycling methods for thermoplastic elastomers. Recent developments and trends in the field of thermoplastic elastomers.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Thermoplastic Elastomers – 2nd Edition/ G. Holden, N.R. Legge, R. Quirk, H.E. Schrolder/ Hanser Publishers, Munich.	1996
2	Hand Book of Elastomers New Developments and Technology/ Anil K. Bhowmick, Howard L. Stephens/ Marcel Dekker, Inc., New York.	1988

3	Handbook of Thermoplastic Elastomers/ Drobny/ William Andrew Publishing, New York, USA, 2nd Edition.	2007
4	Applied Plastic Engineering Handbook: Processing and Materials, Chapter on Thermoplastic Elastomers/ Holden, G/ PP.77-92, Elsevier, Oxford, UK.	2011

1. Subject Code: **PT413**   Course Title: **Resin Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To aware students about resin, their classification and applications.

10. Details of Course

S. No.	Contents	Contact Hours
1	Resins and resinous state, Classification, Natural and synthetic resins, Composition, Purification and Uses, Modification of natural resins.	7
2	Polyester Resins: Curing of resins, Catalysts and Accelerators, Water reducible polyesters, High solid polyesters/ polyesters for powder coatings, Moulding compositions, DMC, SMC, fibre and film forming compositions.	8

3	Phenolic Resins: Basic components, Theory of resinification, Reaction mechanism, Effect of ratio of reacting components and pH on reaction mechanism, Novolacs and Resol, Curing and moulding, Applications of phenolic resins.	9
4	Amino Resins: Synthesis and properties of UF and MF resins, Theory of resinification, Reaction mechanism, Effect of pH on the reaction mechanism, s, Curing and moulding, Applications of amino resins.	9
5	Alkyd Resins: Functionality concepts, Use of polyfunctional acids and alcohols, phthalic acid resins, Manufacturing, Types of modifications and properties of modified alkyd resins, Applications of alkyd resins.	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Polymer and Resins; Their Chemistry and Chemical Engineering/ B. Golding/ D. Van Nostrand Company Inc.	1959
2	Polymer chemistry/ Seymour and Carraher/ Marcel Dekker	2003
3	Synthetic Resins Technology Handbook/ NIIR Board of Consultants & Engineers	2005
4	The Complete Book on Adhesives, Glues & Resins Technology/ NPCS Board of Consultants & Engineers	2007

1. Subject Code: **PT415**   Course Title: **Paint Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with paint, its coating properties and environmental impact.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction to Surface coatings, Classification, Paints, Varnishes, Lacquer, Pigment, Extender, Composition of surface coatings, Global scenario and future prospective of Indian Paint Industry, Aesthetics and saftey standards.	8
2	Inorganic pigments and extenders, Synthesis, micronisation and surface treatment of pigments, Source, manufacture, properties and uses of extenders, pigments such as carbonates, Silicates, Sulphates and Oxides; Extender mixtures, Calcined Pigments and Extenders, Nano pigments and extenders.	8
3	Organic pigments and dyestuffs: Dyes and pigments, Chemical structures and their colour imparting behaviours, Auxochromes and chromophores, Influence of physical factors; colour psychology. Natural organic pigments, Coaltar distillation products, Mordants and precipitants, Bases for colour striking and lakes, miscellaneous salts and chemicals. Chemical reactions for synthesis of various dyes and pigments, Synthetic organic pigments: Azo pigments, Basic and acid dyes pigments, Miscellaneous organic pigments.	12

4	Special effect pigments like pearlescent, nacreous, phosphorescent, fluorescent and luminescent, IR reflecting pigments, thermochromic pigments, polymeric pigments, invisible pigments, High performance Pigments & dyes, Comparison of organic and inorganic pigments, Colour index name and number,Colour coding systems.	7
5	Environmental resistance and ageing properties of paints and coatings, natural & accelerated outdoor weathering tests, weather-o-meter, Evaluation of water based paints, Exterior test protocol, In-can and dry film preservation, Hygiene surfaces.	7

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Paint Technology handbook/ R. talbert/ CRC Press	2008
2	Introduction to Paint Chemistry and principles of paint technology, 4th Ed/ J. Bentley, G.P.A. Turner/ CRC Press.	1997
3	Paints Pigments Varnishes and Enamels Technology Handbook with Process and Formulations/ NIIR Board	2016
4	The Chemistry of Synthetic Dyes, vol 5/ Venkataraman/ Academic Press	1971

1. Subject Code: **PT417**   Course Title: **Footwear Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester : VII

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To familiarize students with shoes, soles, adhesives used, testing and moulding related to footwear.

10. Details of Course

S. No.	Contents	Contact Hours
1	Shoe soles, Soling requirements, synthetic soling materials, compounding & processing. Individual soling compounding-PVC compounding and processing, Thermoplastic Rubber-Compounding and Processing, Polyurethane-Compounding cell structure, processing, Ethylene vinyl acetate, Miscellaneous soling.	8
2	Adhesives, Principle of adhesion, Industrial applications, Socking & combing adhesive, French binding, Heel covering, Sole attaching, Neoprene, PU, hot melt and liquid curing adhesive, Coated fabrics for shoe upper, PVC coated fabric, PU coated fabric etc.	9
3	Durability of shoe upper, soling material assessment – Drum (DIN) abrasion, AK RON Abrasion, Flex Crack performance, Dimensional stability test, sole bond adhesion test, Tear test for soling materials, environmental storage conditions, miscellaneous properties – Hardness and softness; tensile strength; water absorption; oil and slip resistance.	9
4	Unit Soles, Molded and pre-fabricated units, Individual solings – vulcanized rubber, crepe rubber, Thermoplastic rubber, Nylon, polyester, PVC, PU, EVA etc.	8
5	Compression moulding, sponge moulding, direct molded shoes, injection moulding thermoplastic, polyurethane injection moulding, insert moulding, HF flow moulding, vulcanization of solving, Recent advances in footwear technology.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Footwear Design (Portfolio Skills)/ Choklat /Laurence King Publishing	2012
2	Handbook of Footwear Design and Manufacture/ Luximon/ Woodhead Publishing	2013
3	Comprehensive Footwear Technology/ Ganguly/ Oxford University Press	2003
4	The Science of Footwear/ Goonetilleke/ CRC Press	2012

1. Subject Code: **PT419**   Course Title: **Plastic and Environment**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To make student understand about the impact on environment due to manufacturing, processing and applications of plastics.

10. Details of Course

S. No.	Contents	Contact Hours
1	Sources of solid waste and plastic waste, different types of pollution due to plastics, coding and labeling; Global scenario and Indian Plastic Industry; Accumulation of plastic waste in the natural environment.	8
2	Pollution and hazards related to plastics, loading of toxic chemicals from plastics into soil and water (including additives, flame retardants, anti-oxidants etc.); ISI Standards regarding limits of these chemicals in effluents; Effects of plastic debris in the environment and on wildlife.	8
3	Plastic Waste Management; Public awareness regarding hazards caused by indiscriminate use of plastics, proper disposal of plastics; Collection of recyclable plastics. Landfill, Incineration of plastics.	9
4	Environment consciousness; Environment education & awareness; Environmental policies, legislation & code of protection.	9
5	Organizations involved in plastic waste management; Case studies; Methods of sustainable development.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Handbook of green chemistry—green catalysis. Vol I Homogenous catalysis/ Anastas P. T., Crabtree R. H. (ed.)/ John Wiley & Sons.	2009
2	Designing safer polymers/ Anastas, Bickart , Kirchhoff/ John Wiley and Sons.	2000
3	Recycling and Recovering of Plastics/ Brandrup/ Hanser Publications	1996
4	Degradable Polymers, Recycling, and Plastics Waste Management/ Albertsson/ CRC Press	1995

1. Subject Code: **PT421**   Course Title: **Industrial Waste Management**

2. Contact Hours: L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To make student understand about the impact on environment due to the effluents of industries.

10. Details of Course

S. No.	Contents	Contact Hours
1	Magnitude of industrial waste generation and their characteristics, Effluent standards for disposal into water bodies, sewer & land, Waste water characterization and process survey, Methods of waste reduction such as volume & strength reduction, segregation, reuse, recycle, material conservation, recovery process optimization, neutralization, equalization, proportioning and solidification.	11
2	Theories of waste water treatment, Pre-treatment, Biological treatment, Advanced treatment & sludge handling.	7
3	Combined treatment of raw industrial waste with sewage, Common effluent treatment for industrial estates, Selection procedure for physical, chemical & biological methods of industrial waste treatment, Management of industrial waste from small-scale industries.	9
4	Gross polluting industries, Detailed considerations of waste produced from different industries, Nature & quantity of wastes, their characteristics, usual methods of waste management & treatment methods.	9
5	Regulatory authorities, regulations and compliance.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Handbook of Industrial Waste Treatment/ Woodard/ Elsevier	2011
2	Waste water microbiology 4th Ed/ Bitton/ Wiley	2011
3	Guide for Industrial Waste Management/ US Env Prot Agency	1999
4	Sustainable Industrial Design and Waste Management: Cradle-to-Cradle for .../ Salah El Haggar/ Academic Press	2007

1. Subject Code: **PT423**   Course Title: **Polymer Degradation**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge about degradation of polymer.

10. Details of Course

S. No.	Contents	Contact Hours
1	Modes of polymer degradation, Detection of polymer degradation products.	6
2	Thermal and photo-degradation: Mechanistic aspects, Stabilization of polymers, Thermal decomposition & analysis, Light sources, Light absorption and quantum yield, Photochemical reactions, Degradation in the absence of oxygen, Photo-oxidation, Photo-resists, Types of radiations and their effects, Reactive intermediates, Simultaneous cross-linking and degradation, Radiation effects in bio-polymers, Plasma treatment of polymers.	10
3	Mechanical degradation: Bond rupture and experimental findings, Degradation in different media, Ultrasonic degradation.	9
4	Chemical degradation: Solvolysis, Reactions of olefinic double bonds, Oxidative degradation, Ionic degradation, Reaction with air pollutants, Solvent stability.	9
5	Biodegradation: Modes of biodegradation, Enzymatic degradation of biopolymers & synthetic polymers, Microbial degradation of polymers.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Fundamentals of Polymer Degradation and Stabilization/ N.S. Allen, M. Edge/ Elsevier	1992
2	Handbook of Polymer Degradation, Second Edition/ Hamid/ Taylor & Francis	2000
3	Degradable Polymers, Recycling, and Plastics Waste Management/ Albertsson/ CRC Press	1995
4	Polymer Degradation and Stabilisation/ Grassie & Scott/ Cambridge Unversity Press	1988

1. Subject Code: **PT425**   Course Title: **Energy Conservation and Recycling**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To make student understand about the conservation of energy and energy efficiency, recycling and economics.

10. Details of Course

S. No.	Content	Contact Hours
1.	Energy Conservation, Approach and modern Techniques, Benefits, Trends.	4
2.	Techno-Economic evaluation of conservation technologies, Efficiency Improvements, Thermal Utilities, Thermic fluid heating systems, Furnaces, Heating and melting applications, Refractories, Energy conservation in energy intensive chemical and process industries like pulp and paper, cement, sugar & petrochemical, fertilizer industries.	10
3.	Sources of waste heat and its utility, Heat recovery systems (Recuperates, Regenerator, Thermal or Heat wheels, Heat pipes and Heat pumps, etc.), Efficient steam generation fluidized bed boilers, Efficient use of steam traps condensate collections and return, Steam and gas turbine, Cogeneration, Heat exchanger network synthesis, Process heat recovery and recycling.	8

4.	Energy efficiency in buildings & ECBC, Envelop heat loss and heat gain and its evaluation, Opportunities and techniques for energy conservation in buildings, Adoption to sustainable resources, Process and technologies, Green buildings, Intelligent buildings, Rating of buildings.	6
5	Energy storage in conventional and non-conventional energy systems, Technical aspects, Various forms of energy storage and Techno commercial analysis (Economical aspects) thereof.	8
6	Energy economics, Thermal energy conservation, Case studies of commercial/industrial/residential energy conservation systems and their economical analysis.	6

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Industrial Energy Management and Utilization/ Witte et al/ Hemisphere Publication, Washington.	1988
2	Industrial Energy Conservation Manuals/ MIT Press.	1982
3	The efficient use of energy/Dryden/ Butterworths, London.	1982
4	Energy Management Handbook/Turner Wiley, New York.	1982
5	Technology Menu for Efficient energy use- Motor drive systems, Prepared by National Productivity Council and Center for & Environmental Studies- Princeton Univ.	1993

1. Subject Code: **PT427**   Course Title: **Safety & Hazards in Chemical Industries**

2. Contact Hours: L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : VII

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To make student aware about the safety aspects in chemical industries.

10. Details of Course

S. No.	Contents	Contact Hours
1	Plant safety and safety regulations, Safety in chemical & polymer industries, Origin of process hazards, Laws, Codes, Standards, Case histories, Criteria for setting & layout of chemical plant, Factories Act and Safety Regulations.	9
2	Plant hazards such as Fire, Chemicals, Explosion, Electrical, Mechanical, Radiation and Noise, Control, precautions & prevention, Safety measures in plants.	8
3	Storage and transportation of chemicals, Characteristics of chemicals with special reference to safe storage & handling, Layout of storage, Various modes of transport and safety precautions in transportation of different types of chemicals.	5
4	Risk management principles, Risk analysis techniques, Hazard & operability studies, Hazard analysis, Fault tree analysis, Consequence analysis, Human error analysis, Accident error analysis, Economics of risk management.	10
5	Safety Audit, Procedure for safety auditing, Audit report, Safety report.	6
6	Safety training, Emergency planning and disaster management.	4

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Safety and Hazards Management in Chemical Industries/ Vyas/ Atlantic.	2013
2	Chemical Hazards and Safety, 2nd Ed/ Dawande/ Denett & Co.	2012
3	Loss Prevention in the Process Industries/ Lees/ Butterworth-Heinemann	1980
4	Industrial Safety Handbook/ William & Handley/ McGraw Hill.	1969

1. Subject Code: **PT406**   Course Title: **Speciality Polymers**

2. Contact Hours: L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 04

6. Semester   : VIII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge to student about special polymers and their applications.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of speciality polymers, High temperature and fire resistant polymers, Applications of heat resistant polymers like polyamides, polyimides, polyquinolines, polyquinoxalines, PEEK, silicone, polysiloxane, polyphosphazenes, ladder polymer, barrier polymer, dendritic polymers, telechelic polymer, luminescent polymer.	10
2	Conducting polymers, types of conducting polymers, doping of polymeric systems, conduction mechanism, Synthesis, curing reactions, and technological applications of Polyaniline, Polyacetylene, Polypyrrole, Photo-conducting and piezoelective polymers.	10
3	Polymers in corrosion inhibition, Polymers as antistatic agents, Polymer colloids, Polymeric surfactants, Polymers in conversion and storage of solar energy.	7
4	Polymers in telecommunications and power transmission - liquid crystalline polymers, Polymer impregnated concrete ultra-high modulus fibres.	5
5	Synthesis, physical properties and applications of biomedical polymers, hydrophilic polymers and ionic polymers, Natural and synthetic biopolymers and their biomedical applications.	6
6	Recent advancements in speciality polymers.	4

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Speciality Polymers/ R.W. Dyson/ Blackie Academic	1998
2	Functional Polymers/ Bergbreiter & Martin/ Springer	1989

3	Functionalized Polymers & their Applications/ Akelah & Moet/ Chapman & Hall	1990
4	Handbook of Conducting Polymers/ Skotheim & Reynolds/ CRC Press	2007

1. Subject Code: **PT408**   Course Title: **Colouration Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VIII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To make student aware about the colour and its interaction with various polymers.

10. Details of Course

S. No.	Contents	Contact Hours
1	How materials modify light, Perceiving colour, System based on colour mixing and perception, Natural colour system, Colour scale, Principle of measuring color.	8
2	Colourants, Dyes versus Pigments, Solubility, Chemical nature, Transparency, Presence of colour binders.	6

3	Colourant as an engineering material, Organic, Inorganic, Photochromic, Thermochromic and Fluorescent colourants.	10
4	Colourant-polymer interactions, Colourant compounding, Effect of additives on coloring plastics, Colour transparency films, General overview of the recent technological developments in the area of polymer colouration and finishing.	10
5	Environmental issues and reuse of discarded colourants, Potential problems with the interaction between colourants and other additives, Novel colouring materials for the environmentally friendly colouration of polymeric materials.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Coloring of Plastics: Fundamentals, 2nd Ed/ R.A. Charvat/ SPE monograph series	2003
2	Handbook of Textile and Industrial Dyeing: Principles, Processes and Types of Dyes/ M. Clark/ Woodhead Publishing.	2011
3	Principles of Colour Technology/Billmeyer & Saltzman/ Wiley	2000
4	Fundamentals and Practices in Colouration of Textiles, Second Edition/ J N Chakraborty/ Woodhead Publishing.	2014

1. Subject Code: **PT410**   Course Title: **Membrane Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4.	Relative Weight	: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5.	Credits	: 04
6.	Semester	: VIII
7.	Subject Area	: DEC
8.	Pre-requisite	: NIL
9.	Objective	: To make student aware about the theory, principle and applications of membrane.

10. Details of Course

S. No.	Contents	Contact Hours
1	Overview of gas permeation, Pervaporative dialysis, Electro-dialysis, Reverse osmosis, Ultrafiltration, Micro-filtration.	8
2	Concepts of electro-dialysis, Theory, Ion-exchange membranes, Industrial applications of membranes.	8
3	Ultrafiltration, Theory and mechanical concepts, Membranes for ultrafiltration, Process and module configurations.	8
4	Emulsion liquid membranes, Design considerations and applications.	8
5	Newer Membranes and Processes, Membrane based solvent extraction, Hollow fibre contained liquid membrane, Membrane reactors, Facilitated transport, Electrostatic pseudo-liquid membrane, Recent advances in membrane technology	10

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Basic Principles of Membrance Technology, J. Mulder, Springer International	1996

2	Chemical Process: Design and Integration/ Smith/ Wiley	2005
3	Synthetic Polymer Membranes/ Khulbe et al/ Springer	2008
4	Membrance Technology & Applications, Baker, Wiley Blackwell	2012

1. Subject Code: **PT412**   Course Title: **Inorganic Polymers**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VIII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students about synthesis, physical and chemical properties and applications of inorganic polymers.

10. Details of Course

S. No.	Contents	Contact Hours
1	Introduction, Types of inorganic polymers and their special characteristics.	5
2	Characterization of inorganic polymers, Molecular weights, Molecular weight distributions, Chain statistics, Solubility considerations, Crystallinity, Transitions, Spectroscopy, Mechanical properties.	9

3	Polyphosphazenes: Synthesis, Ring opening polymerization, Mechanism, Structure-property relationships; Advanced elastomeric, Fibres, and Film forming, Polyphosphazenes, Polyphosphazenes as biomedical materials, Organometallic polyphosphazenes, Liquid crystalline and high refractive index polymers, Polycarbophosphazenes and polythiophosphazenes.	11
4	Polysilanes and related polymers: Introduction, Synthesis and Chemical modification of polysilanes, Physical properties of polysilanes, Electronic properties and conformations, Photo-degradation of polysilanes, Structure of polysilanes, Technology of polysilanes.	10
5	Miscellaneous inorganic polymers: Boranes, Polymers containing sulfur and nitrogen – properties and applications.	7

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication /Reprint
1	Inorganic Polymers, Second Edition/ Mark, Allcock and West/ Oxford	2005
2	Inorganic Polymers/ Jaeger & Gleria / Nova Science Publisher	2007
3	Inorganic and Organometallic Polymers/ Chandrasekhar/ Springer	2005
4	Inorganic Polymers/ Saxena/ Discovery Publishing House	2007

1. Subject Code: **PT414**   Course Title: **Food Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4.	Relative Weight	:	CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5.	Credits	:	04
6.	Semester	:	VIII
7.	Subject Area	:	DEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To make student aware about the food chemistry and applications of polymer in food packaging.

10. Details of Course

S. No.	Contents	Contact Hours
1	Food chemistry: Composition of foods, Water relationships in food, chemistry of carbohydrates, proteins, amino acids, lipids, vitamins and their functions, Bioavailability and stability of nutrients, Nutritive value of foods, Antioxidants, Flavoring agents, Food Analysis, Food additives.	8
2	Food Microbiology: Microorganisms in foods, Factors that influence the development of microbes in food, Biotechnological improvements, Microbial growth pattern, Spoilage and chemical changes of food, Food borne intoxicants, infections and mycotoxins, Newer methods of food processing.	9
3	Fermentation products: Production of dairy products, Manufacture of milk products, Fermented foods and vegetables, Distilled beverages: Alcohol, wine, brandy and beer.	8
4	Food preservation and storage: Principles of food preservation; Physical, chemical and biological methods, Food preservation with low and high temperatures, drying, Indicator and Food-borne Pathogens.	9
5	Food packaging: Packaging and canning of foods, Active and intelligent packaging, Antimicrobial food packaging, Non-migratory bioactive polymers in food packaging, Plastics for food packaging.	8

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Food Microbiology, 4th Ed/ Frazier and Weshoff/ McGraw Hill	1998
2	Essentials of human nutrition, 3rd ed/ Mann & Trusswell/ Oxford university press	2007
3	Industrial Microbiology, 4th Ed/ Prescott and Reed/ AVI Publishing Company	1983
4	Food processing and preservation/ Sivashankar/ Prentice – Hall of India Pvt.	2002
5	Food-borne Pathogens/ A.M. Emerging/ Woodhead Publ.	2006

1. Subject Code: **PT416**   Course Title: **Process Design and Engineering Economics**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.) : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VIII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To make student aware about the basic of process design, plant location and layout and cost estimation.

10. Details of Course

S. No.	Contents	Contact Hours
1	Basis of Process Design: Steps in process development, selection of process, factors affecting process selection, Project organization, preliminary data collection, process engineering, Feasibility survey, importance of laboratory development to pilot plant, scale up methods, types flow sheet, selection of process equipment, development of process flow sheet from process information. Optimum Design and Design strategy: Basic principle of Optimum Design, general procedure for determining optimum conditions, Optimum production rate in plant.	11
2	Plant Location and Layout: Plant location and layout, factors affecting both planning and layouts, drawings of plant layout, plant elevation drawings and complex engineering flow sheet drawings; environment and safety clearances, Safety methods in plant equipment, problems in standardization and commissioning. Project scheduling, use of PERT/ CPM methods. Project evaluation and assessment of project profitability.	11
3	Cost Estimation: Factors affecting investment and production costs, Capital investments – fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimation capital investment. Estimation of total product cost. Different costs involved in the total product for a typical chemical process plant.	10
4	Cash flow statement, discounted cash flow, pay-back period, breakeven analysis, introduction to market survey, Balance sheet and income statement, minimum economics plant capacity, technological obsolescence, need for expansion and diversification, concept to marginal additional investment, role of research and development, Indian chemical industry, current state and trends.	10

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Plant Design and Economics for Chemical Engineering/ Peters & Timmerhaus/ McGraw Hill	1991

2	A Guide to Chemical Engineering Process Design and Economics/ Ulrich/ John Wiley	1984
3	Chemical Engineering Design, 2nd Ed/ Sinnott, Elsevier	2012
4	Process Engineering Economics/ Couper/ CRC Press	2003

1. Subject Code: **PT418**   Course Title: **Fertilizer Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VIII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge about the properties, applications and packaging of fertilizers.

10. Details of Course

S. No.	Contents	Contact Hours
1	Chemical fertilizers and organic manures; types of chemical fertilizers; Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.	9
2	Phosphatic fertilisers, phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.	9

3	Complex and NPK fertilisers: Methods of production of ammonium phosphates, nitrophosphates, urea and various grades of NPK fertilizers.	8
4	Miscellaneous fertilisers: Mixed fertilizers and granulated mixtures; biofertilizers, Nutrients, Secondary and micro nutrients; Fluid fertilizers, Controlled release fertilizers.	9
5	Applications of polymers in fertilizer industry	7

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Handbook of fertilizer technology/ Association of India, New Delhi.	1977
2	Fertilizer Industry - An Introductory Survey/ Menno, M.G./ Higginbothams Pvt. Ltd.	1973
3	The Chemistry and Technology of Fertilizers/ Sauchelli, V./ ACS monograph No.148, Reinhold Publishing Corp. New York.	1980
4	Biofertilizers in Agriculture, 2nd edition/ N. S. Subba Rao/ Oxford & IBH Publishing Company, New Delhi	1988

1. Subject Code: **PT420**   Course Title: **Fuel Cell Technology**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VIII

7. Subject Area   : DEC

8. Pre-requisite   : NIL

9. Objective   : To impart knowledge about the properties, applications and components of fuel cells.

10. Details of Course

S. No.	Contents	Contact Hours
1	Fuel cells, Working and types of fuel cell, Low, medium and high temperature fuel cell, Liquid and methanol types, Proton exchange membrane fuel cell, Solid oxide, Hydrogen fuel cells, Thermodynamics and electrochemical kinetics of fuel cells, Fuel cell reaction kinetics, Electrode kinetics.	9
2	Fuel cells for automotive applications, Technology advances in fuel cell vehicle systems, Onboard hydrogen storage, Liquid hydrogen and compressed hydrogen, Metal hydrides, Fuel cell control system, Alkaline fuel cell.	9
3	Electrode assembly components, Fuel cell stack, Bi-polar plate, Humidifiers and cooling plates, Fuel cell performance characteristics, Current/voltage, Voltage efficiency and Power density, Ohmic resistance, Kinetic performance, Mass transfer effects.	8
4	Hydrogen, Its merit as a fuel, Applications, Hydrogen production methods, Production from fossil fuels, Electrolysis, Thermal decomposition, Photochemical and Photo-catalytic methods, Hydrogen storage methods, Metal hydrides, metallic alloy hydrides, carbon nano-tubes, sea as source of deuterium, Hydrogen storage technology, pressure cylinders, liquid hydrogen, metal hydrides, carbon fibers, reformer technology, steam reforming, partial oxidation, auto thermal reforming, CO removal.	9
5	Fuel cycle analysis, Application to fuel cell and other competing technologies like battery powered vehicles, si-engine fueled by natural gas and hydrogen and hybrid electric vehicle.	7

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Fuel Cells: From Fundamentals to Applications/ S. Srinivasan/ Springer.	2006
2	Fuel Cell Science and Technology/ Basu, S./ Springer, N.Y	2007
3	Fuel Cells for automotive applications – professional engineering publishing UK.	2004
4	Fuel Cell Technology Handbook SAE International Gregor Hoogers CRC Press.	2003

1. Subject Code: **PT422** Course Title: **Pharmaceutical Technology**

2. Contact Hours : L: 03 T: 01 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 04

6. Semester : VIII

7. Subject Area : DEC

8. Pre-requisite : NIL

9. Objective : To impart knowledge about the design, development, applications and packaging of pharmaceutical compounds.

10. Details of Course

S. No.	Contents	Contact Hours
1	Drug discovery process and drug design: Introduction to drug discovery, Various stages in the process of drug design and molecular discovery to commercialization, Target selection, Drug receptor interaction, Drug action theories, Synthetic methods, Screening approaches, PK & PD, ADMET, Various phases of clinical trials.	10
2	Process technology for drugs and intermediates: Manufacturing processes for drugs and their comparative study, Optimization of organic reactions and processes and scale up, Development techniques for safe process design, Unit operations posing particular hazards during development, Chemical hazards assessment, Process control consideration and safety critical systems, GMP in chemical development.	10
3	Drug delivery systems: Conventional and recent pharmaceutical dosage forms and drug delivery systems, Polymers in Drug delivery modules, Radio pharmaceuticals.	8

| 4 | Pharmaceutical packaging technology: Introduction to Packaging, Classification of packaging, Essential requirements, Functions of packaging, significance of pharma packaging, Properties of ideal package, Packaging formats and materials in pharma industry, New trends in the pharmaceutical packaging. | 8 |
| 5 | Validation and Regulatory requirements: CGMP and Quality assurance, Process, product validation and quality audits, New drug application, generic products, DPCO/NPPA, drugs and cosmetics act and rules including licensing intermediates industry. | 6 |

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication / Reprint
1	Foye's Principles of Medicinal Chemistry/D.A. Williams, 7th Edition.	2012
2	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry/ John M. Beale, Jr., John H. Block, Twelfth edition	2011
3	Fine Chemicals Manufacture - Technology and Engineering/ A. Cybulski/ Elsevier Publication	2000
4	Practical Process Research and Development/ Neal G. Andreson/ Academic Press.	2000
5	Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Howard C. Ansel, 9th Edition,	2011

1. Subject Code: **PT424**   Course Title: **Rocket Propulsion and Explosives**

2. Contact Hours   : L: 03   T: 01   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 04

6. Semester   : VIII

7.	Subject Area	:	DEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To impart knowledge about the propulsion, propellant, and explosives.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of propulsion, Fundamentals of Rocket Propulsion: Impulse, thrust, Energy efficiencies and Effective exhaust velocity, typical Performance values.	8
2	Propellants, Classification and Ingredients; Oxidizers and fuels; Selection criteria for oxidizers and fuels.	8
3	Explosives and High energy molecules, Energetic materials, Classification, precautions during storage.	9
4	Plastic based explosives, Advantages, Binders, Insults, Composition C-4; Semtex and related explosives	8
5	Plastic based explosive detectors, Fluorescing polymer; Portable **Plastic Explosives Detector; Plastic Explosives** for the Purpose of **Detection; Anatomy of Explosives, Detection Equipments.**	9

11. Suggested Books

S. No.	Name of Books/Authors/Publisher	Year of Publication/ Reprint
1	Rocket Propulsion Elements, 8th Ed/ Sutton & Biblarz/ Wiley	2010
2	Propellants and Explosives, Chemical Tech. Review No.40/ Ronald W. James/ Noyes Data Corporation, USA	1974
3	K. Ramamurthi, Rocket Propulsion, Macmillan Publishers.	2010
4	H. Singh, H. Shekhar, Science and Technology of Solid Rocket Propellants, Printwell, Darbhanga.	2005

OPEN ELECTIVE COURSES

CO351 ENTERPRISE & JAVA PROGRAMMING

1. Subject Code: **CO351**   Course Title: **Enterprise & Java programming**

2. Contact Hours   :   L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.)   :   Theory 3 Hrs   Practical 0

4. Relative Weightage   :   CWS 25   PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   :   3

6. Semester   :   V

7. Subject Area   :   OEC

8. Pre-requisite   :   Nil

9. Objective   :   To introduce fundamentals of Enterprise Java Programming, concepts of program development using beans.

10. Details of Course :

Unit No.	Contents	Contact Hours
1.	**Collections :** Collection Interfaces, Concrete Collections, Collections Framework. **Multithreading :** Creating and running thread, Multiple thread synchronization, Thread communication, Thread group, Thread priorities, Daemon Thread, Life Cycle ofThread.	5

2.	Fundamentals in Networking: Sockets in Java - Internet Addressing - DNS – Ipv4,IPv6- URL class - TCP/IP and Datagram. The interfaces and classes for networking :Interfaces and classes of java.net package; InetAddress class : IP address scope - Host name resolution - Methods of InetAddress class; Program to look up the IP addresses for a hostname - Factory methods - Creating and using Sockets : Socket class - constructors and methods of Socket class. Creating TCP servers &clients : TCP/IP server sockets - Constructors and methods of ServerSocket class - Program to create a TCP/IP server and client. Handling URL: URL class - constructors and methods of URL class -URLConnection class - fields of URLConnection class - methods of URLConnection class. Working with Datagrams: DatagramPacket - Constructors for DatagramPacket class - Methods of DatagramPacket class - creating Datagram server and client.	6
3.	JDBC Package :JDBC – JDBC versus ODBC – Types of JDBC drivers – Connection – Statement – PreparedStatement.ResultSet :Fields of ResultSet – Methods of ResultSet – Executing a query - ResultSetMetaData – DatabaseMetaData. Datatypes in JDBC : Basic datatypes in JDBC – Advanced datatypes in JDBC – fields of Statement – methods of Statement – CallableStatement Interface – BatchUpdates	6
4.	Servlets : Using Servlets - Servlet Package - Servlet lifecycle - init() method - service() method , doGet() method, doPost() method and destroy() method . Classes and interfaces of Servlet: Servlet - GenericServlet - ServletConfig - ServletContext - ServletException - ServletInputStream - ServletOutputStream - ServletRequest – ServletResponse. Classes and interfaces of HttpServlet: HttpServlet - HttpServletRequest - HttpServletResponse - Reading HTML form data from Servlets - Response Headers - Response Redirection. Handling Servlets : Servlet Chaining - HttpUtils - Database access with JDBC inside servlet. State and Session management : Cookies - HttpSession - Server Side includes - Request forwarding – RequestDispatcher.	7

5.	Concepts of Java Beans: Java Beans - Advantage of Java Beans - Reflection and Introspection - Customizers – Persistence. Developing Java Beans : Bean Developer Kit (BDK) - Creating a Java Bean - Creating a Bean Manifest file - Creating a Bean JAR file. Controls and Properties of a Bean : Adding controls to Beans - Giving Bean Properties - BeanInfo interface - SimpleBeanInfo class. Types of Properties: Design pattern for Properties: Simple properties - Indexed Properties; Descriptor Classes - Giving Bean methods - Bound and Constrained Properties - Property Editors.	9
6.	Components of EntrepriseBeans : Distributed Multitiered Applications -J2EE components: J2EE clients, Web components, J2EE containers. Developing an Enterprise Bean : Packaging - Enterprise JavaBeans Technology - Enterprise Bean - Contents of an Enterprise Bean. Session Bean : Stateful session bean – life cycle of stateful session bean - Stateless session bean – life cycle of stateless session – ejbCreate methods – Business methods – Home interface – Remote interface – Running the session bean. Entity Bean :Persistence - Bean managed Persistence - Container Managed Persistance - Shared Access - Primary key – Relationships. Message Driven Bean :life cycle of message driven bean – onMessage method.	9
Total		**42**

11. Suggested Books

S. No.	Name of Books / Authors/ Publishers
Text Books	
1.	Java 2 Programming Black Book - Steven Holzner dreamTech Press(ISBN-9788177226553), 2005
2.	JavaBeans Programming from the GroundUp - Joseph O'Neil, TMGH, New Delhi(ISBN- 007463786X), 2001
Reference Books	

3	Head first EJB-O'Reilly (ISBN: 8173665265), 2003
4.	"Beginning Java™ EE 6 Platform with GlassFish 3 From Novice to Professional" by Antonio Goncalves– Apress publication(ISBN: 9781430219545), 2009

CO353 E-COMMERCE AND ERP

1. Subject Code: **CO353**   Course Title: **E-Commerce and ERP**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To introduce E-Commerce and ERP

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Introduction: Definition of Electronic Commerce, E-Commerce: technology and prospects, incentives for engaging in electronic commerce, needs of E-Commerce, advantages and disadvantages, framework, Impact of E-commerce on business, E-Commerce Models.	7
2.	Network Infrastructure for E- Commerce: Internet and Intranet based E-commerce- Issues, problems and prospects, Network Infrastructure, Network Access Equipments, Broadband telecommunication (ATM, ISDN, FRAME RELAY). Mobile Commerce: Introduction, Wireless ApplicationProtocol, WAP technology, Mobile Information device.	7

3.	Web Security: Security Issues on web, Importance ofFirewall, components of Firewall, Transaction security, Emerging client server, Security Threats, Network Security, Factors to consider in Firewall design, Limitation of Firewalls.	6
4.	Electronic Payments: Overview, The SET protocol, Payment Gateway, certificate, digital Tokens, Smart card, credit card, magnetic strip card, E-Checks, Credit/Debit card based EPS, online Banking. EDI Application in business, E- Commerce Law, Formsof Agreement, Govt. policies and Agenda.	6
5.	ERP Introduction, Benefits, Origin, Evolution and Structure:Conceptual Model of ERP, The Evolution of ERP, The Structure of ERP. Business Process Reengineering, Data ware Housing, Data Mining, Online Analytic Processing(OLAP), Product Life Cycle Management(PLM),LAP, Supply chain Management.	8
6.	ERP Marketplace and Marketplace Dynamics:Market Overview, Marketplace Dynamics, The Changing ERP Market. ERP- Functional Modules: Introduction, Functional Modules of ERP Software, Integration of ERP, Supply chain and Customer Relationship Applications. ERP Implementation Basics, ERP Implementation Life Cycle, Role of SDLC/SSAD, Object Oriented Architecture, Consultants, Vendors and Employees, ERP & E-Commerce, Future Directives- in ERP, ERP and Internet.	8
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	Goel, Ritendra "E-commerce", New Age International,2007
2.	Ravi Kalakota, Andrew Winston, "Frontiers of Electronic Commerce", Addison-Wesley. 1996
3.	Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning – Concepts and Practice", PHI 2004
4.	Rahul V. Altekar "Enterprise Resource Planning", Tata McGraw Hill, 2004
5.	Alexis Leon, "ERP Demystified", Tata McGraw Hill, 2014

CO355 CRYPTOGRAPHY AND INFORMATION SECURITY

1. Subject Code: **CO355** Course Title: **Cryptography and Information Security**

2. Contact Hours : L: 3 T: 0 P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs Practical 0

4. Relative Weightage : CWS 25 PRS 0 MTE 25 ETE 50 PRE 0

5. Credits : 3

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : NIL

9. Objective : To study various cryptographic techniques, mathematics related to cryptography and some network security protocols.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	**Introduction:** Need for security, Introduction to security attacks, services and mechanism, introduction to cryptography, Conventional Encryption: Conventional encryption model, classical encryption techniques- substitution ciphers and transposition ciphers, cryptanalysis, stereography, stream and block ciphers, Intruders, Viruses and related threads.	6
2.	**Modern Block Ciphers:** Block ciphers principals, Shannon's theory of confusion and diffusion, Fiestal structure, data encryption standard(DES), strength of DES, crypt analysis of DES, block cipher modes of operations, triple DES, IDEA encryption and decryption, strength of IDEA, key distribution.	6

3.	Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primarily testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms, Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography, Elganel encryption	8
4.	**Message Authentication and Hash Function:** Authentication requirements, authentication functions, message authentication code (MAC), hash functions, security of hash functions and MACS, MD5 message digest algorithm, Secure hash algorithm(SHA), Public Key Infrastructure(PKI): Digital Certificate, private key management, Digital Signatures: Digital Signatures, authentication protocols, digital signature standards (DSS), proof of digital signature algorithm.	6
5.	**Authentication Applications:** Kerberos and X.509, directory authentication service, password, challenge-response, biometric authentication, electronic mail security-pretty good privacy (PGP), S/MIME.	8
6.	**IP Security:** Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. **Web Security:** Secure Socket Layer(SSL) and transport layer security, TSP, Secure Electronic Transaction (SET), Electronic money, WAP security, firewall design principals, Virtual Private Network (VPN) security.	8
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	William Stallings, "Cryptography and Network Security: Principals and Practice", Prentice Hall, New Jersy. 2016
2.	Atul Kahate, "Cryptography and Network Security", TMH. 2009
3.	Behrouz A. Forouzan, "Cryptography and Network Security", TMH.2007
4.	Johannes A. Buchmann, "Introduction to Cryptography", Springer-Verlag. 2004
5.	Bruce Schiener, "Applied Cryptography". 2015

CO357 OPERATING SYSTEM

1. Subject Code: **CO357**   Course Title: **Operating System**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25 ETE 50 PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiar with the fundamental principles of the operating system, its services and functionalities, the concepts of processes, synchronization and scheduling, memory management and need for protection in computer systems

10. Details of Course

Unit No.	Contents	Contact Hours
1.	**Introduction:** Operating system and function, Evolution of operating system, Batch, Interactive, Time Sharing and Real Time System, System protection. **Operating System Structure:** System Components, System structure, Operating System Services.	4
2.	**Concurrent Processes:** Process concept, Principle of Concurrency, Producer Consumer Problem, Critical Section problem, Semaphores, Classical problems in Concurrency, Inter Process Communication, Process Generation, Process Scheduling. **CPU Scheduling:** Scheduling Concept, Performance Criteria of Scheduling Algorithm, Evolution, Multiprocessor Scheduling.	9

3.	**Deadlock:** System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach.	8
4.	**Memory Management:** Base machine, Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Paged replacement algorithms, Allocation of frames, Thrashing, Cache memory organization, Impact on performance.	9
5.	**I/O Management & Disk Scheduling:** I/O devices and organization of I/O function, I/O Buffering, DISK I/O, Operating System Design Issues. **File System:** File Concept, File Organization and Access Mechanism, File Directories, File Sharing, Implementation Issues	9
6.	**Case Studies:** Windows, Linux and Unix	3
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
Text Books	
1.	Silbersachatz and Galvin, "Operating System Concepts", Pearson, 5th Ed, 2001
2.	Tannenbaum, "Operating Systems", PHI, 4th Edition, 2000
Reference Books	
3.	Milenekovic, "Operating System Concepts", McGraw Hill 2001
4.	Dietel, "An introduction to operating system", Addison Wesley 1983

CO359 INTELLECTUAL PROPERTY RIGHTS

1. Subject Code : **CO359**   Course Title: **Intellectual Property Rights**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25 ETE 50   PRE 0

5. Credits : 3

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : Nil

9. Objective : To familiarize the students with basic concepts in each type of IPR together with historical developments in the subject & its importance in modern times.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Introduction: Concept of IPR, Historical development , kinds of IPR,brief description of patent, trademark, copyright ,industrial design, importance of IPR, IPR authorities.	5
2.	PATENTS :Introduction, Indian Patent Act 1970 &2002, Protectable subject matter--patentable invention, Procedure for obtaining patent, Provisional and complete specification Rights conferred on a patentee, transfer of patent, Revocation and surrender of patents, Infringement of patents, Action for infringement, Patent agents, Patent in computer programs.	8
3.	Trademark: Introduction, Statutory authorities, principles of registration of trademarks, rights conferred by registration of trademarks, Infringement of trademarks and action against infringement, procedure of registration and duration,licensing in trademark	7
4.	Copyright: Introduction, Author and ownership of copyright, rights conferred by copyright,term of copyright, assignment/licence of copyright, Infringement of copyright ,remedies against infringement of copyright, registration of copyright, copyright enforcement and societies	7

5.	Industrial design: The design act-2000, registerability of a design, procedure of registration of a design, piracy of a registered design, Case law on designs	6
6.	International IPR & case laws: World intellectual property organization, WCT, WPPT, TRIPS, Copyright societies, international IPR dispute resolution mechanism. Case laws.	9
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
Textbooks:	
1.	Law Relating to Intellectual property, fourth edition by B.L.Wadehra .Universal law publishing co. pvt. Ltd , 2007. ISBN 978-81-7534-588-1
Reference books:	
2.	Intellectual property: Patents, copyright ,trademarks and allied rights. Fifth edition by W.R. Cornish. Sweet & Maxwell publisher, 2003. ISSN 9780421781207
3	Law and practice of intellectual property in India by VikasVashishth, 2006 **ISBN:** 81-7737-119-3
4	Patents ,copyrights, trade marks and design by B L Wadhera, 2014
5	Dr. B. L. Wadhera, "Intellectual Property Law Handbook". Universal Law Publishing, 2002.

CO361 DATABASE MANAGEMENT SYSTEM

1. Subject Code: **CO361**   Course Title: **Database Management System**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6.	Semester	:	V
7.	Subject Area	:	OEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To provide knowledge about the principles, concepts and applications of Database Management System.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	**Introduction:** Data base system concepts and its architecture, Data models schema and instances, Data independence and data base language and interface, Data definition languages, DML. Overall data base structure. **Data modeling using Entity Relationship Model:** E.R. model concept, notation for ER diagrams mapping constraints, Keys, Concept of super key, candidate key, primary key generalizations, Aggregation, reducing ER diagrams to tables, extended ER model.	7
2.	**Relational Data Model and Language:** Relational data model concepts, integrity constraints, Keys domain constraints, referential integrity, assertions, triggers, foreign key relational algebra, relational calculus, domain and tuple calculus, SQL data definition queries and updates in SQL.	7
3.	**Data Base Design:** Functional dependencies, normal forms, 1NF, 2NF, 3NF and BCNF, multi-valued dependencies fourth normal forms, join dependencies and fifth normal forms. Inclusion dependencies, loss less join decompositions, normalization using FD, MVD and JDs, alternatives approaches to database design.	6
4.	**File Organization, Indexing and Hashing** Overview of file organization techniques, Indexing and Hashing- Basic concepts, Static Hashing, Dynamic Hashing, Ordered indices, Multi-level indexes, B-Tree index files, B+- Tree index files, Buffer management **Transaction processing concepts:** Transaction processing system, schedule and recoverability, Testing of serializability, Serializability of schedules, conflict & view serializable schedule, recovery from transaction failures, deadlock handling.	8

5.	**Concurrency Control Techniques:** Locking Techniques for concurrency control, time stamping protocols for concurrency control, concurrency control in distributed systems. multiple granularities and multi-version schemes.	8
6	**Case Studies:** Commercial databases, Oracle, Postgress, MySQL	6
	Total	**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
	Text Books
1	Elmasri, Navathe,"Fundamentals of Database systems", Addision Wesley, 2016
2	Korth, Silberchatz, Sudarshan,"Data base concepts", McGraw-Hill. 2010
	Reference Books
1	Ramakrishna, Gehkre, "Database Management System", McGraw-Hill 2014
2	Date C.J.,"An Introduction to Database systems" 2006

EC351 MECHATRONICS

1. Subject Code: **EC351**   Course Title: **Mechatronics**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To introduce fundamentals of Mechatronics

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Introduction : Basic Definitions and key elements of Mechatronics, Mechatronic Design Approach: Functions of Mechatronic Systems, Ways of Integration, Information Processing Systems (BasicArchitecture and hardware and Software trade-offs, Concurrent Design Procedure for Mechatronic Systems	6
2.	System Interfacing, Instrumentation,and Control Systems: Input and output Signals of a Mechatronic System, Signal Conditioning and microprocessor control, Microprocessor-Based Controllers and Microelectronics, Programmable Logic Controllers	6
3.	Introduction to Micro- and Nanotechnology, Micro-actuators, Micro-sensors, Nanomachines. Modeling Electromechanical Systems: Models for Electromechanical Systems, Rigid Body Models, Basic Equations of Dynamics of Rigid Bodies, Simple Dynamic Models, Elastic System Modeling, Dynamic Principles for Electric and Magnetic Circuits, Earnshaw's Theorem and Electromechanical Stability	10
4.	The Physical Basis of Analogies in Physical System Models: The Force-Current Analogy: Across and Through Variables, Maxwell's Force-Voltage Analogy:Effort and Flow Variables, A Thermodynamic Basis for Analogies	6
5.	Introduction to Sensors and Actuators: Characteristics of Sensor and Actuator Time and Frequency Measurement, The Role of Controls an modelling in Mechatronics: Integrated Modeling, Design, and Control Implementation, Special Requirements of Mechatronics that Differentiate from Classic Systems and Control Design, Modeling as Part of the Design Process, Modeling of Systems and Signals	6
6.	Design Optimizationof Mechatronic Systems: Optimization Methods, Principles of Optimization : ParametricOptimization, General Aspects of the OptimizationProcess, Types of Optimization Methods, Selection of aSuitable Optimization Method, Optimum Design of Induction Motor (IM), IM Design Introduction : Classical IM Design, Use of a Neuron Network for the Identification ofthe Parameters of a Mechanical dynamic system, Mechatronics and Computer Modelingand Simulation, Mechatronics and the Real-Time useof Computers, Communications andComputer Networks,Control withEmbedded Computersand ProgrammableLogic Controllers	8
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	Mechatronics : an introduction by Robert H Bishop, Taylor & Francis, 2005
2	Introduction to Mechatronics by KK AppuKuttan Oxford University Press, 2007

EC353 COMPUTER VISION

1. Subject Code : **EC-353**   Course Title: **Computer Vision**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS -   MTE 25 ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To introduce fundamentals of Computer Vision and algorithms for object detection, recognition and tracking.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Introduction to computer vision: Role of Artificial intelligence and image processing in Computer Vision, Industrial Machine Vision applications, System architecture. Visual Sensors: Camera sensors: RGB, IR, Kinect sensor, Camera interfaces and video standards, Characteristics of camera sensors commercially available cameras. Camera Calibration: Interior, exterior calibration and rectification using Tsai's Calibration method.	5

2.	Basics of image processing – Pixel representations histograms ,transforms, colour filters, noise removal, Geometry: Math methods -linear algebra, vectors, rotations, Stereo – Epi-polar geometry, correspondence, triangulation ,Disparity maps . Basics of video processing – Background subtraction techniques – frame differencing, Gaussian Mixture Modelling (GMM), Object localization and processing:- Contours, edges, lines, skeletons.	7
3.	Image representation: Local Wavelet basis (multiscale), Global Fourier basis(Frequency), Adaptive basis (PCA and ICA) , Adaptive basis(discriminants) Basics of Object detection – Template matching, Cascade classifiers.	8
4.	Object Recognition : Object Modeling, Bayesian Classification, Feature Selection and Boosting, Scene and Object Discrimination.	6
5.	Motion and Tracking: Motion detection and tracking of point features, optical flow, SURF, SIFT. Tracking- Kalman filter, Particle Filter, Comparison of deterministic and probabilistic methods condensation, tracking humans, multi-frame reconstruction under affine and perspective projection geometry.	8
6.	Introduction to Computer Vision programming libraries: MATLAB/ OpenCV. advantages and disadvantages of each .	8
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	Computer Vision: A Modern Approach (2nd Edition) 2nd Edition by David A. Forsyth (Author), Jean Ponce (Author), 2002
2.	Learning OpenCV: Computer Vision with the OpenCVLibrary Gary Bradski, Adrian Kaehler, 2008

EC355 EMBEDDED SYSTEM

1. Subject Code: **EC- 355**   Course Title: **Embedded Systems**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Knowledge of Computer Architecture and Microprocessors

9. Objective   : To introduce fundamentals of 16 and 32 bit Microcontrollers, assembly language programming. The course also focuses on interfacing of different interrupt driven peripherals. It also covers in detail Real Time Operating Systems, Bus architecture, Digital Signal Processors and System On-Chip.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Overview of Embedded Systems: Characteristics of Embedded Systems. Comparison of Embedded Systems with general purpose processors. General architecture and functioning of micro controllers. PIC and 8051 micro controllers : Architecture, memory interfacing , interrupts, instructions, programming and peripherals .	8
2.	ARM : Architecture, memory interfacing , interrupts, instructions and Assembly Language programming. Exception processing and pipeline architecture and applications.	12

3.	Digital Signal Processors: DSP Architecture, DSP applications, algorithms, data path, memory, addressing modes, peripherals. TI and Sharc family of DSP processors.	4
4.	System On Chip : Evolution, features, IP based design, TI OMAP architecture and peripherals. Digital Multimedia processor: Architecture and peripherals.	4
5.	SRAM, DRAM working and organization. Interfacing memory with ARM 7. Elements of Network Embedded Systems	4
6.	RTOS : RT-Linux introduction, RTOS kernel, Real-Time Scheduling Bus structure: Time multiplexing, serial, parallel communication bus structure. Bus arbitration, DMA, PCI, AMBA, I2C and SPI Buses.	10
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	Computers as components: Principles of Embedded Computing System Design, Wayne Wolf, Morgan Kaufman Publication, 2000
2.	ARM System Developer's Guide: Designing and Optimizing System Software, Andrew N. Sloss, Dominic Symes, Chris Wright, , Morgan Kaufman Publication, 2004
3.	Design with PIC Microcontrollers, John B. Peatman, Pearson Education Asia, 2002
4.	The Design of Small-Scale embedded systems, Tim Wilmshurst, Palgrav, 2003
5.	Embedded System Design, Marwedel, Peter, Kluwer Publishers, 2004

EC357 DIGITAL IMAGE PROCESSING

1. Subject Code: **EC 357**   Course Title: **Digital Image Processing**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6.	Semester	:	V
7.	Subject Area	:	OEC
8.	Pre-requisite	:	Signals and Systems
9.	Objective	:	To introduce the fundamentals of visual information, representation of 2-D and 3-D information, enhancement of information, retrieval of information, and various colour models.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Introduction to Image processing, fundamental steps in DIP, concept of visual information, image formation model, image sampling and quantization, digital image representation, spatial and gray level resolution, relationship between pixels, application of image processing system.	6
2.	Introduction to Multidimensional signals and systems, 2D-Signals, 2D systems, classification of 2D system, 2D convolution, 2D Z-transform, Image Transform: 2D-DFT, discrete cosine, discrete sine, Haar, Walsh, Hadamard, Slant, KL, SVD, Hough, Radon, Ridgelet.	8
3.	Image enhancement; Spatial domain: linear transformation, image negative, grey level shifting, non-linear transformation, logarithmic transformation, exponential transformation, grey level slicing, bit plane slicing, image averaging, mask processing, histogram manipulations, histogram thresholding, histogram stretching, histogram equalization, noise removing filters, smoothing filters, sharpening filters. Enhancement in Frequency Domain; ideal low pas filter, Butterworth low pass filter, ideal high pass filters, Butterworth high pass filter, band pass filter, Gaussian filters, Homomorphic filtering.	10
4.	Image restoration: degradation model, noise models, restoration in presence of noise, periodic noise removal in frequency domain, notch filters, inverse filtering, Wiener filtering.	6

5.	Introduction to Morphological Image Processing operations, dilation and erosion, opening and closing, hit-or-miss transformation, boundary extraction, region filling, extraction connected components, convex hull, thinning, thickening, skeletons, pruning.	6
6.	Introduction to various colour models: RGB, CMY, CMYK, HSI, HSV, and YCbCr. Concept of image compression, Image Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region based segmentation, use of motion in segmentation.	6
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	Digital Image Processing/ Gonzalez and Woods/ Pearson Education, 2008/Third Edition
2.	Fundamentals of Digital Image Processing/ A.K. Jain/ PHI, Indian Edition
3.	Digital Image Processing using MATLAB/ Gonzalez, Woods, and Eddins/ McGraw Hill, Second/ 2013
4.	Digital Image Processing/ K.R. Castleman/ Pearson, 2014
5.	Digital Image Processing Algorithms and Applications/I. Pitas/John Wiley, 2002
6.	Image Processing, Analysis, and Machine Vision/Milan Sonka, Vaclav Hlavac, Roger Boyale/ Cengage Learning, 4th Edition

EC359 VLSI DESIGN

1. Subject Code: **EC -359**   Course Title: **VLSI Design**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To give the student an understanding of the different design steps required to carry out a complete digital VLSI (Very-Large-Scale Integration) design in silicon.

10. Details of Course

Unit No.	Contents	Contact Hours
1.	Introduction to VLSI, Manufacturing process of CMOS integrated circuits, CMOS n-well process design rules, packaging integrated circuits, trends in process technology. MOS transistor, Energy band diagram of MOS system,MOS under external bias, derivation of threshold voltage equation, secondary effects in MOSFETS	6
2.	MOSFET scaling and small geometry effects, MOScapacitances, Modeling of MOS transistors using SPICE, level I II and equations, capacitance models. The Wire: Interconnect parameters: capacitance, resistanceand inductance. Electrical wire models: The ideal wire, the lumpedmodel, the lumped RC model, the distributed RC model, the transmission line model, SPICE wire models.	6
3.	MOS inverters: Resistive load inverter, inverter with n-type MOSFET load, CMOS inverter: Switching Threshold, Noise Margin, Dynamic behavior of CMOS inverter, computing capacitances, propagation delay, Dynamic power consumption, static power consumption, energy, and energy delay product calculations, stick diagram, IC layout design and tools.	8

4.	Designing Combinational Logic Gates in MOS and CMOS: MOS logic circuits with depletion MOS load. Static CMOS Design: Complementary CMOS, Ratioedlogic, Pass transistor logic, BiCMOS logic, pseudo nMOS logic, Dynamic CMOS logic, clocked CMOS logic CMOS domino logic, NP domino logic, speed and power dissipation of Dynamic logic, cascading dynamic gates.	8
5.	Designing sequential logic circuits: Timing matrices for sequential circuits, classification of memory elements, static latches and registers, the bistability principle, multiplexer based latches , Master slave Edge triggered register , static SR flip flops, dynamic latches and registers, dynamic transmission gate edge triggered register, the C2MOS register	8
6.	Pulse registers, sense amplifier based registers, Pipelining, Latch verses Register based pipelines, NORA-CMOS. Two-phase logic structure; VLSI designing methodology –Introduction, VLSI designs flow, Computer aided design technology: Design capture and verification tools, Design Hierarchy Concept of regularity, Modularity & Locality, VLSI design style, Design quality.	6
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers
1.	Digital integrated circuits a design perspective byJan M Rabaey, Anantha Chadrakasan Borivoje Nikolic, Pearson education, 2011.
2.	CMOS digital integrated circuits by Sung MO KangYusuf Leblebici, Tata McGraw Hill Publication, 2002
3.	Principle of CMOS VLSI Design by Neil E Weste and Kamran Eshraghian, Pearson education, 2000.

EE351 POWER ELECTRONIC SYSTEMS

1. Subject Code: **EE-351**   Course Title: **Power Electronic Systems**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits : 3

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : NIL

9. Objective : To familiarize the students with power electronics and its applications.

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	Solid State Power Devices: Principle of operation of SCR, dynamic characteristic of SCR during turn ON and turn OFF, parameters of SCR, dv/dt and di/dt protection, snubber circuit, commutation circuits; Principle of operation ofMOSFET, IGBT, GTO, MCT, SIT, SITH, IGCT, their operating characteristics.	8
2.	Single-phase Converter: Half wave converter, 2-pulse midpoint converter, half controlled and fully controlled bridge converters, input current and output voltage waveforms, effect of load and source impedance, expressions for input power factor, displacement factor, harmonic factor and output voltage, effect of free-wheeling diode, triggering circuits. Three-phase Converter: Half wave, full wave, half controlled and fully controlled bridge converters, effect of load and source impedance, expressions for input power factor, displacement factor, harmonic factor and output voltage,	8
3.	AC-AC Converters: Principle of operation of cycloconverter, waveforms, control technique; Introduction of matrix converter.	4
4.	DC-DC Converters: Principle of operation of single quadrant chopper, continuous and discontinuous modes of operation; Voltage and current commutation, design of commutating components; Introduction to SMPS.	4

5.	Inverters: Voltage source and current source inverters, Principle of operation of single-phase half bridge and full bridge voltage source inverters, voltage and current waveforms; Three-phase bridge inverter, 120^0 and 180^0 modes of operation, voltage and current waveforms with star and delta connected RL load; Voltage and frequency control of inverters; PWM techniques-single pulse, multiple pulse, selective harmonic elimination, sinusoidal PWM.	8
6.	Applications: FACTS Technology: Reactive power control in power systems, transmission system compensation, static series and shunt compensation, static shunt and series compensators- SVC, STATCOM, TCSC, SSSC and their working principles and characteristics. Combined series-shunt compensators –UPFC and its applications and characteristic. VSC-HVDC Systems: Principles and applications	10
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1.	Mohan N., Undeland T. M. and Robbins W. P., "Power Electronics-Converters, Applications and Design", 3rd Ed., Wiley India, 2002.
2.	Rashid M. H., "Power Electronics Circuits Devices and Applications", 3rd Ed., Pearson Education, 2004.
3.	N.G. Hingorani and L. Gyugyi, "Understanding FACTS", IEEE Press, 2000
4.	K.R. Padiyar, "Facts Controllers In Power Transmission and Distribution", New Age publishers, 2013
5.	HVDC power transmission system, K.R.Padiyar, NewAge Publishers,2011

EE353 ELECTRICAL MACHINES AND POWER SYSTEMS

1. Subject Code: **EE-353**   Course Title: **Electrical Machines and Power Systems**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4.	Relative Weight	:	CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0
5.	Credits	:	3
6.	Semester	:	V
7.	Subject Area	:	OEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To familiarize the students with electrical machines and power systems.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Transformers : constructional features, types, Special constructional features – cruciform and multiple stepped cores, cooling methodology, conservators, breather, Buchholz relay, voltage, current and impedance relationships, equivalent circuits andphasor 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.	8
2	Asynchronous machines: 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.	8
3	Synchronous machines : 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	9
4	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	9

5	Transmission lines: 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.	8
Total		**42**

11. Suggested Books

S. No.	Name of Authors /Books / Publishers
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
3	Nagrath I. J and Kothari D.P. 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2010.
4	Power System Analysis, J. Grainger and W.D. Stevenson, TMH, 2006.
5	Electrical Power Systems,C. L.Wadhwa, New age international Ltd. Third Edition, 2010
6	Electric Power Generation, Transmission&Distribution,S.N.Singh, PHI Learning, 2008.

EE-355 INSTRUMENTATION SYSTEMS

1. Subject Code: **EE-355**   Course Title: **Instrumentation Systems**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   :   NIL

9. Objective   :   To familiarize the students with instrumentation systems.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Transducers-I:Definition, advantages of electrical transducers, classification, characteristics, factors affecting the choice of transducers, strain gauges, resistance thermometer, thermistors, thermocouples, LVDT, RVDT	8
2	Transducers-II:Capacitive, piezoelectric, Hall effect and opto electronic transducers. measurement of motion, force, pressure, temperature flow and liquid level.	8
3	Telemetry:General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter. Data Acquisition System:A/D and D/A converters, analog data acquisition system, digital data acquisition system, modern digital data acquisition system and signal conditioning.	8
4	Display Devices and RecordersDisplay devices, storage oscilloscope, DSO, spectrum analyzer, digital recorders. RecentDevelopments:Introduction to virtual and intelligent instrumentation, fibre optic transducers, smart sensors, smart transmitters, process instrumentation diagrams.	8
5	Programmable Logic Controllers :Evolution of PLC-sequential and programmable controllers, architecture and programming of PLC, relay logic and ladder logic, functional blocks, communication networks for PLC, field bus, profi-bus, mod-bus	10
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Electronic Instrumentation and Measurement Techniques, W.D. Cooper and A.D. Helfrick, Prentice Hall International, 2009.
2	Measurement Systems Application and Design Ernest Doebelin, McGraw- Hill Higher Education, 5th edition , 2003
3	Instrumentation, Measurement and Analysis, B.C. Nakra& K. Chaudhry, Tata McGraw Hill, 2nd Edition, 2001.
4	Advanced Measurements and Instrumentation, A.K. Sawhney, DhanpatRai& Sons, 2010
5	Process Control Instrumentation Technology, Curtis D. Johnson, Pearson, 6th edition, 1999
6	Programmable Logic Controllers, Frank D. Petruzella McGraw-Hill Higher Education, 4th edition, 2010

EE357 UTILIZATION OF ELECTRICAL ENERGY

1. Subject Code: **EE-357**   Course Title: **Utilization of Electrical Energy**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the concept of electrical power, energy and its utilization.

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	Illumination: Definition:- Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux. Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light, Review of laws of illumination, Different types of lighting sources and their use in domestic, street and industrial lighting, Energy considerations. LED's and their driving circuits.	10
2	Electric Heating : Advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating, properties of resistance heating elements, Induction heating; principle of core type and coreless induction furnace, Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace, Dielectric heating, applications in various industrial fields, Infra-red heating and its applications, Microwave heating	08
3.	Electric Welding: Introduction to electric welding, Welding methods, Principles of resistance welding, types – spot, projection seam and butt welding and welding equipment used, Principle of arc production, electric arc welding, characteristics of arc, Design of Power supply and welding control circuit, comparison between AC and DC arc welding, welding control.	08
4.	Electrolytic Processes: Need of electro-deposition laws of electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing, buffing equipment and accessories for electroplating factors affecting electro-deposition , principle of galvanizing and its applications, anodising and its applications, electroplating on non-conducting materials, manufacture of chemicals by electrolytic process, electrolysis for water purification	08
5.	Refrigeration and Air Conditioning and Water Coolers: Principle of air conditioning, vapour pressure, refrigeration cycle, eco-friendly refrigerants, description of electrical circuit used in a) refrigerator, b) air-conditioner, and c) water cooler, variable speed drive for compressors, high speed compressors, insta-chill, Peltier effect, thermoelectric cooling, sterling engines, solar concentrator heating and cooling,	08
Total		**42**

11. Suggested books:

S. No.	Name of Authors /Books / Publishers
1.	Dubey G. K., "Fundamentals of Electric Drives", 2nd Ed., Narosa Publishing House,2007.
2.	Taylor E. O., "Utilization of Electric Energy (in SI units)", Orient Longman, Revised in S.I. units by Rao, V.V.L,1999
3.	Hancock N. N., "Electric Power Utilisation", Wheelers,1979.

EE-359 NON-CONVENTIONAL ENERGY SYSTEMS

1. Subject Code: **EE-359**   Course Title: **Non-conventional Energy Systems**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the non-conventional sources of energy and their integration to the grid.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	**Introduction to Non Conventional Energy Systems** Various non-conventional energy resources Introduction, availability, classification, relative merits and demerits. Solar Cells: theory of solar cells, solar cell materials, solar cell array, solar cell power plant, limitations. Solar Thermal Energy: solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance, solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.	10
2	**Geothermal Energy** Resources of geothermal energy, thermodynamics of geo-thermal energy conversion, electrical conversion, non-electrical conversion,environmental considerations. Magneto-hydrodynamics (MHD):principle of working of MHD power plant, performance and limitations.	8
3	Fuel Cells: Basic principle of working, various types of fuel cells, performance and limitations.	8
4	**Thermo-electrical and thermionic conversions** Principle of working of thermo-electrical and thermionic conversions, performance and limitations. Wind energy: wind power and its sources, site selection criteria, momentum theory, classification of rotors, concentrations and augments, wind characteristics, performance and limitations of wind energy conversion systems.	8
5	**Energy from Bio-mass, Ocean Thermal, Wave and bio-waste** Availability of bio-mass and its conversion principles, ocean thermal energy conversion principles, performance and limitations, wave and tidal energy conversion principles, performance and limitations, bio-waste recycling power plants.	8
Total		**42**

11. Suggested books:

S. No.	Name of Authors /Books / Publishers
1	Renewable Energy Resources, John Twidell, Tony Weir, Taylor and Francis, 2nd edition,2005.

2	Solar Engineering of Thermal Processes,John A. Duffie, William A. Beckman, John Wiley & Sons, 4th edition,2013.
3	Biofuels, Solar and Wind as Renewable Energy Systems: Benefits and Risks,D. Pimentel, Springer,1st edition,2010.
4	Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers,Chetan Singh Solanki, PHI Learning,2013.
5	Non Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd.,2006

EE-361 EMBEDDED SYSTEMS

1. Subject Code: **EE-361**   Course Title: **Embedded Systems**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the concepts of embedded systems.

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	Embedded Processing – Evolution, Issues and Challenges;	1
2	System and Processor Architecture : von Neumann, Harvard and their variants	2

3	Memory Architecture and Devices; Input-Output Devices and Mechanisms	5
4	Instruction Set and Addressing Modes, Interfacing of Memory and Peripheral Devices – Functional and Timing Issues	6
5	Application Specific Logic Design using Field Programmable Devices and ASICs	2
6	Analog to Digital and Digital to Analog Converters	2
7	Bus I/O and Networking Considerations, Bus and Wireless Protocols	4
8	Embedded Systems Software : Constraints and Performance Targets	2
9	Real-time Operating Systems : Introduction, Scheduling in Real-time Operating Systems	4
10	Memory and I/O Management : Device Drivers	2
11	Embedded Software Development : Flow, Environments and Tools	2
12	System Specification and Modelling	2
13	Programming Paradigms	2
14	System Verification	2
15	Performance Analysis and Optimisation : Speed, Power and Area Optimisation, Testing of Embedded Systems	4
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1.	S. Heath, "Embedded Systems Design", Elsevier India,2005
2.	M. Ben-Ari, "Principles of Concurrent and Distributed Programming", Pearson,2005
3.	Jane Liu, "Real Time Systems", Pearson,2002

EN-351 ENVIRONMENTAL POLLUTION AND E –WASTE MANAGEMENT

1. Subject Code: **EN-351**   Course Title: **Environmental Pollution & E- Waste Management**

2. Contact Hours   :   L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) :   Theory: 3 Hrs.   Practical: 0

4. Relative Weightage   :   CWS 25 PRS 0   MTE 25 ETE 50 PRE 0

5. Credits   :   3

6. Semester   :   V

7. Subject Area   :   OEC

8. Pre-requisite   :   Nil

9. Objective   :   The overall aims of the course are for students to acquire understanding of the new and emerging contaminants from various industrial processes and their transformation products. Studying emerging environmental issues related to newer methods of manufacture of industrial products.

10. Details of Course

Unit No.	Contents	Contact Hours
1	UNIT-I New and emerging pollutants and related transformation products, Effects & risks of emerging contaminants on ecosystems and humans, Persistent pollutants. Analytical methods for identifying emerging pollutants and the products of their transformation	9
2	UNIT-II Micro pollutants- Pesticides, Pharmaceutical - Veterinary and human drugs, personal care products, Surfactants and surfactant metabolites, Flame retardants, Industrial additives and agents.Emerging pollutants' toxicity, and their water-related characteristics (degradability, solubility, sorption…)	9

3	UNIT-III Emerging Issues - E-waste, Hazardous Waste, Nuclear Waste, Nano pollution, Thermal Pollution, pollutant emission and treatment	8
4	UNIT-IV Emerging pollutants' emergence and fate in surface and ground water, as well as mathematical modelling, Sustainable Development, Risk mitigation	8
5	UNIT-V Transformation Products of Emerging Contaminants in the Environment, Removal of emerging contaminants from water, soil and air, methods and preventive measures.	8
Total		**42**

Course Outcome:
1. Introduction to new and emerging contaminants and their transformation products.
2. Study of pollutants from manufacturing of goods.
3. Emerging area in environmental pollution.
4. Study of life cycle of a contaminant, modeling and mitigation.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1.	G. Buttiglieri, T.P. Knepper, (2008), Removal of emerging contaminants in Wastewater Treatment: Conventional Activated sludge Treatment, Springer-Verlag Berlin Heidelberg, HdbEnvChem, vol. 5, Part S/2:1-35, DOI: 10.1007/698_5_098
2.	Alok Bhandari; Rao Y. Surampalli; Craig D. Adams; Pascale Champagne; Say Kee Ong; R. D. Tyagi; and Tian Zhang, Eds., (2009) Contaminants of Emerging Environmental Concern, American Society of Civil Engineers, ISBN (print): 978-0-7844-1014-1, ISBN (PDF): 978-0-7844-7266-8
3.	Dimitra A. Lambropoulou, Leo M. L. Nollet Eds. () Transformation Products of Emerging Contaminants in the Environment: Analysis, Processes, Occurrence, Effects and Risks, 1st Edition, Wiley, ISBN-13: 978-1118339596, ISBN-10: 1118339592

EN353 OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT

1. Subject Code: **EN- 353**   Course Title: **Occupational Health and Safety Management**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs

4. Relative Weightage   : CWS 25 PRS 0   MTE 25 ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Prerequisite   : Nil

9. Course Objectives   : 1. Introduction about occupational health and related issues.
                  2. To give a basic idea about environmental safety management, industrial hygiene.
                  3. To introduce about training cycle, chemical hazards and control measures.
                  4. To aware and provide knowledge about ergonomics and different disorders.
                  5. To provide knowledge about different standards related to safety and health.

10. Detail of Course:

Unit no.	Contents	Contact Hours
1	UNIT –I Definition of Occupational Health as per WHO/ILO. Occupational Health and Environmental Safety Management – Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.	8

2	UNIT –II Occupational Health and Environment Safety Management System, ILO and EPA Standards. Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.	8
3	UNIT –III 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. Chemical Hazard: Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, Vapours, Smoke and aerosols. Evaluation and control of basic hazards, concepts of dose response relationship, bio-chemical action of toxic substances. Concept of threshold, limit values.	9
4	UNIT –IV Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit. Ergonomics-Introduction, Definition, Objectives, Advantages. Ergonomics Hazards. Musculoskeletal Disorders and Cumulative Trauma Disorders. Physiology of respiration, cardiac cycle, muscle contraction, nerve conduction system etc. Assessment of Workload based on Human physiological reactions. Permissible limits of load for manual lifting and carrying. Criteria or fixation limits.	9
5	UNIT –V Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department, Safety committee and Function.	8
Total		**42**

Course Outcomes:
1. The student will be able to understand the basics of occupational health and related issues.
2. Understanding of the fundamental aspects of safety, industrial hygiene along with learning theory to safety training methodology.
3. Considerate about hazardous materials, emergency management, ergonomics and human factors

4. Able to understand the adverse effects of hazards and develop control strategies for hazardous conditions and work practices
5. Learn about Indian standards of health and safety and able to apply applicable standards, regulations and codes.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1.	Handbook of Occupational Health and Safety, NIC, Chicago, 1982.
2.	Encyclopedia of Occupational Health and Safety, Vol. I and II. International Labour Organisation, Geneva, 1985.
3.	Accident Preventional Manual, NSC Chicago, 1982.
4.	Henrich, H.W., Industrial Accident Prevention, McGraw Hill, 1980.

EN-355 GIS & REMOTE SENSING

1. Subject Code: **EN-355**   Course Title: **GIS & Remote Sensing**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs

4. Relative Weightage   : CWS 25 PRS 0   MTE 25 ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Prerequisite   : Nil

9. Course Objectives   :
1. Introduce GIS and its significance in engineering and science.
2. To familiarize students with GIS data and its applications.
3. To familiarize students about the basics of remote sensing and its multi concepts.
4. To disseminate knowledge about sensors and different kind of resolution in the area of remote sensing.
5. To familiarize students about the diverse applications of remote sensing.

10. Detail of Course:

Unit no.	Contents	Contact Hours
1	Unit-1: Geographic Information System Introduction, Definition of GIS, Components of GIS, Input data for GIS, Geographical concepts	7
2	Unit-2:GIS Data GIS data types, Data representation, Data sources, Geo-referencing of GIS data, GIS database, Database Management System, Data analysis terminology, GIS software packages, GIS application	9
3	Unit-3:Remote Sensing Introduction to Remote Sensing and Remote Sensing System, Multi concept of remote sensing, Advantages and disadvantages of remote sensing, Electromagnetic radiation, Polarisation, Thermal radiation	8
4	Unit-4:Remote Sensing Platforms Important remote sensing satellites, Classifications of sensors and platforms, Passive and Active sensors, Major remote sensing sensors, Spatial resolution, Spectral resolution, Radiometric resolution, Temporal resolution, Glopal Positioning System	9
5	Unit-5:Application of Remote Sensing Digital Image Processing, Application of Remote Sensing in Land use and Land cover mapping, Ground water mapping, Urban growth studies, Wasteland mapping, Disaster management, Agriculture, Forestry application	9
	Total	**42**

Course Outcomes:
1. The Student will learn about basics of GIS and its significance.
2. The Student will be able to understand the utility of GIS data as well as Data Management System.
3. The Student will learn the fundamentals of remote sensing.
4. The unit of Remote Sensing Platform will generate a clear cut understanding among students about the satellites, their functioning and Global Positioning System. Geographical information system, its components, DMS and its various applications in real life.
5. The Student will be able to attain thorough knowledge about the application of remote sensing in different areas.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1.	Fundamentals of Remote Sensing – George Joseph, University Press, Hyderabad, India.
2.	Remote Sensing and Geographical Information System – AM Chandra & SK Ghosh Narosa Publishing House, New Delhi.
3.	Concepts and Techniques of Geographic Information Systems – C. P. Lo & Albert K.W. Yeung, PHI Learning Private Limited, New Delhi.
4.	Geographic Information System – Kang Tsung Chang, Tata Mc Graw hill, Publication Edition, 2002.

EP351 PHYSICS OF ENGINEERING MATERIALS

1. Subject code: **EP351**   Course title: **Physics of Engineering Materials**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the fundamentals /basic concepts and advances of the different materials keeping in view of the engineering applications. There is ample opportunity to become involved in cutting edge Materials Science and Engineering Research

10. Detail of Course:

Unit No.	Contents	Contact Hours
1.	**Crystallography:** Introduction to crystal physics,Space lattice, Basis and the Crystal structure, Bravais lattices; Miller indices, simple crystal structures,Interplanar spacing, Intra and Intermolecular bonds (Ionic, Covalent, Metallic, Van der Waals and Hydrogen Bond), Defects in crystals, Basics of X- ray diffraction and its applications	10
2.	**Semiconductors:** Band theory of solids, Intrinsic and Extrinsic semiconductors, Statistics of electrons and holes in intrinsic semiconductor, Hall effect, Effect of temperature on conductivity, Generation and recombination, drift and diffusion current, Einstein relation, Applications of Semiconducting Materials.	10
3.	**Dielectric and Magnetic Materials** *Dielectric Materials:* Dielectric polarization and dielectric constant, Various polarization processes, Applications of Dielectric Materials *Magnetic Materials:* Concept of Magnetism, Classification of dia-para, Ferro, Antiferro and Ferrimagnetism, ferrites, soft and hard magnetic materials, Applications of Magnetic Materials	07
4.	**Superconductivity:** Introduction and historical developments; General properties of super conductors, Meissner effect and its contradiction to the Maxwell's equation; Types of Superconductors, London equations, Penetration depth, High Temperature Superconductors, Applications of superconductors.	07
5.	**Advanced Engineering Materials:** Introduction, Synthesis, characterization and applications of Photonic glasses, Phosphors and Nanophosphors, other selective topics in advanced materials.	08
Total		**42**

11. Suggested Books:

S. No.	Name of Books/ Authors
1.	Introduction to Solid State Physics, by C. Kittel, 1996/ John Wiley & sons
2.	Solid State Physics, by S. O. Pillai, 2010/ New Age International (P) Ltd.
3.	Materials Science and Engineering by V. Raghavan, 2009/PHI Learning Pvt. Ltd.
4.	Solid State Physics, N. W. Ashcroft and N. D. Mermin, 1976/ HBC Publication
5.	Engineering Materials Science by Milton Ohring, 1995/Academic Press
6.	Material Science and engineering: An Introduction By W. D. Callister Junior, 2007/ John Wiley & Sons, Inc
7.	Handbook of Electronic and Photonic Materials by SafaKasap, Peter Capper (Eds.), 2006/Springer

EP353 NUCLEAR SECURITY

1. Subject code: **EP353**　　　　Course title: **Nuclear Security**

2. Contact Hours　　　　　　: L: 3　　　T: 0　　　P: 0

3. Examination Duration (Hrs)　: Theory: 3　　　Practical: 0

4. Relative Weight　　　　　: CWS: 25　PRS:--　MTE: 25　ETE: 50　PRE: --

5. Credits　　　　　　　　　: 3

6. Semester　　　　　　　　: V

7. Subject area　　　　　　: OEC

8. Pre-requisite　　　　　　: Basic knowledge of Nuclear Physics

9. Objective　　　　　　　　: This course will provide basic understanding of Nuclear Security which is essential for establishing nuclear culture in the society

10. Detail of Course:5th/6th Semester

S. No.	Contents	Contact Hours
1.	Introduction to nuclear security: Basics of nuclear security, Practice and culture, Background, Objective, Scope, Structure, Nuclear security and safety culture: Characteristics of nuclear security culture	08
2.	Nuclear security regime, Importance of human factor and management leadership in nuclear security, Nuclear security threats: Threat informed security, The design basis threat	07
3.	System characterization, PPS requirements and objectives: Facility characterization, Target identification, Consequence analysis, PPS performance objectives	06
4.	Physical protection system technologies: Intrusion detection, Exterior and Interior Sensors, Access control, Contraband detection, Field detection sensors at borders/major public Events, Alarm assessment, Communication and display, Access delay, Response and neutralization, Response strategies and impact of On and Off site response, Cyber security.	09
5.	Security system design and evaluation: Adversary path analysis and Multi path optimization, Scenario development, Insider analysis, Transportation, Design approaches and vulnerability assessments, System design at major public events, Design of security systems to interrupt illicit trafficking, Analysis of quantitative risk assessment methods.	08
6.	Consequence mitigation and event response: Consequence management following nuclear events, Analysis of deterrence value of security measures, Roles and responsibilities of institutions and individuals	04
Total		**42**

11. Suggested Books

S. No.	Name of Books/ Authors
1.	Nuclear security briefing book, by Wyn Bowen, Matthew Cottee, Chris Hobbs, Luca Lentini and Matthew Moran, 2014/King's College, London, UK
2.	IAEA Nuclear Security Series No. 13, Nuclear Security recommendations on physical protection of nuclear material and nuclear facilities by IAEA, 2011/ International Atomic Energy Agency (IAEA)
3.	The International Legal Framework of Nuclear Security: IAEA International law series No. 4 by IAEA, 2011/International Atomic Energy Agency (IAEA)
4.	Seeking Nuclear Security Through Greater International Cooperation by Jack Boureston and Tanya Ogilvie-White, 2010/Council on Foreign Relations (CFR's) International Institutions
5.	Book Review: South Asia's Nuclear Security by Bhumitra Chakma , 2015/Oxon, UK, Routledge

HU351

1. Subject Code: **HU351**   Course Title: **Econometrics**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)   : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25 ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective:

10. Details of Course

Unit	Contents	Contact Hrs
1.	Introduction Concept of Econometrics, methodology of Econometrics, types of Econometrics, Difference between Econometrics and Mathematical Economics, Type of Data, Sources of data, Estimating Economic Relationship	8
2.	Mathematics and Economic Application Differential Calculus and its application in Economics- Price and Cros Elasticity of demand, Profit maximization under Perfect Competition, Monopoly, Oligopoly and Monopolistic Competition Integral Calculus and its application in Economics - Capital Formation, Compound Interest; Capital value and Flow Value; Consumer surplus under pure competition and monopoly; Producers Surplus Differential Equation and its application in Economics – Market Price Function; Dynamic Multiplier;	12
3.	Regression Statistical verses Deterministic Relationships, Regression verses Causation; Two variable Regression Analysis; Population Regression Function (PRG), Stochastic specification of PRF; The Significance of the Stochastic Term; stochastic disturbance Term; the sample regression Function (SRF); Method of Ordinary Least Squares; Properties of Least Square Estimators: The Gauss-Markov Theorem, Coefficient of determination r^2: A Measure of "goodness of fit"; Monto Carlo Experiments	8
4.	Classical Normal Linear Regression Mode (CNLRM) The Probability distribution of Disturbances (meu); Normality Assumption, Method of Maximum Likelihood Multiple regression Analysis: The Problem of estimation; The problem of Inference Cobb-Douglas Production function; Polynomial Regression Model; Testing for structural or Parametric stability of regression Models; the Chow test	6
5.	Dummy Variable (DV) Regression Models Nature; ANOVA models; Regression with a mixture of Quantitative and Qualitative regressors: The ANCOVA Models; DV alternative to the Chow Test; Interaction effects using Dummy Variable; Use of DV in seasonal Analysis	6
Total		**40**

11. Suggested books

S.No.	Name of Books, Authors, Publishers
1.	Wooldridge Jeffrey , Introductory Econometrics, Cencage Learning- ISBN-13-978-81-315-1673-7; ISBN-1081-315-1673-3,2014
2.	Damodar N. Gujrati, Basic Econometrics, Mcgraw Hill Education (India) Limited, Fifth Edition,2013 ISBN-978-0-07-133345-0; ISBN; 0-07-133345-2
3.	Ramu Ramanathan, Introductory Econometrics with Applications, Harcourt Brace Jovanovich Publishers, Latest USA ISBN-

MA351 HISTORY CULTURE & EXCITEMENT OF MATHEMATICS

1. 1 Subject code: **MA351**   Course title: **History Culture and Excitement of Mathematics**

2. Contact Hours   : L-3   T-0   P-0

3. Examination Duration (Hrs)   : Theory: 3hrs

4. Relative weightage   : CWS: 25 PRS: -   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre requisite   : --

9. Objective: To be capable in learning the history and culture on the Mathematics subjects

Unit No.	Contents	Contact Hours
1.	Ancient, Medieval and Modern Indian Mathematics: Aryabhata, Brahmagupta, Bhaskar, Lilavati, Ramanujan	7
2	Introduction to Ancient books of Indian Mathematicians: Sidhantas, Sulvasutras, Vedic Mathematics	7

3	Contribution of Indian Mathematicians in the field of Mathematics: Value of Pi, The symbol zero, Number theory, Trigonometry, and Mensuration, Hindu Multiplication, Long Division, Indeterminate equation	7
4	Mathematicians Around the world: Newton, Leibnitz, Cauchy, Lagrange in the field of Geometry, Calculus, Algebra, Probability	7
5	Algebra in the Renaissance: Solution of cubic equation, Ferrari's Solution in the quartic equation, Irreducible Cubics and complex numbers	7
6	Paradoxes, Fallacies and Pitfalls of Mathematics	7
Total		**42**

11. Suggested books

S.No.	Name of Books, Authors, Publishers
1.	History of Mathematics, by carl B Boyer, Wiley International edition, 1968.
2.	Mathematics of Music, Susan Kelly, UW-L Journal of under graduate research, Vol-XIV, 2011.

ME 351 POWER PLANT ENGINEERING

1. Subject Code: **ME 351**   Course Title: **Power Plant Engineering**

2. Contact Hours: 42   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with thermodynamic cycles and various components of power plants.

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10. Details of Course:

S. No.	Contents	Contact Hours
1	Indian energy scenario, Indian coals: formation, properties, analysis, benefication and heating value calculation of coals; coking and non-coking coals, fuel handling systems; coal gasification. Classification of power plants, base load and Peak load power stations, co-generated power plant, captive power plant, and their fields of application & selection criteria,.	7
2	**Steam Generators:** High pressure utility boiler, natural and forced circulation, coking and non-coking coal, coal benefication, coal pulverization, pulverized fuel firing system, combustion process, need of excess air, cyclone furnace, fluidized bed boiler, electrostatic precipitators and wet scrubbers, boiler efficiency calculations, water treatment.	7
3	**Combined Cycle Power Plants:** Binary vapour cycles, coupled cycles, gas turbine- steam turbine power plant, gas pipe line control, MHD-Steam power plant.	7
4	**Other power plants:** Nuclear power plants - working and types of nuclear reactors, boiling water reactor, pressurized water reactor, fast breeder reactor, controls in nuclear power plants, hydro power plant -classification and working of hydroelectric power plants, tidal power plants, diesel and gas power plants.	7
5	**Instrumentation and Controls in power plants:** Important instruments used for temperature, flow, pressure, water/steam conductivity measurement; flue gas analysis, drum level control, combustion control, super heater and re-heater temperature control, furnace safeguard and supervisory system (FSSS), auto turbine run-up system(ATRS).	7
6	**Environment Pollution and Energy conservation:** Economics of power generation: load duration curves, power plant economics, pollution from power plants, disposal/management of nuclear power plant waste, concept of energy conservation and energy auditing.	7
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	**Power Plant Engineering** by M.M. Elwakil, Tata McGraw Hill, ISBN- 0070662746.
2	**Power Plant Engineering** by P.K Nag, Tata McGraw Hill, ISBN- 0070435993.
3	**Steam and Gas turbines** by A Kostyuk and V Frolov, MIR Publishers, ISBN- 9785030000329.
4.	**Modern Power Plant Engineering** by J Wiesman and R Eckart, Prentice hall India Ltd, ISBN- 97801359725.
5.	**Planning Fundamentals of thermal Power Plants** by F.S Aschner, John Wiley, ISBN- 07065159X.
6.	**Applied Thermodynamics** by T.D Eastop and McConkey, Longman Scientific and Technical, ISBN- 0582305351.
7.	**CEGB volumes on power plant, Cwntral Electricity Generation Board, ISBN- 0080155680.**
8.	**NTPC/NPTI publications on Power plants**, ISBN- 9788132227205.

ME353 RENEWABLE SOURCES OF ENERGY

1. Subject Code: **ME 353**   Course Title: **Renewable Sources of Energy**

2. Contact Hours: 42   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with renewable energy sources like solar, geothermal, wind and tidal.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Man and Energy, world production and reserve of conventional energy sources, Indian production and reserves, Energy alternatives	7
2	Solar radiation: Origin, nature and availability of solar radiation, estimation of solar radiation. Photovoltaic cells. Design consideration and performance of different types of solar cells. Flat plate, focusing collectors. Effects of receiving surface location and orientation.	7
3	Devices for solar thermal collection and storage. Energy storage devices such as water storage systems, packed Bed storage systems, phase change storage systems. Heat transfer considerations relevant to solar energy. Characteristics of materials and surfaces used in solar energy absorption.	7
4	Application systems for space heating, solar water pumps, solar thermal pond, Solar Thermal Power plants, solar distillation, Solar Refrigeration and solar air conditioning, other solar energy utilization.	7
5	Solar PV systems. Fuel Cell Technologies. Generation and utilization of biogas, design of biogas plants, Wind energy systems.	7
6	Geothermal Energy Systems. Tidal energy systems. Oceanic power generation. Design considerations, Installation and Performance Evaluation. MHD power generations. Role of the nonconventional energy sources in power planning.	7
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	G. D. Rai, "Energy Technolgy", Khanna Publishers, ISBN- 97881740907438.
2	S.P. Sukhatme, " Solar Energy", Tata-Mcgraw hill, New Delhi, ISBN- 0074624531.
3	"Solar Energy thermal process" JADuffie and W.A. Beckman, John Wiley& sons, New York, ISBN- 1118418123.

4	Solar energy, Frank Kaieth& Yogi Goswami, Taylor and Francis, ISBN- 1560327146.
5	Treatise of Solar Energy, H.P. Garg, John Willey & sons, ISBN- 9027719306.

ME355 COMBUSTION GENERATED POLLUTION

1. Subject Code: **ME 355**   Course Title: **Combustion Generated Pollution**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To introduce the students to different types of fuels, emissions from various engines, exhaust treatment of various engines and instruments used for measuring emissions.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Engine fundamentals: Fuels, alternative fuels for IC engines, Type of hydro carbons. Gasoline specifications. Effect of Engine parameters on performance, fuel injection for SI engines, Engine vehicle road performance, road performance and fuel economy.	7
2	Emissions and air pollution: Automotive Emissions and their role in air pollution. Photo-chemical smog. Chemistry of smog formation. Combustion in Homogeneous mixtures, emission formation. Incomplete combustion, formation of hydro-carbons, Carbon monoxide and oxides of nitrogen, Aldehyde emissions.	7

3	Influence of design and operating variables on gasoline engine exhaust emissions. Hydrocarbon Evaporative Emissions: Various sources and methods of their control. Canisters for controlling evaporative emissions. Emission control systems for gasoline engines: Blow by control closed PCV system design.	7
4	Exhaust treatment devices: Air injection into exhaust system.	7
5	Thermal reactors, Catalytic convertor. Stratified charge engines. Honda CVCC engine. Diesel engine combustion Emissions: Sources of emissions during combustion. Effect of air fuel ratio, speed, injection timing on performance and emission formation. D.I and I.D.I engine emissions.	7
6	Methods of reducing emissions, exhaust gas recirculation, smoke emission from diesel engines. Emission Instruments: Non- dispersive Infrared analyzer, Gas chromatograph, flame ionization detector, chemiluminescent analyzer	7
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Combustion generated air pollution, Earnest S Starkman, Springer, ISBN-9780306305302.
2	Fundamentals of Air pollution engineering, Richard C. Hagan, Prentice Hall, ISBN-0133325371.
3	Air pollution threat & response, David Alym, Addison-Wesley Publication, ISBN-0201043556.

ME357 THERMAL SYSTEM

1. Subject Code: **ME 357**   Course Title: **Thermal System**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4.	Relative Weight	: CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0
5.	Credits	: 3
6.	Semester	: V
7.	Subject Area	: OEC
8.	Pre-requisite	: NIL
9.	Objective	: To familiarise the students with the process of thermodynamic analysis of engineering systems and to enhance critical thinking and provide them with a wider view to handle engineering problems.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Fundamentals**: properties of pure substance in Solid, Liquid and Vapour Phases, PVT Behavior of simple compressible system, T-S and H-S diagram, Steam Tables, determination of quality of steam, Throttling Calorimeter, Combined Separating & Throttling Calorimeter, Maxwell and other thermodynamics relations, mixture of non reactive ideal gases, Real gases, Compressibility chart, Law of corresponding state, Air water vapor mixture, calculation of properties of air water vapour mixture.	7
2	**Rankine Cycle And Analysis**: Rankine cycle and its representation on T-S and H-S diagrams; Effect of low backpressure and high entry pressure and temperature and its limitations; necessity of re-heating, ideal and actual regenerative feed water heating cycle and its limitations. Typical feed water heating arrangements for various capacity power plants.	7
3	**Introduction To Boilers**: Classification of Boilers, Boiler mountings and accessories; draft systems, circulation system; Combustion and its calculations, and Boiler performance.	7
4	**Steam Nozzles**: Types of Nozzles, Flow of steam through nozzles; Condition for maximum discharge through nozzle; Nozzle efficiency. Effect of friction and Supersaturated flow through nozzle.	7

5	**Steam Turbines** : Working principle and types of steam turbines; Velocity diagrams for impulse and reaction turbines, compounding of impulse turbines; Optimum velocity ratio and maximum efficiency. Comparison of impulse and reaction turbines. Condition line and reheat-factor, losses in steam turbines; governing of steam turbines.	7
6	**Condensers and Cooling towers**: Types and working of condensers, types and performance of cooling towers.	7
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	**Engineering Thermodynamics** by P.K.Nag, Tata McGraw Hill Publishing Company Limited, ISBN – 1259062562, 2013.
2	**Engineering Thermodynamics**byRogers, Pearson Education, ISBN- 631197036.
3	**Thermodynamics** by Kenneth Wark, Mcgraw-hill Book Company, 5th edition, ISBN- 0070682860, 1988.
4.	**Engineering Thermodynamics: work and heat transfer** by Gordon Rogers and Yon Mayhew, Longman, 4th edition, ISBN – 0471861731, 1992.
5.	**Fundamentals of Classical Thermodynamics** by Van Wylen and Sonntag, John Wiley & Sons Inc., 3rd edition, ISBN – 0471861731, 1986.
6.	**Fundamentals of Engineering Thermodynamics** by Moran and Shaprio, **John Wiley & Sons, Inc., 7th edition, ISBN – 0470917687, 2010.**
7.	**Thermodynamics: An Engineering Approach** by Cengel and Boles, The McGraw-Hill Companies, 8th edition, ISBN: 0073398179, 2014.
8.	**Applied Thermodynamics for Engineering Technologists**byT.D. Eastop, Prentice Hall, 5th edition, ISBN- 05820919344, 1993.
9.	**Treatise on Heat Engineering** by V. P.Vasandani and D.S. Kumar, Metropolitan Book Co. (p) Ltd., ISBN- 810003500.

ME359 REFRIGERATION & AIR CONDITIONING

1. Subject Code: **ME 359** Course Title: **Refrigeration and Air Conditioning**

2. Contact Hours : L: 3 T: 0 P: 0

3. Examination Duration (Hrs.) : Theory: 3 Practical: 0

4. Relative Weight : CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0

5. Credits : 3

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : NIL

9. Objective : To learn properties of different refrigerants, and thermodynamic cycles of refrigeration.To understand comfort parameters and air conditioning.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	**Introduction to Refrigeration**: Necessity and applications, unit of refrigeration and C.O.P., types of Ideal cycles of refrigeration, air-refrigeration, bell coleman cycle, open and dense air systems, actual air-refrigeration system problems, refrigeration needs of aircrafts, actual refrigeration system	7
2	**Vapour Compression Refrigeration**: Working principle and essential components of the plant, simple vapour compression refrigeration cycle - COP, Representation of cycle on T-S and p-h charts - effects of sub cooling and super heating - cycle analysis - Actual cycle, Influence of various parameters on system performance – necessity of multistaging, multistage compression system, and their analysis, necessity and working of cascading system	10

3	**Refrigerants and Absorption Refrigeration:** Desirable properties of refrigerants, classification of refrigerants used, nomenclature, ozone depletion, global warming, vapor absorption system, calculation of max COP.	4
4	**Air Conditioning**: Psychometric properties & processes, comfort air-conditioning, summer and winter air-conditioning, cooling & dehumidification systems, load calculation and applied psychrometry.	7
5	**Human Comfort:** Requirements of human comfort and concept of effective temperature, comfort chart, comfort air-conditioning, requirements of industrial air-conditioning, air-conditioning load calculations.	7
6	**Control:** Refrigeration and air-conditioning control, air handling, air distribution and duct design	7
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	**Refrigeration and Air Conditioning** by C. P. Arora, Tata McGraw Hill, ISBN-9788120339156.
2	**Refrigeration and Air Conditioning** by A. R .Trott and T. C. Welch, Butterworth-Heinemann, ISBN- 9780080540436.
3	**Refrigeration and Air ConditioningTechnology** by Whitman, Jhonson and Tomczyk, Thomson Delmer Learning, ISBN- 1111644470.
4	**Refrigeration and Air Conditioning** by Abdul Ameen, Prentice Hall of India Ltd, ISBN- 9789303206560..
5	**Basic Refrigeration and Air Conditioning** by P. N. Ananthanarayan, Tata McGraw Hill, ISBN- 9789383286560.
6	**Refrigeration and Air Conditioning** by Wilbert F. Stoecker and Jerold W. Jones, Tata McGraw Hill, ISBN- 007061623X.
7.	**Refrigeration and Air Conditioning by** Richard Charles Jordan, Gayle B. Priester, Prentice hall of India Ltd, ISBN-9780406269313.

8	**ASHRAE Handbook – Refrigeration 2010,** ISBN- 9781933742922.

ME361 INDUSTRIAL ENGINEERING

1. Subject Code: **ME361**   Course Title: **Industrial Engineering**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To make students aware of industrial engineering concepts of work study and measurement, quality control and reliability etc.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	**Introduction** Introduction, Definition and objectives of Industrial Engineering, Scope of Industrial Engineering, Production systems and their classifications; Productivity-Total and partial productivity, Reasons and remedy for poor productivity	7
2	**Job analysis and Work Measurement Systems** Work System Design: Taylor's scientific management, Gilbreth's contributions; method study, micro-motion study, principles of motion economy; work measurement - stop watch time study, micro motion and memo motion, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering	7

3	**Production Planning and Control** Types and characteristics of production systems Objective and functions of Production, Planning & Control, Routing, Scheduling and Operations scheduling, production scheduling, job shop scheduling problems, sequencing problems, scheduling tools and techniques, Loading, Dispatching and its sheets & Gantt charts	7
4	**Quality Engineering** Quality concept and costs; statistical quality control, Concept of specification limits, statistical control limits, process capability, Process control and control charts for both attributes and variable data. Acceptance Sampling- Single and double sampling	7
5	**Reliability and Maintenance** Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; Maintenance management and its objectives, Various types of Maintenance Planning, House Keeping, 5S concepts	7
6	**Material Handling** Principles, functions, and objectives of Material Handling; Selection and classification of Material Handling Equipments; Relation of material handling with plant layout	7
Total		**42**

11. Suggested Books

S. No.	Name of Authors /Books / Publishers
1	Industrial Engineering and Management; B. Kumar, Khanna Publication, ISBN-8174091963, 2011.
2	Introduction to work Study, International Labour Office, Geneva, 3rd edition, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi, ISBN- 8120406028, 2008.
3	Industrial Engineering and Management, Pravin Kumar, Pearson Education, 1st edition, ISBN- 9789332543560, 2015.

ME363 PRODUCT DESIGN & SIMULATION

1. Subject Code: **ME363**   Course Title: **Product Design & Simulation**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the process of product design and development.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	**Stages in design process:** Introduction to various stages of the design process: Formulation of problem, Generate alternatives, Evaluation, Guided Redesign. Case study.	5
2	**Product life cycle:** New product introduction: early introduction, increased product life. Life cycle management tool, System integration, QFD, House of quality, Pugh's method, Pahl and Beitz method. Case studies	5
3	**Value engineering:** Introduction, nature and measurement of value. Value analysis job plan. Creativity. Value analysis test. Case studies	5
4	**Concurrent/ reverse engineering:** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reengineering	5

5	**Material selection:** Materials in design. The evolution of engineering materials. Design tools and material data. Material selection strategy, attribute limits, selection process, material selection. Case studies	5
6	**Process selection:** Introduction. Process classification: shaping, joining and finishing. Systematic process selection, process cost. Computer – aided process selection	5
7	**Design for manufacture and assembly:** Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA. Advantages of DFMA with case studies. Design features and requirements with regard to assembly, Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives	4
8	**System Simulation**: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages	4
9	**Simulation of Mechanical Systems**: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems	4
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
TEXT BOOKS:	
1	David G Ullman, "The Mechanical Design Process." Publisher-McGrawhillIncSingapore, ISBN-13: 9780072975741, 1992.
2	Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1 / e 2004 , Publisher- Pearson Education New Delhi , ISBN-13: 9780130212719,
3	L D Miles "Value Engineering."Publisher- McGraw-Hill, 1972
4	Karl T Ulrich, Steven D Eppinger , " Product Design &Development."Publisher-Tata McGrawhill New Delhi, ISBN-13: 9780078029066, 2003

5	Hollins B & Pugh S "Successful Product Design." Publisher- Butter worths London, ISBN 9780408038614.
6	N J M Roozenberg , J Ekels , N F M Roozenberg " Product Design Fundamentals and Methods ."Publisher- John Willey & Sons, ISBN-13: 9780471954651, 1995.

ME365 COMPUTATIONAL FLUID DYNAMICS

1. Subject Code: **ME 365**   Course Title: **Computational Fluid Dynamics**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To provide basic concepts of CFD in terms of comprehensive theoretical study and its computational aspects.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Introduction to CFD, Historical background, Impact of CFD	3
2	The Governing Equations of Fluid Dynamics Derivation, Discussion of physical meanings and Presentation of forms particularly suitable to CFD.	7
3	Mathematical Behavior of Partial Differential Equations: Impact on CFD	6

4	Basic Aspects of Discretization: Introduction to Finite Difference, Finite Elements and Finite Volume Methods. Detailed treatment of Finite Difference method, explicit and implicit methods, errors and stability analysis.	12
5	Grids with Appropriate Transformations Adaptive grids and unstructured meshes. Lift reduction, down force generation and drag reduction. An introduction to the aerodynamics of airflows for cooling.	7
6	Commercial codes (e.g. FLUENT etc.). Grid generation, techniques and application. Basic principles and concepts and the characteristics of wings and diffusers	7
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Computational Fluid Dynamics",John Anderson," McGraw- Hill Ltd.
2	Computational Fluid Dynamics",Tu, Elsevier.
3	Introduction to Computational Fluid Dynamics,Niyogi, Pearson Education, Delhi

ME367 FINITE ELEMENT METHODS

1. Subject Code: **ME 367**   Course Title: **Finite Element Methods**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite : NIL

9. Objective : To enable students to apply Galerkin method and virtual work principle to problems in solid mechanics. To teach them numerical solution of differential equations with finite element method.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Fundamental concepts of the Finite Element Method. One Dimensional Problem(Bar of uniform and variable cross sections), The Galerkin Approach, The potential –Energy Approach, shape Functions, Derivation of stiffness matrix and load vector for the element and for the entire domain. Evaluation of displacement, stresses and reaction forces.	12
2	**Trusses**:-. Introduction, Plane Trusses, Local and Global coordinate Systems, Element Stiffness Matrix and Stress calculations	3
3	Two –Dimensional problem using Constant strain triangles(CST), Two-dimensional isoparametric elements and numerical integration ,element stiffness matrix, Force vector.	6
4	Applications of finite element method to heat transfer.	4
5	Application of finite element method to electrical systems.	10
6	**Dynamic analysis**:- Element mass matrices,Evaluation of Eigenvalues and Eigenvectors. Use of Softwares such as MAT LAB/ABAQUS/ANSYS/ NASTRAN/ IDEAS. Basic feature of these softwares.	7
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Finite Element Procedures, K.J. Bathe, Prentice Hall of India.
2	Finite Elements in Engineering by Chandrupatla and Belegundu.
3	Finite element Method by J.N.Reddy.
4.	Finite element Method,O.C. Zienkiewicz& R.A. Taylor
5.	Finite element Analysis,C.S. Krishnamurthy
6.	Finite element Method, Kenneth H. Hubener
7.	Finite Element Method, Desai & Abel

ME369 TOTAL LIFECYCLE MANAGEMENT

1. Subject Code: **ME 369**   Course Title: **Total Lifecycle Management**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the concept of Total Life Cycle, and applying life cycle thinking to define tradeoffs. This course also introduces to sustainability and use of renewable resources.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	**Introduction:** Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly), QFD (Quality function deployment), RP (Rapid prototyping), TD (Total design), for integrating these technologies, Organizing for CE, CE tool box, Collaborative product development	8
2	**Use of Information Technology:** IT support, Solid modeling, Product data management, Collaborative product Commerce, Artificial Intelligence, expert systems, Software hardware component design.	8
3	**Design Stage:** Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrent engineering design, automated analysis, Idealization control, CE in optimal structural design, Real time constraints	8
4	**Need for PLM:** Importance of PLM, Implementing PLM, Responsibility for PLM, Benefits to different managers ,Components of PLM, Emergence of PLM, Lifecycle problems to resolve, Opportunities to seize	9
5	**Components of PLM:** Components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards	9
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Integrated Product Development M.M. Anderson and L Hein IFS Publications
2	Design for Concurrent Engineering J. Cleetus CE Research Centre, Morgantown
3	Concurrent Engineering Fundamentals: Integrated Product Development Prasad Prentice hall India

4	Concurrent Engineering in Product Design and Development I Moustapha New Age International
5	Product Lifecycle Management John Stark Springer-Verlag, UK
6	Product Lifecycle Management Michael Grieves McGraw Hill
7	Concurrent Engineering: Automation tools and Technology Andrew Kusiak Wiley Eastern

ME371 VALUE ENGINEERING

1. Subject Code: **ME 371**   Course Title: **Value Engineering**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To understand the concept and approaches of value analysis and engineering with an emphasis on case studies.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	An Overview Of Value Engineering-Concepts and approaches of value analysis and engineering - importance of value, Function - identity, clarify – analysis	8

2	Evaluation of VE-Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value	8
3	Results accelerators, Basic steps in using the systems	8
4	Understanding the decision environment, Effect of value analysis on other work in the business- Life Cycle Cost (LCC), Case studies	9
5	VE Level Of Effort-VE Team, coordinator, designer, different services, definitions, construction management contracts, value engineering case studies, Effective organization for value work, function analysis system techniques- FAST diagram, Case studies	9
Total		**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Parker, D.E., "Value Engineering Theory", Sundaram publishers, 1990
2	Miles, L.D., "Techniques of Value Engineering and Analysis", McGraw Hill Book Co., 2nd End., 1972
3	Khanna, O.P., "Industrial Engineering and Management", Dhanpat Rai and Sons, 1999.

MG351 FUNDAMENTALS OF FINANCIAL ACCOUNTING AND ANALYSIS

1. Subject Code : **MG351**   Course Title: **Fundamentals of Financial Accounting and Analysis**

2. Content Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS: 25 PRS   MTE: 25 ETE : 50 PRE

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite : Nil

9. Objective : Familiarizing the students with the financial environment of business, especially the financial markets and acquaint them with accounting mechanics, process and system.

10. Details of Course:

Unit No.	Detail Contents	Contact Hours
1	**Introduction to Management** :Basic concepts of management, management process, principles of management, functions, levels, managerial roles and skills, managerial ethics and corporate social responsibility	8
2	**Introduction to Financial Environment and accounting:** Financial Markets - Capital Markets, Basics of capital market mechanism, instruments, financing and rating institutions. Importance, Objectives and Principles of Accounting, Accounting Concepts and conventions, and the Generally Accepted Accounting Principles (GAAP) Overview of the Accounting Process. Accounting standards as Issued by Institute of Chartered Accountants of India (ICAI).	10
3	**Overview of Business Activities and Principal Financial Statements:** Observe the types of information provided by the three principal financial statements and how firms might use this information in managing and evaluating a business. Understand the rationale and the information value of the statements of Balance Sheet, Profit and Loss statement, cash flows.	8
4	**Financial Analysis-I:** Distinction between cash profits and book profits. Understanding the cash flow statement and the funds flow statement.	8
5	**Financial Analysis –II**: Importance, objectives and concept of Ratio Analysis- Liquidity, leverage, solvency and profitability ratios.	8
Total		**42**

11. Suggested Books

S. No.	Name of Books / Authors/ Publishers
1	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education,2011, ISBN- 978-0273755869
2	Introduction to Accountancy, 10 ed., T.S. Grewal, S. Chand and Company (P) Ltd., New Delhi,2009, ISBN- 9788121905695
3	Advance Accounts by M.C Shukla and T.S Grewal and SC Gupta, S. Chand and Company (P) Ltd., New Delhi,1997, ISBN- 9788121902786
4	Financial Accounting, 4 ed, S.N. Maheshwari and S.K. Maheshwari, Vikas Pulication,2005, ISBN- 8125918523
5	Financial Accounting Reporting & Analysis, Cengage, 7/e, W Albrecht Stice & James Stice, Cengage Learning,2010, ISBN- 0538746955

MG353 FUNDAMENTALS OF MARKETING

1. Subject Code : **MG353**   Course Title : **Fundamentals of Marketing**

2. Content Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory: 3 Hrs   Practical 0

4. Relative Weightage   : CWS:25 PRS   MTE:25 ETE:50   PRE

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : The basic objective of this paper is to make students aware of fundamental concepts of marketing necessary for making decisions in complex business situations by managers and start up entrepreneurs.

10. Details of Course:

Unit No.	Detail Contents	Contact hours
1	**Basic concepts of management**: management process, principles of management, functions, levels, managerial roles and skills, managerial ethics and corporate social responsibility	8
2	**Introduction to marketing**: nature and scope of marketing, marketing mix, marketing vs. sales, role of marketing in society, interface of marketing with other departments in organization, Customer Life Time Value, ethical issues in marketing Concept of market segmentation: consumer and industrial, targeting and positioning, sales forecasting	9
3	**Product mix decisions:** new product development process, test marketing, concept of Product Life Cycle, product packaging decisions	8
4	**Pricing decisions** : consideration in setting price, major pricing strategies, promotional mix decisions: advertising, sales promotion, personal selling, publicity, opportunities and avenues of online promotion	9
5	**Promotion and distribution decisions** :design and management of distribution channel for physical products and services, reasons of channel conflict, handling strategies, basic challenges in supply chain management of e-commerce firms	9
Total		**42**

11. Suggested Books

Unit No.	Name of Books / Authors/ Publishers
1	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education, 2011, ISBN-978-0273755869
2	Marketing Management, 14th ed., Philip Kotler , Kevin Lane Keller, Abraham Koshy and MithileswarJha, Pearson Education, New Delhi, 2013,(**ISBN-10:** 9788131767160)

3	Marketing, 14th ed., Etzel, Bruce J Walker, William J Stanton and Ajay Pandit, Mc Graw Hill Education, 2009, ISBN -9780070151567
4.	MKTG, Charles W Lamb, Joe F Hair, Carl NcDaniel and Dheeraj Sharma, Cengage Learning,2012, ISBN- 9788131517086
5.	Marketing Management, RajanSaxena, Tata Mc Graw Hill Education, 2005, ISBN-9780070599536

MG355 HUMAN RESOURCE MANAGEMENT

1. Subject Code : **MG355**   Course Title : **Human Resource Management**

2. Content Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory: 3 Hrs   Practical 0

4. Relative Weightage   : CWS:25 PRS   MTE:25 ETE:50   PRE

5. Credits   : 3

6.   Semester   : V

7.   Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To develop necessary understanding in design and execution of human resource strategies for the achievement of organization goals.

10. Details of Course**:**

Unit No.	Content	Contact hours
1.	**Basic concepts of management:** management process, principles of management, functions, levels, managerial roles and skills, managerial ethics and corporate social responsibility	8

2.	**Introduction:** Concept, nature, scope, objectives and importance of HRM; Evolution of HRM; Environment of HRM; Personnel Management vs HRM. Acquisition of Human Resources: HR Planning; Job analysis – job description and job specification; recruitment – sources and process; selection process – tests and interviews; placement and induction. Job changes – transfers, promotions/ demotions, separations.	9
3.	**Training and Development:** Concept and importance of training; types of training; methods of training; design of training programme; evaluation of training effectiveness; executive development – process and techniques; career planning and development.	8
4.	**Performance Appraisal:** Performance appraisal – concept and objectives; traditional and modern methods, limitations of performance appraisal methods.	8
5.	**Compensation and Maintenance:** Compensation: job evaluation – concept, process and significance; components of employee remuneration – base and supplementary; maintenance: overview of employee welfare, health and safety, social security.	9
	Total	**42**

11. Suggested Books

S. No	Name of the book /Authors /Publishers
1	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education, 2011, ISBN-978-0273755869
2	Human Resource Management, G. Dessler, B. Varkkey, Pearson prentice Hall, 2011, (ISBN – 978-81-317-5426-9)
3	International HRM a cross cultural approach, T. Jackson, Sage publications, London, 2002, (ISBN – 0-7619-7404-0)
4	HRM and Performance: Achievements and Challenges, D. E. Guest, J .Paauwe, P. Wright, John Wiley and sons, UK, 2013, (ISBN – 978-1-118-48261-2)
5	A Handbook of Human Resource Management Practice, M. Armstrong, Kogan Page Limited, UK, 2007 ,(ISBN – 978–0–7494–4631-4)

MG357 KNOWLEDGE AND TECHNOLOGY MANAGEMENT

1. Subject Code : **MG 357**   Course Title : **Knowledge and Technology Management**

2. Content Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.) : Theory: 3 Hrs   Practical 0

4. Relative Weightage   : CWS:25 PRS   MTE:25 ETE:50 PRE

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : Preparing the students to understand how the new age organizations are leveraging on the power of knowledge and technology. Acquiring the knowledge to address the issues faced by the corporate world for a deeper understanding.

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Basic concepts of management**, management process, principles of management, functions, levels, managerial roles and skills, managerial ethics and corporate social responsibility	8
2.	Introduction to Knowledge Management: Data, Information, Knowledge Management (KM), Knowledge Society, Knowledge Economy, Types of Knowledge, Tacit knowledge and explicit knowledge, Essential components of KM model Building Knowledge Assets: Various knowledge assets, Tools of Knowledge, Knowledge Audit, AAR (After Action Review), Analyzing current knowledge state.	9

3.	Creating Strategies for Success: KM strategy, Codification, Personalization, Knowledge Management Implementation, Generating a KM-specific vision, Integrating organizational and business goals with KM, Choosing the right KM techniques, Relevant case studies in this area.	9
4.	Understanding Technology: Definition, Key concepts, Need for technology, History of technological developments, Role and importance of technology in 21st century, Recent developments in the field of technology.	8
5.	Technology-Management integration: Management as a concept, Technology management, Life cycle approach to technology management, Innovation, Creativity, Technology innovation process.	8
Total		**42**

11. Suggested Books

S. No.	Name of Books /Authors/Publishers
1.	Fundamental of Management, Stephen P. Robbins, David A. De Cenzo and Mary Coulter, Pearson Education,2011, ISBN-978-0273755869
2	Knowledge Management in Organizations: A Critical Introduction, Donald Hislop, Oxford University Press,2013, ISBN: 9780199691937.
3	The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation, IkujiroNonaka and Hirotaka Takeuchi, Oxford University Press,1995, ISBN: 0195092694.
4	Hitotsubashi on Knowledge Management (Hardcover), Hirotaka Takeuchi and IkujiroNonaka, John Wiley and Sons, 2004, ISBN: 0470820748.
5	Management of Technology: The Key to Competitiveness and Wealth Creation, Tarek Khalil and Ravi Shankar, McGraw Hill Education (India) Private Limited, 2nd Edition, 2012, ISBN: 9780070677371.

PE351 ADVANCED MACHINING PROCESS

1. Subject Code: **PE-351** Course Title: **Advanced Machining Process**

2. Contact Hours : L: 3 T: 0 P: 0

3. Examination Duration (Hrs.) : Theory: 3 Practical: 0

4. Relative Weight : CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0

5. Credits : 3

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : NIL

9. Objective : To understand basic principles of various processes and their applications. State various parameters influencing the machining process.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	Introduction, need of advanced machining processes, hybrid processes, microelectro mechanical system, (MEMS), nano electromechanical systems(NEMS),Ultrasonic micro machining - mechanics of cutting, parametric analysis, process capabilities, applications.	7
2	Abrasive jet machining: Introduction, set ups, gas propulsion system, abrasivefeeder, machining chamber, AJM nozzle, abrasive parametric analysis, processcapabilities, applications, abrasive micro machining, Water jet machining:Introduction, process characteristics, process performance, applications, Abrasive Water jet machining: Abrasive finishing process: Working principle, parametric analysis, process variables, process performance and applications,	8

3	Abrasive flow machining-Working principle, parametric analysis, process variables, process performance and applications, Magnetorheological abrasive flow finishing- Working principle, parametric analysis,process variables, process performance and applications, Magnetic float polishing,Magnetic abrasive finishing- Working principle, parametric analysis, processvariables, process performance and applications	10
4	Electro discharge machining (EDM): Introduction, Working principle, parametricanalysis, process variables, process characteristics, applications, hybrid processessuch as electro discharge grinding, diamond grinding, wire EDM, Electrodischargemicro grinding,	7
5	Laser beam machining- production of laser, working principle, types of laser, processcharacteristics and applications. Electron beam machining: Working principle,process parameter, process characteristics, and applications. Ion beam machining:Working principle, process parameter, process characteristics, and applications.	8
6	Plasma arc machining: Working principle, Plasma arc cutting system, applications.	2
Total		**42**

11. Suggested Books:

S. No.	Title, Author, Publisher and ISBN No.
1	Advanced machining process, Dr.V.K.Jain, Allied publisher, **ISBN**:978-81-7319-915-8.
2	Non traditional methods of manufacturing, Shan&Pandey, **ISBN**, 0070965536

PE353 SUPPLY CHAIN MANAGEMENT

1. Subject Code: **PE-353**　　　　　　　Course Title: **Supply Chain Management**

2. Contact Hours　　　　　　　　: L: 3　　　T: 0　　　P: 0

3. Examination Duration (Hrs.)　: Theory: 3　　　　Practical: 0

4. Relative Weight　　　　　　　: CWS: 25　PRS: 0　　MTE: 25　ETE: 50　PRE: 0

5. Credits　　　　　　　　　　　: 3

6.	Semester	:	V
7.	Subject Area	:	OEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To understand the key considerations at the various stages involved in the supply of product in order to maintain the smooth flow from source to the point of consumption so that overall organizational performance may improve.

10. Details of Course:

Unit No.	Contents	Contact Hours
1	**Introduction:**Perspective of Supply Chain Management, Managing uncertainty, Key issue in supply chain management.	6
2	**Inventory Management and Risk Pooling:** Inventory management, Classification of inventory, Centralized versus Decentralized Warehousing and Risk pooling, Value of Information, Quantification of Bullwhip effect, Causes and remedies of Bullwhip effect.	8
3	**Resource planning:** Aggregate Production Planning- Chase and leveling strategies, MRP, MRP-II, Agile manufacturing Systems	6
4	**Procurement and Outsourcing strategies:**Introduction, outsourcing benefits and risks, Make/Buy decision, e-procurement, Vendor selection and quota allocation.	7
5	**Strategic Alliances:** Introduction, Third party logistics, Demand driven strategies, Distribution strategies- direct shipment, cross docking, transshipment, Supplier relationships management, Customer relationship management.	8
6	**International Issues in Supply Chain Management:** Concepts in Globalization, Globalization forces, Risks and Advantages of International supply chains, Issues in International supply chain management, Regional differences in logistics.	7
Total		**42**

11. Suggested Books:

S. No.	Title, Author, Publisher and ISBN No.
1.	Simchi-Levi, Kaminsky, Philip K. and 'Designing and Managing the Supply Chain: Concepts, Strategic and Case Studies', McGraw-Hill/Irwin, (ISBN, 10: 0072357568, 13: 978-0072357561).
2	Supply Chain Management by Chopra and Mendle, **ISBN**: 9780132743952
3	Supply Chain Management: Text and Cases by JannatSah.,**ISBN**-10: 8131715175.

PE355 WORK STUDY DESIGN

1. Subject Code: **PE-355**　　　　　Course Title: **Work Study Design**

2. Contact Hours　　　　　　　　: L: 3　　T: 0　　P: 0

3. Examination Duration (Hrs.)　: Theory: 3　　　Practical: 0

4. Relative Weight　　　　　　　: CWS: 25　PRS: 0　MTE: 25　ETE: 50　PRE: 0

5. Credits　　　　　　　　　　　: 3

6. Semester　　　　　　　　　　: V

7. Subject Area　　　　　　　　: OEC

8. Pre-requisite　　　　　　　　: NIL

9. Objective　　　　　　　　　　: To provide basic understanding to the students about the concept and significance of work study and ergonomics. To impart thorough knowledge to the students about various techniques of work-study for improving the productivity of an organization.

10. Details of Course:

Unit No.	Contents	Contact Hrs
1	Productivity: Definition, reasons for low productivity, methods to improve productivity, Work-study and productivity	4

2	Human factor in work-study: Relationship of work-study man with management, supervisor & workers, qualities of a work-study man.	5
3	Method-study: Definition, objectives, step-by-step procedure, questioning techniques, charts and diagrams for recording data. Like outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart, cycle graph, Chrono-cycle graph, therbligs, micro motion study and film analysis, Simo chart, principles of motion economy. Development and installation of new method..	9
4	Work-Measurement: Definition, various techniques of work-measurement work-sampling, stopwatch time study & its procedure, Job selection, Equipment and forms used for time study, rating, methods of rating, allowances and their types, standard time, numerical problems, predetermined - time standards and standard data techniques. Incentive: Meaning, objectives of an incentive plan, various types of incentive plans	9
5	Ergonomics: Introduction, history of development, man-machine system and its components. Introduction to structure of the body- features of the human body, stress and strain, metabolism, measure of physiological functions- workload and energy consumption, biomechanics, types of movements of body members, strength and endurance, speed of movements. NIOSH lifting equation, Lifting Index, Maximum acceptable Weights and Forces, Distal upper extremities risk factors, Strain Index, RULA, REBA.	8
6	Applied anthropometry - types, use, principles in application, design of work surfaces and seat design. Visual displays for static information, visual displays of dynamic information, auditory, tactual and olfactory displays and controls. Assessment of occupational exposure to noise, heat stress and dust .Effect of vibration/ noise, temperature, illumination and dust on human health and performance	7
Total		**42**

11. Suggested Books:

S. No.	Title, Author, Publisher and ISBN No.
1.	Barnes Ralph M., "Motion & Time study: Design and Measurement of Work", Wiley Text Books, **ISBN-10:** 8126522178, 2009.

2	Marvin E, Mundel& David L, "Motion & Time Study: Improving Productivity", Pearson Education,**ISBN-10:** 0136030440, 2000.
3	Benjamin E Niebel and FreivaldsAndris, "Methods Standards & Work Design", McGraw Hill,**ISBN-10**1259064840, 1997.
4	International Labour organization, "Work-study", Oxford and IBH publishing company Pvt. Ltd., N.Delhi, **ISBN-10** 8120406028, 2001

PE357 PRODUCT DESIGN & SIMULATION

1. Subject Code: **PE-357**   Course Title: **Product Design & Simulation**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   **:** CWS: 25 PRS: 0   MTE: 25 ETE: 50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To allow students to develop the technical, analytical, and managerial skills necessary to perform the tasks successfully.

10. Details of Course:

Unit No.	Content	Contact Hours
1	**Stages in design process:** Introduction to various stages of the design process: Formulation of problem, Generate alternatives, Evaluation, Guided Redesign. Case study.	6

2	**Product life cycle:** New product introduction: early introduction, increased product life. Life cycle management tool, System integration, QFD, House of quality, Pugh's method, Pahl and Beitz method. Case studies.	6
3	**Value engineering:**Introduction, nature and measurement of value. Value analysis, job plan. Creativity and techniques of creativity. Value analysis test. Case studies. **Material selection:**Materials in design. The evolution of engineering materials. Design tools and material data. Functional material, shape and process. Material selection strategy, attribute limits, selection process, common methods of material selection. Case studies.	6
4	**Concurrent/ reverse engineering:** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reengineering. **Process selection:** Introduction. Process classification: shaping, joining and finishing. Systematic process selection, Ranking, process cost. Computer – aided process selection.	6
5	**Design for manufacture and assembly:**Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA. Advantages of DFMA with case studies. Design features and requirements with regard to assembly, product Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives.	8
6	**System Simulation**: Techniques of simulation, Monte Carlo method, Experimental nature ofsimulation, Numerical computation techniques, Continuous system models, Analog andHybrid simulation, Feedback systems, Computers in simulation studies, Simulation softwarepackages. **Simulation of Mechanical Systems**: Building of Simulation models, Simulation oftranslational and rotational mechanical systems, Simulation of hydraulic systems.	10
Total		**42**

11. Suggested Books:

S. No.	Title, Author, Publisher and ISBN No.
1	**Product Design and Development**, "Karl T. Ulrich, Steven D. Eppinger"Mc GrawHill.**ISBN:**9780072296471
2	**Integrated Product and Process Development**, "John M. Usher, Utpal Roy and H. R. Parasaei.ISBN: 978-0-471-15597-3
3	**Product Design for Manufacture and Assembly**, "G. Boothroyd, P. Dewhurst and W. Knight" MarceDaker.ISBN:978-1420089271
4.	**Engineering Design and Design for Manufacturing**: A structured approach, "John R. Dixon and CPoli" Field Stone Publishers, USA. ISBN: 9780964527201
5.	**Material Selection in Mechanical Design**, "M. F. Ashby"Elsevier. ISBN: 9780080419077

PE359 TOTAL LIFE CYCLE MANAGEMENT

1. Subject Code: **PE359 Course**   Title: **Total Life Cycle Management**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   **:** CWS: 25 PRS: 0   MTE:25   ETE:50   PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To familiarize the students with the concept of Total Life Cycle, management of old vehicles, applying life cycle thinking to define tradeoffs. This course also introduces to sustainability, use of renewable resources.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction :** Definition of Total Life Cycle (TLC) – Conceptof TLC - Life Cycle Impacts - Integrating Life Cycle Technologies- Products and Processes Within TLC - TLC Methodology- TLC AccessementData to Complex Products – ResultantImprovement for Product	8
2	**Vehicles End of Life** : Design for End of Old VehicleManagement - Problems of Old Vehicles in EmergingMarkets - Recovery and Economic Feasibility of MaterialsSuch As Plastic, Rubber, Aluminium, Steel, etc.	8
3	**Trade-offs :** Applying Life Cycle Thinking to Define TradeoffsAlong the Supply, Manufacture - Use and End of Life Chain- Effects on the Customer - Expectation of the Customer -Evaluate Product Cost on Fuel Consumption, Emission,Durability, Environment and Health	10
4	**Sustainability:**What Is Sustainability - Use of RenewableResources - View to Design Horizon.	8
5	**Harmonization of Environmental Goals:** TLC for Emerging Vs Developed Markets - Rules and Regulations to Guide Designers - International Common Practices for End of LifeVehicles.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers
1	Life Cycle Management Case Study of an Instrument Panel /SAE, 1997/
2	Accident Reconstruction: Automobiles, Tractor-semitrailers, Motorcycles, and Pedestrians /Society of Automotive Engineers, 1987 /0898834546, 9780898834543.

PE361 TOTAL QUALITY MANAGEMENT

1. Subject Code: **PE-361**   Course Title: **Total Quality Management**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (Hrs.)   : Theory: 3   Practical: 0

4. Relative Weight   : CWS: 25 PRS: 0   MTE: 25 ETE: 50 PRE: 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To understand the philosophy and core values of Total Quality Management (TQM); determine the voice of the customer and the impact of quality on economic performance and long-term business success of an organization;

10. Details of Course:

Unit No.	Content	Contact Hours
1	**Introduction to Quality-** Definition of Quality- product, user, value, and manufacturing based perspectives, Dimensions of Quality, Quality Planning, Quality costs- optimization of quality costs, seven tools of quality control;Philosophies of Quality Gurus- Deming, Juran, Crosby, Feigenbaum, Ishikawa, Taguchi. Comparison of Quality Philosophies.	9
2	**Statistical Process Control-**Introduction to Quality characteristics-variables and attributes, Types and causes of variations, Control Charts for variables and attributes, Process capability.	8
3	**Acceptance Sampling-**Sampling process and lots formation; Advantages and applications of acceptance sampling; characteristics of O.C. Curve; Single, double, multiple, sequential sampling; ASN, ATI, AOQL, AOQ, AQL, LQL, Producer's and Consumer's risks.	7
4	**Six Sigma and ISO 9000:2000-** Principles of Six Sigma, Statistical basis, Tools and techniques, DMAIC principle, application of six sigma in manufacturing and service organizations, structure of ISO standards, Factors leading to ISO, Implementation and registration, Benefits of ISO.	6

5	**Life Testing-Reliability-**Life testing: objective, failure data analysis, MTTF, MTBF, hazard rate, exponential and Weibull models, system reliability-series, parallel and mixed configurations, Markov model.	6
6	**Reliability Design and Allocation-** Design for reliability, reliability improvement techniques, active redundancy and standby redundancy, K-out-of-N redundancy and maintenance policies.	6
Total		42

11. Suggested Books:

S. No.	Title, Author, Publisher and ISBN No.
1.	Evans JR,Lindsay WM, "The Management and Control of Quality", Cengage learning, India, **ISBN-10:** 8131501361, 2011
2	BediKanishka,"Quality Management",Oxford University Press India, **ISBN-10:** 0195677951, 2006
3	Besterfield,"Total Quality Management", Pearson Education, **ISBN-10:** 9332534454, 2015
4	Gryna FM, Chua RCH, Defeo JA, "Juran"s Quality Planning and Analysis for Enterprise Quality", McGraw Hill Education (India) Private Limited, **ISBN-10:** 0070618488, 2006

PT361 HIGH PERFORMANCE POLYMERS

1. Subject Code: **PT361**   Course Title: **High Performance Polymers**

2. Contact Hours   : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 03

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective : To impart knowledge about heat resistant polymers, liquid crystalline polymers, conducting and other special polymers.

10. Details of Course

S. No.	Contents	Contact Hours
1	Heat resistant polymers: Requirements for heat resistance, Determination of heat resistance, Synthesis, Structure-property relationships, Applications of heat resistant polymers like polyamides, polyimides and its derivatives, polyquinolines, polyquinoxalines, PBT, PBO, PBI, PPS, PPO, PEEK, engineering plastic blends.	9
2	Liquid crystalline polymers, Concept of liquid crystalline phase, Theories of liquid crystallinity, Characteristics of LC state and LCPs, Rheology of liquid crystalline polymers, Blends of LCPs, Self reinforced composites, Applications.	9
3	Conducting polymers, Conduction mechanism, semi-conductors and conducting polymers, Band theory, Doping of polymeric systems, Processing and testing of conducting polymers, Applications and recent advances in conducting polymers.	9
4	Synthesis and applications of photosensitive polymers, Curing reactions.	6
5	Polymers in specialty applications: Polymers in agricultural applications, Green houses, Mulches, Control release of agricultural chemicals, Seed coatings, Polymers in construction and building applications.	9
Total		**42**

11. Suggested Books

S. No.	Name of Books/Authors/Publisher
1	Encyclopedia of Polymer science and Engineering Vol.1-17/ J.I. Kroschwitz, 2007
2	Additive for coatings/ John Bieleman/ Wiley-VCH, 2000.
3	Fire Properties of Polymeric Composites Materials/ A.P. Mouritz, A G. Gibson/ Springer, 2006.

| 4 | Modern Biopolymers science: Bridging the divide between fundamentals treatise and industrial application/S. Kasapis, I.T. Nortan, J.B. Ubbink/ Elsevier 2009 |

PT363 SEPARATION TECHNOLOGY

1. Subject Code: **PT363** Course Title: **Separation Technology**

2. Contact Hours : L: 03 T: 00 P: 00

3. Examination Duration (Hrs.) : Theory: 03 Practical: 00

4. Relative Weight : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits : 03

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : NIL

9. Objective : To familiarize students with various separation techniques.

10. Details of Course

Unit No.	Contents	Contact Hours
1	Separation factors and its dependence on process variables, classification and characterization, thermodynamic analysis and energy utilization, kinetics and mass transport, Theory of cascades and its applications.	7
2	Membrane Separations, Merits and demerits, Commercial, pilot plant polarization of membrane processes and laboratory membrane permeators, Dialysis, Reverse osmosis, Ultrafiltration, Membrane operations, Design controlling factors.	7
3	Separation by Sorption Techniques, Types and choice of adsorbents, chromatographic techniques, Retention theory mechanism, Design controlling factors, ion exchange chromatography equipment and commercial processes, recent advances in sorption technology.	7

4	Ionic Separations: Theory, mechanism and equipments for electrophoresis, dielectrophoresis and electro dialysis, Controlling factors, Applications, Design considerations.	7
5	Thermal Separation: Thermal diffusion, Rate law, Theories of thermal diffusion for gas and liquid mixtures, Equipments design and applications, Zone melting, Equilibrium diagrams, Controlling factors, Apparatus and applications.	7
6	Other Techniques: Adductive crystallization, Molecular addition compounds, Clathrate compounds and adducts, Equipments, Applications, Economics and commercial processes. Foam Separation: Surface adsorption, Nature of foams, Apparatus, Applications and Controlling factors.	7
Total		**42**

11. Suggested Books

S. No.	Name of Books/Authors/Publisher
1	New Chemical Engineering Separation Techniques/ Schoen/ Wiley Interscience, New York, 1972.
2	Separation Processes/ C.J. King/ Tata McGraw Hill, New Delhi,1982.
3	Bioseparations – Principles and Techniques/ B. Sivasankar/ Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4	Separation process Principles/ Seader, Henley and Roper/ John Wiley & Sons 2010
5	Membrane Separation processes/ Kaushik Nath/ PHI , 2008.

PT365 NON-CONVENTIONAL ENERGY

1. Subject Code: **PT365**   Course Title: **Non-Conventional Energy**

2. Contact Hours   : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5.	Credits	:	03
6.	Semester	:	V
7.	Subject Area	:	OEC
8.	Pre-requisite	:	NIL
9.	Objective	:	To make student aware about the fundamentals and applications of non-conventional energy.

10. Details of Course

Unit No.	Contents	Contact Hours
1	Renewable and non-renewable energy sources, trends in energy consumption, Global and National scenarios, Prospects of renewable energy sources, Energy Management.	6
2	Solar Energy: Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, measurement of solar radiation, flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, Storage of solar energy-thermal storage, Photo voltaics - solar cells & its applications.	6
3	Wind Energy: Basic system principles, Assessment of wind available, Design principles, Manufactured designs, Sizing and storage of energy, System efficiency, Overview of wind industry.	4
4	Energy from Biomass: Calorific value of Biomass samples, Pyrolysis, Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.	6
5	Geothermal Energy: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages, and application of geothermal energy.	4

6	Ocean Energy: Ocean Thermal Electric Conversion systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.	4
7	Magnetohydrdynamic Power Generation: Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.	4
8	Fuel Cells: Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, applications of fuel cells.	4
9	Hydrogen Energy: Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.	4
Total		**42**

11. Suggested Books

S. No.	Name of Books/Authors/Publisher
1	Principles of Sustainable Energy Systems, Second Edition/ Frank Kreith, Susan Krumdieck/ CRC Press, 2013.
2	Non-conventional energy sources/ G.D. Rai/ Khanna Publishers, 2004.
3	Solar Energy: Fundamentals and Applications/ H.P. Garg & Jai Prakash/ Tata McGraw Hill, 2000
4	Solar Engineering of Thermal Processes/ Duffic and Beckman/ John Wiley, 2013
5	Non Conventional Energy Resources/ Saeed and Sharma/ S.K. Kataria& Sons ,2013

PT367 POLYMER WASTE MANAGEMENT

1. Subject Code: **PT367**   Course Title: **Polymer Waste Management**

2. Contact Hours   : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4.	Relative Weight	: CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00
5.	Credits	: 03
6.	Semester	: V
7.	Subject Area	: OEC
8.	Pre-requisite	: NIL
9.	Objective	: To impart knowledge about polymer waste and their management.

10. Details of Course

Unit No.	Contents	Contact Hours
1	Polymer and Plastics Waste: Definition of plastics waste and the associated problems, Identification, collection methods and separation. Integrated waste management – source reduction, recycling, energy recovering process through thermal and biological destruction, Land filling and composting.	8
2	Plastics waste management: Source reduction, reuse, repair, recycling, and incineration with examples. Plastics recycling: Classification, Code of practice, Primary, secondary, territory and quaternary recycling with examples, Waste plastics as fillers.	8
3	Recycling and degradation of plastics: Recycling and sustainability correlation, Basic principles and recovery, recycling and resource conservation.	9
4	Recycling of plastics by surface refurbishing, Application of a coating, polishing, Plastics, Environmental and Thermal ageing, Chemical degradation, Wear and erosion, Biodegradable plastics – an overview.	9
5	Environmental issues, policies and legislation in India.	8
Total		**42**

11. Suggested Books

S. No.	Name of Books/Authors/Publisher
1	Plastics Recycling – Products and Processes/ Ehrig (Ed.)/ Hanser Publication, 1993
2	Recycling and recovery of plastics/ Brandrup/ Hanser Publishers, New York, 1996
3	Handbook of Plastics Recycling/ By Francesco La Mantia/ Rapra Tech Ltd , 2002
4	Introduction to Plastics Recycling/ By VannessaGoodship/ Rapra Tech Ltd ,2007

PT369 NANOTECHNOLOGY IN POLYMERS

1. Subject Code: **PT369**   Course Title: **Nanotechnology in Polymers**

2. Contact Hours   : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.) : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50 PRE: 00

5. Credits   : 03

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To make student aware about the applications of nanopolymers in various fields.

10. Details of Course

S. No.	Contents	Contact Hours
1	Concepts of nanotechnology, Time and length scale in structures, Nanosystems, Dimensionality and size dependent phenomena, Surface to volume ratio-Fraction of surface atoms, Surface energy and surface stress, surface defects, Properties at nanoscale (optical, mechanical, electronic, and magnetic).	8
2	Nano-materials, Classification based on dimensionality, Quantum Dots, Wells and Wires, Carbon-based nano-materials, Metal based nano-materials, Nanocomposites, Nanopolymers, Nanoglasses, Nanoceramics, Biological nanomaterials.	8
3	Synthesis of nanopolymers, Chemical Methods, Metal Nanocrystals by Reduction, Solvothermal Synthesis, Photochemical Synthesis, Sonochemical Routes, Chemical Vapor Deposition, Metal Oxide - Chemical Vapor Deposition, Physical Methods such as ball Milling, electrodeposition, spray pyrolysis, flame pyrolysis, DC/RF magnetron sputtering, Molecular beam epitaxy.	9
4	Nanofabrication, Photolithography and its limitations, Electron beam lithography, Nanoimprint, Soft lithography patterning, Characterization with Field Emission Scanning Electron Microscopy, Environmental Scanning Electron Microscopy, High Resolution Transmission Electron Microscope, Scanning Tunneling Microscope, Surface enhanced Raman spectroscopy, X-ray Photoelectron Spectroscopy, Auger electron spectroscopy, Rutherford back scattering spectroscopy.	9
5	Applications of nanomaterials, Solar energy conversion and catalysis, Molecular electronics and printed electronics, Nanoelectronics, Polymers with aspecial architecture, Applications in displays and other devices, Nanomaterials for data storage, Photonics, Plasmonics, Nanomedicine, Nanobiotechnology and Nanotoxicology.	8
Total		**42**

11. Suggested Books

S. No.	Name of Books/Authors/Publisher
1	Organic and Inorganic Nanostructures/ Nabok/ Artech House, 2005.
2	Nanoscience: Nanotechnologies and Nanophysics/ Dupas, Houdy, Lahmani/ Springer-Verlag Berlin Heidelberg ,2007

3	Nanostructured Materials and Nanotechnology/ H.S. Nalwa/ Academic Press , 2002
4	A Textbook of Nanoscience and Nanotechnology/ Pradeep/ Tata McGraw Hill Education Pvt. Ltd. , 2012

PT371 APPLICATIONS OF POLYMER BLENDS AND COMPOSITE

1. Subject Code: **PT371**   Course Title: **Applications of Polymer Blends and Composite**

2. Contact Hours   : L: 03   T: 00   P: 00

3. Examination Duration (Hrs.)   : Theory: 03   Practical: 00

4. Relative Weight   : CWS: 25 PRS: 00 MTE: 25 ETE: 50   PRE: 00

5. Credits   : 03

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : NIL

9. Objective   : To make student aware about the applications of polymers, blends and composites.

10. Details of Course

Unit No.	Contents	Contact Hours
1	Concepts of polymer blends, Advantages of blends over conventional polymers, Significance of polymer blend technology, Different steps involved in designing of a blend, Different methods of blending, Characterization of polymer blends.	8
2	Compatibilization and Phase Morphology, Role of compatibilizers in blend technology, techniques of compatibilization, Phase structure development in polymer blends, Factors affecting morphology of polymer blends, Properties of polymer blends.	8

3	Reinforcements, Properties and applications of Glass, Carbon, Kevlar, polyethylene, boron, ceramic and natural fibers. Concepts of matrix material, Thermoset matrix materials like - epoxy, polyester, vinyl esters, phenolic resin, polyimides, Thermoplastic matrix materials like - polyolefins, polyether ether ketones, polyphenylene sulfide, thermoplastic polyimides.	9
4	Concept of composites, particulate and fibrous composites, Properties of composites, Fabrication of continuous and short fiber composites and particulate composites, mechanical and physical properties	9
5	Applications of blends and composites for civil, aerospace, automobiles etc	8
Total		**42**

11. Suggested Books

S. No.	Name of Books/Authors/Publisher
1	Fibre Reinforced composites/ P. K. Malik/ Marcel Deckar, 1988.
2	Composites Manufacturing: Materials, Product, and Process Engineering/ S.K. Mujumdar/ CRC press ,2002
3	Fibre-glass Reinforced Plastics/ N. P. Cheremisinoff (Ed)/ Noyce Pub, 1988.
4	Design Data for Reinforced Plastics/ N. L. Hancex, R. M. Mayer/ Chapman Hall, 1994.
5	Reinforced Plastics: Properties and Applications/ Raymond Seymour/ The Materials Information Society, 1991.

IT351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

NAME OF DEPTT: **Information Technology**

1. Subject Code: **IT351**   Course Title: **Artificial Intelligence and Machine Learning**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE)(Hrs.)   : Theory 3 Hrs   Practical 0

4.	Relative Weightage	: CWS 25 PRS 0 MTE 25 ETE 50 PRE 0
5.	Credits	: 3
6.	Semester	: V
7.	Subject Area	: OEC
8.	Pre-requisite	: Knowledge of discrete mathematics
9.	Objective	: The student should be able to understand the different supervised, unsupervised and reinforcement learning algorithms and choose the appropriate machine learning tool for different real world examples.

10. Details of Course

S.No.	Contents	Contact Hours
1.	**Introduction** to Artificial Intelligence and Machine learning, State Space representation of problems, Concept of Search, overview of different tasks: classification, regression, clustering, control, Concept learning.	6
2.	**Heuristic Search Techniques:** Generate and Test, Hill Climbing, Best-first search, Branch and bound, A* algorithm, Game playing.	6
3.	**Knowledge Representation:**Propositional logic, Predicate Logic, semantic nets, frames	8
4.	**Supervised Learning:** Decision trees, nearest neighbors, linear classifiers and kernels, neural networks, linear regression; Support Vector Machines.	8
5.	**Unsupervised Learning:** Clustering, Expectation Maximization, Dimensionality Reduction, Feature Selection, PCA, factor analysis, manifold learning.	8
6.	**Applications &Research Topics**: Applications in the fields of web and data mining, text recognition, speech recognition	6
	TOTAL	**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
	Text Book	
1.	Artificial Intelligence by Elaine Rich, K. Knight, McGrawHill	2009
1.	Introduction to Machine Learning, Alpaydin, E., MIT Press, 2004	
2.	Machine Learning, Tom Mitchell, McGraw Hill, 1997.	1997
3.	Elements of Machine Learning, Pat Langley Morgan Kaufmann Publishers, Inc. 1995. ISBN 1-55860-301-8	1995
	Reference Book	
4.	The elements of statistical learning, Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. Vol. 1. Springer, Berlin: Springer series in statistics, 2001.	2001
5.	Machine Learning: A probabilistic approach, by David Barber.	2006
6	Pattern recognition and machine learning by Christopher Bishop, Springer Verlag, 2006	2006

IT353 DATA STRUCTURES AND ALGORITHMS

NAME OF DEPTT: **Information Technology**

1. Subject Code: **IT353**   Course Title: **Data Structures and Algorithms**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6. Semester   : ODD

7. Subject Area   : OEC

8. Pre-requisite : Nil

9. Objective : The objective of the course is to familiarize students with basic data structures and their use in fundamental algorithms.

10. Details of Course

S.No.	Contents	Contact Hours
1.	**Introduction:** Introduction to Algorithmic, Complexity- Time-Space Trade off. Introduction to C programming through Arrays, Stacks, Queues and Linked lists.	8
2.	**Trees:** Basic Terminology, Traversals, Binary search trees, optimal and average BST's. 2-4 trees, Applications of Binary search Trees, Complete Binary trees, Extended binary trees.	7
3.	**Introduction to algorithms:** Concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations. Growth of Functions, Master's Theorem, **Searching and Searching:** Linear Search, Binary search, Insertion Sort, Quick sort, Merge sort, Heap sort, Radix Sort.	9
4.	**Graphs:** Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs, Breadth first search and connected components. Depth first search in directed and undirected graphs and strongly connected components.	8
5.	**Spanning trees:** Prim's and Kruskal's algorithm, union-find data structure. Dijkstra's algorithm for shortest paths, shortest path tree. Directed acyclic graphs: topological sort and longest path. **Dynamic programming**: Principles of dynamic programming. Applications: Matrix multiplication, Travelling salesman Problem.	10
Total		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
	Text Books:	
1.	Horowitz and Sahni, "Fundamentals of Data structures", Galgotia publications	1983
2.	Tannenbaum, "Data Structures", PHI	2007(Fifth Impression)
3.	T .H . Cormen, C . E . Leiserson, R .L . Rivest "Introduction to Algorithms", 3rd Ed., PHI.	2011 (reprint)
4.	E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms," Galgotia Publication	
	Reference Books	
1.	R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C", PHI	2009(Fourth Impression)
2.	Aho ,Ullman "Principles of Algorithms "	

IT355 COMMUNICATION AND COMPUTING TECHNOLOGY

NAME OF DEPTT: Information Technology

1. Subject Code: **IT355** Course Title: **Communication and Computing Technology**

2. Contact Hours : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage : CWS 25 PRS 0   MTE 25 ETE 50 PRE 0

5. Credits : 3

6. Semester : V

7. Subject Area : OEC

8. Pre-requisite : Operating systems, Algorithm Design and Analysis and data structures

9. Objective : To introduce the concept of Communications in Computer networks

10. Details of Course

S.No.	Contents	Contact Hours
1.	**Introduction** to Goals and Applications of Networks, Network structure and architecture, The TCP/IP reference model, services, Network Topology.	6
2.	**Data Link Layer and Medium Access sub layer** - Channel Allocations, LAN protocols -ALOHA protocols - Overview of IEEE standards - FDDI. - Elementary Data Link Protocols, Sliding Window protocols.	6
3.	**Network Layer**: Routing, Congestion control, Internetworking -TCP / IP, IP packet, IP address, IPv6 and Mobile IP.	8
4.	**Transport Layer:** Design issues, TCP and UDP, connection management, Congestion control, Leaky bucket, Token bucket algorithm. QoS.	8
5.	**Application Layer:** File Transfer, Access and Management, Electronic mail, Virtual Terminals, Internet and Public Networks, Firewalls	6
6.	**Information and Web security**: IP Security, Architecture, Authentication header, Encapsulating security payloads, combining security associations, Secure Socket Layer(SSL) and transport layer security, TSP, Secure Electronic Transaction (SET), Electronic money.	8
	TOTAL	**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
	Text Book	
1.	S. Tananbaum, "Computer Networks", 3rd Ed, PHI	1999

2.	U. Black, "Computer Networks-Protocols, Standards and Interfaces", PHI	1996
3.	W. Stallings, "Computer Communication Networks", PHI	1999
3.	Data Communications and Networking, Behrouz A. Forouzan 5/e	2013
Reference Book		
4.	William Stallings, "Cryptography and Network Security: Principals and Practice", Prentice Hall, New Jersy.	2001
5.	Behrouz A. Forouzan, "Cryptography and Network Security", TMH.	2006

IT357 INTERNET AND WEB PROGRAMMING

NAME OF DEPTT: Information Technology

1. Subject Code : **IT357**   Course Title: **Internet and Web Programming**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25   PRS 0   MTE 25   ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To introduce the concept of internet and web programming

10. Details of Course

S.No.	Contents	Contact Hours
1.	**Internet and WWW:** Internet basic, Introduction to internet and its applications, E- mail, telnet, FTP, e-commerce, video conferencing, e-business. Internet service providers, domain name server, internet address World Wide Web (WWW): World Wide Web and its evolution, uniform resource locator (URL), browsers - internet explorer, netscape navigator, opera, firefox, chrome, mozilla. Search engine, web saver - apache, IIS, proxy server, HTTP protocol.	6
2.	**WEBSITES BASIC ANDWEB 2.0**: Web 2.0: Basics-RIA Rich Internet Applications - Collaborations tools - Understanding websites and web servers: Understanding Internet – Difference between websites and web server- Internet technologies Overview – Understanding the difference between internet and intranet; HTML and CSS: HTML 5.0 , XHTML, CSS 3.	6
3.	**E-MAIL SECURITY & FIREWALLS** : PGP - S/MIME - Internet Firewalls for Trusted System: Roles of Firewalls - Firewall related terminology- Types of Firewalls - Firewall designs - SET for E-Commerce Transactions, intellectual property: copyright, patents, trademarks, cyber laws	8
4.	**SERVELETS AND JSP**: JSP Technology Introduction-JSP and Servelets- Running JSP Applications Basic JSP- JavaBeans Classes and JSP-Tag Libraries and Files- Support for the Model- View- Controller Paradigm- Case Study- Related Technologies.	8
5.	**XML**: Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, Well formed, using XML with application.XML, XSL and XSLT. Introduction to XSL, XML transformed simple example, XSL elements, transforming with XSLT	6
6.	**PHP:** Starting to script on server side, Arrays, function and forms, advance PHP, Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP my admin and database bugs.	8
	TOTAL	**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
	Text Books	
1.	Internet and Web Technologies by Raj Kamal, Tata McGraw Hill edition. (ISBN: 9780070472969)	2002
2.	An Introduction to Search Engines and Web Navigation, Mark Levene, Pearson Education. (ISBN: 978047052684)	2010
3.	Modeling the Internet and the Web,PierreBaldi,PaoloFrasconi, Padhraic Smyth, John Wiley and Sons Ltd. (ISBN: 978-0-470-84906-4)	2003
	Reference Books	
4.	HTML: A Beginner's Guide by Wendy Willard, Tata McGraw-Hill (ISBN: 9780070677234)	2009
5.	PHP and MySQL for Dynamic Web Sites, Ullman, Larry, Peachpit Press.1 (ISBN: 978-0-321-78407-0)	2012

IT359 JAVA PROGRAMMING

NAME OF DEPTT: Information Technology

1.   Subject Code: **IT359**   Course Title: **Java Programming**

2.   Contact Hours   : L: 3   T: 0   P: 0

3.   Examination Duration (ETE) (Hrs.) : Theory   3 Hrs   Practical 0

4.   Relative Weightage   : CWS 25 PRS 0   MTE 25   ETE 50   PRE 0

5.   Credits   : 3

6.   Semester   : V

7.   Subject Area   : OEC

8.   Pre-requisite   : Nil

9. Objective   :   To introduce the concept of java programming

10. Details of Course

S.No.	Contents	Contact Hours
1.	**Introduction to Java**: Programming language Types and Paradigms, Computer Programming Hierarchy, How Computer Architecture Affects a Language? , Why Java?, Flavors of Java, Java Designing Goal, Role of Java Programmer in Industry, Features of Java Language, JVM –The heart of Java , Java's Magic Byte code.	6
2.	**The Java Environment:** Installing Java, Java Program Development, Java Source File Structure, Compilation, Executions. Lexical Tokens, Identifiers, Keywords, Literals, Comments, Primitive Datatypes, Operators Assignments.	6
3.	**Object Oriented Programming**: Class Fundamentals , Object & Object reference, Object Life time & Garbage Collection, Creating and Operating Objects , Constructor & initialization code block, Access Control, Modifiers, methods Nested , Inner Class &Anonymous Classes, Abstract Class & Interfaces Defining Methods, Argument Passing Mechanism, Method Overloading, Recursion, Dealing with Static Members, Finalize() Method, Native Method.	8
4.	**Extending Classes and Inheritance**: Use and Benefits of Inheritance in OOP, Types of Inheritance in Java, Inheriting Data members and Methods, Role of Constructors in inheritance, Overriding Super Class Methods, Use of "super", Polymorphism in inheritance, Type Compatibility and Conversion Implementing interfaces.	8
5.	**Package**: Organizing Classes and Interfaces in Packages, Package as Access Protection, Defining Package, CLASSPATH Setting for Packages, Making JAR Files for Library Packages Import and Static Import Naming Convention For Packages.	6
6.	**GUI Programming**: Designing Graphical User Interfaces in Java, Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features Using Swing Components, Java Utilities (java.util Package) The Collection Framework: Collections of Objects, Collection Types, Sets , Sequence, Map, Understanding Hashing, Use of Array List & Vector.	8
TOTAL		**42**

11. Suggested Books

S.No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
	Text Books	
1.	The Complete Reference Java,, Herbert Schildt, ISBN: 978-0-07163177-8, Publisher: McGraw Hill	7th Edition
2.	Thinking in Java, Bruce Eckel, ISBN: 0-13-187248-6, Publisher: Prentice Hall	4th Edition
3.	The Java Programming Languages,, Ken Arnold, ISBN-13: 978-032134980, Publisher: Sun	4th Edition,
4.	Java in Nutshell,, Benjamin,ISBN: 9781449371296, Publisher: O'Reilly Media, Inc.	6th Edition

1. Subject Code: **CE351**   Course Title: **Geoinformatics and its Applications**

2. Contact Hours   : L: 3   T: 0   P: 0

3. Examination Duration (ETE) (Hrs.) : Theory 3 Hrs   Practical 0

4. Relative Weightage   : CWS 25 PRS 0   MTE 25 ETE 50   PRE 0

5. Credits   : 3

6. Semester   : V

7. Subject Area   : OEC

8. Pre-requisite   : Nil

9. Objective   : To familiarize the students with the concepts of the subject and its related applications in Civil Engineering and allied fields.

10. Details of Course

S. No.	Contents	Contact Hours
1	**Introduction to Geoinformatics, Remote Sensing, GIS and GPS:** Definitions of Geoinformatics, Remote Sensing, GIS and GPS, sources of energy, electromagnetic spectrum, electromagnetic radiation, reflection, transmission and absorption, Platforms and sensors, active and passive sensors, PAN, Multi and hyperspectral remote sensing data acquisition systems	8
2	**Maps, Datums, Projections Systems and spatial data analysis** - Plane and Geodetic surveying, Classification of surveys, Basic Principles of Surveying, Type of maps, scales and uses, plotting accuracy, map sheet numbering. Datums, coordinates and map projection systems. Data retrieval and querying, measurements in GIS, classification, accuracy.	8
3	**Optical, Thermal and Microwave Remote Sensing**. Brief review of Optical, thermal and microwave remote sensing, their utility, merit and demerits, Interaction of EMR with atmosphere, scattering, refraction, absorption, transmission, atmospheric windows, interaction of EMR with earth surface, spectral characteristics of remote sensing data,	8
4	**Basic Photogrammetry and Digital Image Processing:** Photogrammetry, aerial and terrestrial, applications of photogrammetry, types and geometry of aerial photograph, flying height and scale, relief (elevation) displacement. Digital image, digital image processing introduction to, preprocessing, enhancement, classification, visual image interpretation, Introduction to software - MATLAB, ENVI, ERDAS, AutoCAD etc	10
5	**Applications of Geoinformatics, Remote Sensing, GIS and GPS:** Land cover classification survey and Mapping, Digital elevation model (DEM), Introduction to SAR data, Applications in Disaster management, geology, forest security and military projects.	8
Total		**42**

11.   Suggested Books:

S.N.	Name of Books/ Authors	
1	Agarwal, C.S. and Garg, P.K., "Remote Sensing in Natural Resources Monitoring and Management", Wheeler Publishing House(ISBN 6-74-268173-4)	2000
2	Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis. (ISBN 0-74-68914355-7)	2002
3	Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information System", Oxford University Press. (ISBN 0-07-985256-4)	2000
4	Chandra, A.M. and Ghosh, S.K., "Remote Sensing and Geographical Information Systems", Alpha Science. (ISBN 0-07-8452567-1)	2005
5	Gopi, S., "Global Positioning System: Principles and Applications", Tata McGraw Hill. (ISBN 0-07-7691528-1)	2005

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