DEPARTMENT OF CHEMICAL ENGINEERING

B.Tech

Chemical Engineering

CURRICULUM

&

SYLLABUS

2018 REGULATION

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

(DEEMED TO BE UNIVERSITY)

ANANDNAGAR, KRISHNANKOIL-626126

VISION & MISSION

UNIVERSITY VISION	DEPARTMENT VISION
To be a Center of Excellence of International repute in education and research.	To be a globally recognized department through excellence in teaching and research
UNIVERSITYMISSION	**DEPARTMENT MISSION**
To produce technically competent, socially committed technocrats and administrators through quality education and research.	To provide quality education and training that can prepare graduates with excellent technical and leadership skills, integrity and social responsibility

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

PEO1: Graduates would engage in advanced studies in engineering, Science and in other related areas.

PEO2: Graduates would be successful as engineers and further develop skills through lifelong learning.

PEO3: Graduates would have effective communication and managerial skills and assume leadership roles in industry and /or in business and contribute to the upliftment of the society.

STUDENT OUTCOME

SO-1: Ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.

SO-2: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social , environmental and economic factors.

SO-3: An ability to communicate effectively with a range of audiences.

SO-4: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

SO-5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan task and meet objectives.

SO-6: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

SO-7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

PROGRAM OUTCOMES

The student will have

1. An ability to apply knowledge of mathematics, science and chemical engineering in the design and operation of chemical processes
2. An ability to identify, formulate and solve complex problems in the various domains of chemical engineering such as fluid mechanics, heat transfer, mass transfer, mechanical operations and transport phenomena
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
4. An ability to design and conduct experiments, as well as to analyze and interpret data
5. An ability to use the techniques, skills, and modern engineering tools necessary for chemical engineering practice
6. A knowledge of contemporary issues
7. The broad education necessary to understand the impact of chemical engineering solutions in a global, economic, environmental and societal context
8. An understanding of professional and ethical responsibility
9. An ability to work individually and as a member of a team
10. An ability to communicate effectively
11. An ability to function on multidisciplinary teams
12. A recognition of the need for, and an ability to engage in life-long learning

CURRICULUM STRUCTURE

S.No	Curriculum Component		Credits
I	Basic science and mathematics		25
II	Humanities and social science	3	12
	Soft skills	3	
	Humanities Elective	6	
III	Basic Engineering		24
IV	**Program core**		61
	a)Core Courses	48	
	b)Community Service Project	3	
	c)Project Work	10	
V	**Elective courses**		
	a)Major Elective	18	36
	b)Open elective	18	
VI	Internship/ Industry Training	2	2
VII	Mandatory Courses	-	-
Total Credits			**160**

I. Basic Science and Mathematics

S.No	Course Code	Course Name	Course Type	L	T	P	C
1	PHY18R175	Optics, Electromagnetism and Quantum mechanics	IC	3	1	2	5
2	CHY18R171	Chemistry	IC	3	1	2	5
3	MAT18R101	Calculus and Linear algebra	T	3	1	0	4
4	MAT18R102	Multiple Integration, Ordinary Differential Equations and Complex Variable	T	3	1	0	4
5	MAT18R204	Partial differential equations and Transforms	T	3	1	0	4
6	BIT18R101	Biology for Engineers	T	3	0	0	3

II. Humanities and Social Science

S.No	Course Code	Course Name	Course Type	L	T	P	C
1	HSS18R151	English for Technical Communication	TP	2	0	2	3

III. Soft Skills

S.No	Course Code	Course Name	Course Type	L	T	P	C
1	HSS18R101	Soft Skills – I	T	3	0	0	1
2	HSS18R102	Soft Skills – II	T	3	0	0	1
3	HSS18R201	Soft Skills – III	T	3	0	0	1

IV. Basic Engineering

S. No	Course code	Course Name	Course Type	L	T	P	C
1	MEC18R151	Engineering Graphics & Design	TP	3	0	2	3
2	EEE18R171	Basic Electrical and Electronics Engineering	IC	3	1	2	5
3	CSE18R171	Programming for problem solving	IC	3	1	2	5
4	MEC18R204	Engineering and solid mechanics	T	3	1	0	4
5	MEC18R152	Engineering Practice	TP	3	0	2	3
6	CHE18R271	Material science	IC	3	0	2	4

V Program Core

a) Core courses

S. No	Course Code	Name of the course	Course Type	L	T	P	C	Pre-requisite	Co-requisite
1	CHE18R201	Chemical Process Calculations	T	3	0	0	3	-	-
2	CHE18R202	Chemical Technology	T	3	0	0	3	-	-
3	CHE18R203	Chemical Engineering Thermodynamics	T	3	0	0	3	-	-
4	CHE18R272	Mechanical Operations	IC	3	0	2	4	-	-
5	CHE18R273	Fluid Mechanics	IC	3	0	2	4	-	-
6	CHE18R274	Heat Transfer	IC	3	0	2	4	-	-

7	CHE18R371	Process Dynamics and Control	IC	3	0	2	4	MAT18R204	-
8	CHE18R372	Chemical Reaction Engineering	IC	3	0	2	4	-	-
9	CHE18R373	Process Equipment Design Drawing	IC	3	0	2	4	CHE18R302	-
9	CHE18R301	Mass Transfer I	T	3	0	0	3	-	-
10	CHE18R302	Mass Transfer II	T	3	0	0	3	CHE18R301	-
11	CHE18R303	Numerical Methods in Chemical Engineering	T	3	0	2	4	-	-
12	CHE18R381	Mass Transfer Laboratory	L	0	0	3	2	-	CHE18R302
13	CHE18R401	Transport Phenomena	T	3	0	0	3	CHE18R272	-

Community Service Project

S. No	Course Code	Name of the course	Course Type	L	T	P	C
1	CHE18R399	Community Service Project	Project	0	0	3	3

Project Work

Project Work (10credit)

S. No	Course Code	Name of the course	Course Type	L	T	P	C
1	CHE18R499	Project Work	Project	0	0	10	10

Industry Training

S. No	Course Code	Name of the course	Course Type	L	T	P	C
1	CHE18R397	Industry Training	Training	0	0	1	1

Internship Training

S. No	Course Code	Name of the course	Course Type	L	T	P	C
1	CHE18R398	Internship Training	Training	0	0	1	1

Elective Courses

b)Professional Elective

S. No	Course Code	Name of the course	Course Type	L	T	P	C	Pre-requisite
1	CHE18R304	Heterogeneous Catalysis	T	3	0	0	3	
2	CHE18R305	Process Modeling and simulation	T	3	0	0	3	CHE18R203
3	CHE18R306	Interfacial Science and Engineering	T	3	0	0	3	-
4	CHE18R307	Process Utilities and pipeline design	T	3	0	0	3	CHE18R373
5	CHE18R308	Boundary Layer Theory	T	3	0	0	3	CHE18R272
6	CHE18R309	Nano science and technology	T	3	0	0	3	-
7	CHE18R310	Green Technology	T	3	0	0	3	-
8	CHE18R311	Petroleum Refinery Engineering	T	3	0	0	3	-
9	CHE18R402	Process Instrumentation	T	3	0	0	3	-
10	CHE18R403	Colloids and Surface Science	T	3	0	0	3	-
11	CHE18R404	Multiphase Flow	T	3	0	0	3	CHE18R272
12	CHE18R405	Computer Aided Process Plant Design	T	3	0	0	3	CHE18R373
13	CHE18R406	Fertilizer Technology for Chemical Engineers	T	3	0	0	3	-
14	CHE18R407	Environmental Engineering	T	3	0	0	3	-
15	CHE18R408	Chemical Process in Pulp and Paper Technology	T	3	0	0	3	-
16	CHE18R409	Electrochemical Engineering	T	3	0	0	3	-
17	CHE18R410	Chemical Process Plant Safety	T	3	0	0	3	-

Open Elective

S. No	Course Code	Name of the Course	Course Type	L	T	P	C	Pre-requisite
1	CHE18R312	Corrosion Science and Engineering	T	3	0	0	3	-
2	CHE18R313	Separation Technique	T	3	0	0	3	-
3	CHE18R314	Fertilizer Technology	T	3	0	0	3	-
4	CHE18R315	Membrane Science and Technology	T	3	0	0	3	-
5	CHE18R316	Process Industrial Safety	T	3	0	0	3	-
6	CHE18R317	Fuel and Combustion Engineering	T	3	0	0	3	-
7	CHE18R318	Pulp and Paper Technology	T	3	0	0	3	-
8	CHE18R319	Treatment of Industrial Effluents	T	3	0	0	3	-
9	CHE18R321	Coal Processing Technology	T	3	0	0	3	-
10	CHE18R322	Batteries and Fuel Cells	T	3	0	0	3	-
11	CHE18R411	Drugs and Pharmaceuticals Technology	T	3	0	0	3	-
12	CHE18R412	Polymer Science and Technology	T	3	0	0	3	-
13	CHE18R413	Pharmaceutical Engineering	T	3	0	0	3	-
14	CHE18R414	Disaster Management in Chemical Industries	T	3	0	0	3	-
15	PHY18R301	Photonics and optoelectronic devices	T	3	0	0	3	-

c) Humanities Elective

S.No	Course Code	Name of the Course	Course Type	L	T	P	C	Pre-requisite
1	HSS18R001	Management Concepts and Techniques	T	3	0	0	3	-
2	HSS18R002	Marketing Management	T	3	0	0	3	-
3	HSS18R003	Organizational Psychology	T	3	0	0	3	-

4	HSS18R004	Project Management	T	3	0	0	3	-
5	HSS18R005	Stress Management and Coping Strategies	T	3	0	0	3	-
6	HSS18R006	Engineering Economics	T	3	0	0	3	-
7	HSS18R007	Human Resource Management and Labour Law	T	3	0	0	3	-
8	HSS18R008	Entrepreneurship Development	T	3	0	0	3	-
9	HSS18R009	Cost Analysis and Control	T	3	0	0	3	-
10	HSS18R010	Product Design and Development	T	3	0	0	3	-
11	HSS18R011	Business Process Reengineering	T	3	0	0	3	-
12	HSS18R012	Political Economy	T	3	0	0	3	-
13	HSS18R013	Professional Ethics	T	3	0	0	3	-
14	HSS18R014	Operations Research	T	3	0	0	3	-
15	HSS18R015	Total Quality Management	T	3	0	0	3	-
16	HSS18R016	Advanced Soft skills	T	3	0	0	3	-

d. Honours

S.No	Course Code	Name of the Course	Course Type	L	T	P	C	Pre requisite
1.	CHE18R415	Computational Heat Transfer	T	3	0	0	3	CHE18R274
2	CHE18R416	Computational Fluid Dynamics	T	3	0	0	3	CHE18R273
3	CHE18R417	Fluidization Engineering	T	3	0	0	3	CHE18R372
4	CHE18R418	Optimization for Chemical Engineers	T	3	0	0	3	CHE18R303

Mandatory Courses

1. Environmental Sciences
2. Indian Constitution
3. Essence of Indian Traditional Knowledge

Basic Science and Mathematics

		L	T	P	C
PHY18R175	Optics, Electromagnetism and Quantum mechanics	3	1	2	5

Pre-requisite: Nil **Course Category:** Basic Sciences

Course Type: Integrated Course

Course Objectives:

- To understand the basic concepts of optics, quantum physics and its applications.
- To provide the students a firm understanding of the basics of Electricity, Magnetism and its applications.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Understand the concepts of diffraction and polarization.

CO2: Apply the concepts of optics in laser and fiber optics.

CO3: Explore the knowledge on electro statistics.

CO4: Understand the fundamentals of magnetism.

CO5: Apply the knowledge on solving the wave equations

Mapping of COs with Pos

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H										
CO2	H	H						H		M		
CO3	H	H		M				H		M	L	
CO4	H	H		M				H				
CO5	H	H					L					

Unit1: Diffraction and Polarization **12 Hours**

Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction Grating and its applications. Polarization: Introduction, polarization by reflection, polarization by double refraction, scattering of light, circular and elliptical polarization, optical activity

Unit2: Laser and Fiber Optics **12 Hours**

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne), solid-state lasers (Neodymium), applications of lasers in science, engineering and medicine. Numerical aperture and Acceptance angle of fiber – Types of optical fiber - Active and passive fiber sensors- Endoscope.

Unit3: Electromagnetism and dielectrics **12 Hours**

Laws of electrostatics, electric current and the continuity equation, laws of magnetism. Ampere's Faraday's laws. Maxwell's equations. Polarization, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics, Dielectric Breakdown – Types and Remedies

Unit4: Magneto statics and Magnetic materials **12 Hours**

Magneto statics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic

properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, Para- and Ferro-magnetic materials.

Unit5: Quantum Mechanics **12Hours**

Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in a box (1D) .

List of Experiments

1. To determine the dispersive power of prism using spectrometer and mercury source
2. To determine the wavelength of sodium light by Newton's Ring
3. To determine the wavelength of sodium light using diffraction grating
4. To determine the numeral aperture (NA) of an Optical Fibre.
5. To find the wavelength of He-Ne Laser using transmission diffraction grating.
6. To determine the refractive index of a prism/ liquid using spectrometer.
7. Deflection magnetometer – M and BH – TAN C position
8. To determine the thickness of a material using air wedge method
9. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
10. Determination of dielectric constant of liquids / Solids
11. Determination of Magnetic Susceptibility

Text Book(s)

1. Ghana, "Optics" Fifth edition, Tata McGraw-Hill Inc, 2012.
2. N. Subramanian and Brij Lal, "A Text Book of Optics", S. Chand Limited, 2015.
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009.
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011
5. Rajagopal K. Engineering Physics. PHI, New Delhi, 2011

Reference Books

1. Kailas K. Sharma Optics: Principles and Applications Elsevier, 2006
2. William T. Silfvast, Laser Fundamentals, Cambridge University Press, New York, 2nd Edition, 2004
3. Gaur R. K, and Gupta S. L, Engineering Physics, Dhanpat Rai & Sons, New Delhi, 7th Edition, 1993
4. Halliday D, Resnick R and Waler J, Fundamentals of Physics, Wiley and Sons, New York, 6th Edition, 2001.
5. Practical Physics – S.L. Gupta & V. Kumar (Pragati Prakashan).
6. Advanced Practical Physics – B.L. Workshop and H.T. Flint (KPH)
7. Advanced Practical Physics Vol. I & II – Chauhan & Singh (Pragati Prakashan)
8. Physics Laboratory Manual, prepared by Department of Physics, Kalasalingam University.

CHY18R171	Chemistry	L	T	P	C
		3	1	2	5

Pre-requisite: Nil **Course Category:** Basic Sciences

Course Type: Integrated Course

Unit -I: Atomic and Molecular Structure

Schrodinger wave equation: Derivation of time independent Schrodinger wave equation, Representation of Schrodinger wave equation in polar coordinates - Radial distribution function graphs of s, p, d and f

orbital's. Molecular Orbital Theory: MOT concept, MO diagrams of homo-nuclear diatomic molecules (hydrogen, nitrogen and oxygen) and hetero-nuclear diatomic molecules (carbon monoxide and nitric oxide). Crystal field theory: CFT concept, weak and strong ligands, energy level diagrams of transition metal ions (Fe^{2+}& Fe^{3+}) in octahedral and tetrahedral complexes and their magnetic properties. Intermolecular forces - Ionic, dipolar and van der Waals interactions.

Unit-II: Periodic Properties

Effective nuclear charge - Factors affecting effective nuclear charge: Penetration or shielding of orbital's - Variation of s, p, d and f orbital energies of atoms in the periodic table - Aufbau principle(Building-up principle)**:** Application of Aufbau principle in writing electronic configuration, Deviation from Aufbau principle - Periodicity of properties in a periodic table - Periodic properties: Atomic and ionic sizes, ionization energies, electron affinity and electro negativity - Variation of periodic properties in the periodic table - Hard soft acids and bases: Concept and examples.

Unit-III: Free Energy and Chemical Equilibria

Thermodynamic functions: Definition and mathematical expression for Work, Energy, Enthalpy, Entropy and Free energy - Nernst equation: Derivation, apply Nernst equation to determine of solubility product, pH (glass electrode). Potentiometric titrations: Acid-Base, Redox and precipitation reaction - Water analysis: Hardness by EDTA method and chloride ion by Argentomentric method - Corrosion: Definition, types (dry & wet) and mechanism. and control of Dry and Wet corrosion.

Unit-IV: Organic Reactions

Nucleophilic substitution reactions: Definition, types and examples of nucleophile, Compare nucleophilicity and basicity of a nuceophile - Types of nucleophilic substitution (case RX and ArX): Mechanism of S_N1, S_N2, S_Ni and Benzyne. Electrophilic substitution reactions: Definition, types and examples of electrophile - Electrophilic substitution reactions of hydrocarbons: Halogenation, sulphonation, nitration. Friedel crafts alkylation and acylation reaction. Nucleophilic addition reactions (case aldehydes and ketones): Polarity of C=O bond. General mechanism of nucleophilic addition reactions on aldehydes and ketones: HCN, HOH, ROH and $NaHSO_3$ addition. Electrophilic addition reactions (case alkenes): General mechanism of electrophilic addition reactions on alkene - Addition of HBr [Markownikoff & Anti-Markownikoff (peroxide effect)] - Addition of alkene (polymerization of ethylene). Elimination reactions: Types of elimination reactions (case alkyl halides): Dehydrohalogenation of alkyl halides - E_1 and E_2 mechanism - Dehydration of alcohols to alkene and ethers. Greener synthesis of drug molecules (Aspirin and Ibuprofen)

Unit-V: Stereochemistry & Spectroscopic Techniques

Stereochemistry **-** Definition with examples: Geometrical isomers (alkene) and stereoisomers, symmetry, chirality, enantiomers, diastereomers, meso and racemic mixture. Representation of 3D structures: Wedge formula, Fischer projections, Newmann and Sawhorse formula (upto 2 carbons) - Conformational analysis: Ethane, butane and cyclohexane - Configurationally analysis: Rules of RS nomenclature and application of RS nomenclature to molecules containing one chiral centre. Electronic spectroscopy: Principle, instrumentation, selection rules and medicinal application of fluorescence spectroscopy. Nuclear magnetic resonance spectroscopy (^{1}H-NMR): Principle, instrumentation, chemical shift, coupling constant and application (structural identification of the compound C_3H_6O from ^{1}H-NMR data). X-ray diffraction: Principle, instrumentation and applications X-ray diffraction.

List of Experiments (Any 10)

1. Determination of Viscosity by Ostwald Viscometer.
2. Determination of surface tension by stalagmometer.

3. Adsorption of acetic acid by charcoal.
4. Determination of chloride content of water.
5. Estimation of hardness of water by EDTA method.
6. Determination of the rate constant of a reaction
7. Thin layer chromatography.
8. Determination of the partition coefficient of a substance between two immiscible liquids
9. Determination of Saponification /acid value of oil.
10. Preparation of Aspirin
11. Potentiometric titration of strong acid vs. strong base.
12. Potentiometric titration of weak acid vs. strong base.
13. Determination of cell constant and conductance of solutions.

Text Books

1. Engineering Chemistry, 2nd Edition, Wiley India (P) Ltd., 2018.
2. Stereochemistry of Organic Compounds, Ernest L. Eliel, Samuel H. Wilen Student edition, Wiley India (P) Ltd., 2017.
3. University Chemistry, by B. M. Mahan and R.J.Mayers, Pearson Publishers, 11th Edition, Noida, 2017.
4. Chemistry Laboratory Manual, Department of Chemistry, Kalasalingam University, 2018.

Reference Books

1. Fundamentals of Molecular Spectroscopy, by C. N. Barnwell and E.M. McCash, Tata McGraw-Hill Publishers, 4th Edition, New Delhi, 2008.
2. Physical Chemistry, by P. W. Atkins and J.D. Paula, W H Freeman & Co Publishers, 10th Edition, 2014.
3. Modern Inorganic Chemistry, R. D. Madan, 4th Edition S. Chand & Company Ltd., 2009.
4. Organic Chemistry, Paula Y. Bruice, 7th Edition, Pearson (Dorling Kindersley India (P) Ltd.) 2014.
5. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M. S. Pathania, 47th Edition, Vishal Publishing Co., 2017.
6. Spectrometric Identification of Organic Compounds, Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8th Edition, Wiley India (P) Ltd., 2010.
7. Inorganic Chemistry, Peter Atkins, Mark Weller, Fraser Armstrong, Jonathan Rourke, Tina Overton, Michael Hagerman 5th Edition, Oxford press, 2015.
8. Organic Chemistry, Volume 1, I. L. Finar, 6th Edition, Pearson (Thomson press India (P) Ltd.) 2014

MAT18R101 Linear Algebra And Calculus	L	T	P	Credit
	3	1	0	4

Pre-requisite: Nil **Course Category:** Basic Sciences and Mathematics
Course Type : Theory

Course Objective:

To enable the students to acquire knowledge and skills in basic components of calculus, to handle the Situations involving multivariable calculus, and to diago1n4alizable a symmetric matrix is using Eigen values and eigen vectors.

Course Outcomes:

Upon successful completion of this course, students will be able to

1. Know the fundamental theorems such as Rolle's Theorem, Mean value theorem, Taylor's theorem and its Applications.
2. Understand the basic concepts of limit, continuity, derivative, partial derivative and total derivative and Its applications.
3. Solve the real world problems using differentiation and integration.
4. Understand the concepts of sequence, convergent of sequences, series and testing of convergent of series Using different methods.
5. Find the solution of simultaneous linear equations using matrices and to find the Eigen values and Eigen Vectors of a matrix, Cayley-Hamilon theorem and orthogonal transformations.

Mapping of Course Outcome(s):

CO/PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	H	H										
CO2	H	H										
CO3	H	H		M								
CO4	H	H		M								
CO5	H	H					L					

Unit 1: Calculus

Rolle's Theorem- Mean value theorems - Taylor's and Maclaurin theorems with remainders - Indeterminate forms and L'Hospital's rule - Maxima and minima.

Unit 2: Multivariable Calculus (Differentiation)

Limit, continuity and partial derivatives - directional derivatives - total derivative - Maxima, minima and saddle points - Method of Lagrange multipliers.

Unit 3: Calculus (Applications)

Curvature (Cartesian coordinates) - Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Unit 4: Sequences and series

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions;

Unit 5: Matrices

System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigen values and eigenvectors; Clayey-Hamilton Theorem - Diagonalization of matrices - Orthogonal transformation- Reduction of Quadratic form to Canonical form.

Text Book(s)

1. Grewal, B.S., Grewal, J.S., *Higher Engineering Mathematics*, Khanna Publishers, New Delhi, 43rd Edition, 2015.., 2012

Reference Book(s)

1. Kreyszig, E, *Advanced Engineering Mathematics*, John Wiley and Sons (Asia) Limited, Singapore, 10th Edn. 2001.
2. Ramana B. V., *Engineering Mathematics*, Tata McGraw-Hill Publishing Company Limited, New Delhi, Edition 2005.
3. Veerarajan,T., *Engineering Mathematics (For First Year)*, Tata McGraw-Hill publishing company Limited, 2008

MAT18R102 Multiple Integration, Ordinary Differential Equations and Complex Variable	L	T	P	Credit
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Basic Sciences and Mathematics **Course Type** :Theory			

Course Objective

To enable the students to understand the concepts of multiple integrations, their applications, and to handle analytic functions on complex plane and perform complex integration.

Course Outcomes

Upon successful completion of this course, students will be able to

1. Understand the concepts of double and triple integral and its applications.
2. Know about the applications of double and triple integral in vector calculus.
3. Know the methods of solving differential equations of first and second orders.
4. Understand the concepts of analytic functions, conformal mappings and bilinear transformations.
5. Understand the concepts of singularity, residues and evaluation of certain improper integrals.

Mapping of Course Outcome(s)

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H										
CO2	H	H										
CO3	H	H		M								
CO4	H	H		M								
CO5	H	H					L					

Unit 1: Multivariable Calculus (Integration)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double Integrals, Change of variables (Cartesian to polar), Applications: areas and volume; Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds;

Unit 2: Integral theorems

Gradient, curl and divergence. Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Unit 3: Ordinary differential equations

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equations.

Unit 4: Complex Variable – Differentiation

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit 5: Complex Variable – Integration

Contour integrals, Cauchy Integral formula (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (Integration around small semicircles and rectangular contours).

Text Book(s)

1. Grewal, B.S., Grewal, J.S., *Higher Engineering Mathematics*, Khanna Publishers, New Delhi, 43rd Edition, 2015.

Reference Book(s)

1. Kreyszig, E, *Advanced Engineering Mathematics*, John Wiley and Sons (Asia) Limited, Singapore, 10th Edn. 2001.
2. Ramana B. V., *Engineering Mathematics*, Tata McGraw-Hill Publishing Company Limited, New Delhi, Edition 2005.
3. Veerarajan, T., *Engineering Mathematics (For First Year)*, Tata McGraw-Hill publishing company Limited, 2008.

MAT18R204 Partial Differential equations and Transforms	L	T	P	Credit
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Basic Sciences and Mathematics **Course Type** :Theory			

Course Objective

To enable the students to solve the partial differential equations, to understand discrete and continuous transformations, and to solve differential equations and difference equations using transform techniques.

Course Outcomes

Upon successful completion of this course, students will be able to

1. Know the method of solving first and second order partial differential equations.
2. Classify the second order partial differential equations and to know about solving of initial and boundary value problems.
3. Understand the concept of Laplace transform and its application in solving ordinary differential equations and partial differential equations.
4. Know about Z transform and its application in solving difference equations.
5. Know about Fourier transforms and its properties.

Mapping of Course Outcomes

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H										
CO2	H	H										
CO3	H	H		M								
CO4	H	H		M								
CO5	H	H					L					

Unit 1: Partial Differential Equations

First order partial differential equations, solutions of first order linear and non-linear PDEs. Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular integral method.

Unit 2: Applications of Partial Differential Equations

Flows, vibrations and diffusions, second-order linear equations and their classification, Initial and boundary conditions, solution of the wave equation and diffusion equation by the method of separation of variables, The Laplacian in plane, cylindrical and spherical polar coordinates and solutions.

Unit 3: Laplace Transform

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of Integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.

Unit 4: Z Transform

Z-transform - Elementary properties - Inverse Z - transform - Convolution theorem – Formation of difference equations - Solution of difference equations using Z - transform.

Unit 5: Fourier Transform

Fourier series – Half range sine and cosine series - Fourier integral theorem (without proof) - Fourier Transform pair - Sine and Cosine transforms – Properties - Transforms of simple functions – Convolution theorem - Parseval's Identity.

Text Books

1. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.
2. Veerarajan, T., *Engineering Mathematics (For First Year)*, Tata McGraw-Hill publishing company Limited, 2008.

Reference Books

1. Kreyszig, E, *Advanced Engineering Mathematics*, John Wiley and Sons (Asia) Limited, Singapore, 10th Edn. 2001.
2. Grewal, B.S., Grewal, J.S., *Higher Engineering Mathematics*, Khanna Publishers, New Delhi,37th Edition, 5th Reprint 2004.

BIT18R101	Biology For Engineers	L	T	P	C
		3	0	0	3

Pre-requisite: Nil **Course Category:** Basic Sciences
Course Type: Theory

Course outcomes

CO1: Describe the fundamentals of cell structure and cell cycle

CO2: Understand the classification and functions of bio molecules

CO3: Elaborate the basic cellular mechanisms such as replication, transcription and translation

CO4: Describe the underlying concepts of infection and immunity.

CO5: Explain various applications of biology

Unit I: Introduction **9 hours**

Fundamental difference between science and engineering- comparison between eye and camera, Bird flying and aircraft; major discoveries in biology- ; Classification based on: Cellularity- Unicellular and Multi cellular; Ultra structure - prokaryotes and eukaryotes; three major kingdoms of life; Cell structure, intracellular organelles and their functions, comparison of plant and animal cells- Overview of Cell cycle and cell division

Unit II: Bio molecules **9 hours**

Chemistry of bio molecules: Carbohydrates, Lipids, Proteins; classification of amino acids; classification of proteins based on structure and functions; Nucleic acids -types, structure and function of DNA and RNA

Unit III: Genes to Proteins **9 hours**

Gene, Genome and chromosome; Central dogma of molecular biology; Classical experiments of DNA: Griffith and, Avery, McCarty and MacLeod, Meselson and Stahl - DNA replication, Transcription and Translation

Unit IV: Microbiology **9 hours**

Microscopy; Microbes as infectious agents - malaria, tuberculosis, typhoid, polio, dengue, AIDS;; cultivation of bacteria. Immunity - innate and acquired immunity - organs and cells of the immune system - classification of antibodies - types of T cells - transplantation, autoimmunity overview

Unit V: Applications of Biology **9 hours**

Healthcare-antibiotics, vaccines, monoclonal antibodies, insulin and interferon; Beneficial bacteria - probiotic bacteria, nitrogen fixing bacteria, fermentation and fermented foods and products Environmental - waste water treatment, bioremediation; Biomaterials and biopolymers for medical and environmental applications; Biosensors;

Text Books

1. De Roberts, E.D.P. and De Roberts, E.M.F. - Cell and Molecular Biology- Lippincott Williams & Wilkins- Philadelphia- USA- 8th Edition- 2010.
2. Voet, D., Voet, G., - Biochemistry - John Wiley and Sons, Singapore - 3rd Edition- 2001.
3. Pelczar MJ, Chan ECS and Krieg NR - Microbiology - Tata McGraw Hill, India- 7th Edition- 2010

References

1. Friefelder. D. -Molecular Biology- McGraw-Hill Companies- New York, USA- 5th Edition- 201

HSS18R151English For Technical Communication	L	T	P	Credit
	2	0	2	3

Pre-requisite: Nil **Course Category:** Humanities and Social science
Course Type : Theory with Practical

Course Objective(s)

To help the learner develop listening skills by providing them with inspiring material; To help the learner acquire the ability to speak comfortably in real-life situations; To inculcate in students a taste for English so that they take to reading novels, dailies, and motivational books and dailies; To help learners passionately improve their vocabulary; To enable students to write all kinds of letters, job applications, and reports; To help learners sit for the BEC Examinations.

Course Outcome(s)

After Successful completion of course, the students will be able to,

CO1: Learn to speak good English covering their day to day activities

CO2: Understand the importance of Listening in order to communicate well

CO3: Make Situational Dialogues on emerging multiple situations

CO4: Learn the importance of Reading aloud Newspapers and other Texts

CO5: Compose effective error free composition

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1.		M										
CO2.			M									
CO3.				L								
CO4.	M											
CO5.											M	

Unit I: Focus on Language and Communication **12 Hours**

What is Communication? Verbal and Non-verbal communication -– Cloze reading – Skimming-Scanning-Letters - Leave , Permission, Apology and Informal Letters - Spoken English – Meeting; parting; Meeting at a train station – Asking questions at the train station; Meeting at the airport; getting information at the airport- Definitions for technical terms - Etymology of Scientific Terms - Parts of Speech – Tenses – (Practical)- Preparing a short profile.

Unit II: Listening Skills **12 Hours**

Listening Comprehension - Listening to an audio -Types of Listening & Tips for Effective Listening. – Dialogue Writing - Telephonic Conversation. Major English Accents - British Accent (BBC) - American Accent (CNN) - Indian Accent (Doordharshan, NDTV, etc). Language Focus – Articles - Prepositions - Numerical Adjectives--(Practical) - Listening to Received Pronunciation.

Unit III: Speaking Skills **12 Hours**

Giving Instructions – Recommendations – Situational Conversations using the telephone; getting help in stores; going shopping; talking about shopping; shopping for clothes; asking about prices; Role plays - Communicating Politely- Oral Presentation Strategies - O_2r_0ganizing Contents -. Language Focus - Verbs—transitive & intransitive - Active Voice & Passive Voice - Direct Speech - Indirect Speech-(Practical) - Narrating events /stories.

Unit IV: Reading Skills **12 Hours**

Converting newspaper headlines into sentences - Note-making - Outline/Linear Method of Note-making - Sentence Method of Note-making - Schematic/Mapping Method of Note-making. Creative Writing - Language Focus - Jumbled Sentences – Summary Writing –- Replacing words with the noun forms of verbs - Conditional Clauses (Practical) Guessing Meaning from context.

Unit V: Writing Skills **12 Hours**

Dialogue Writing – Telephone conversation - Use of Abbreviations - Avoiding clichés, jargons and foreign words –Paragraph development - Kinds of Paragraphs - Effective Construction of Paragraphs, - Process Description - Language Focus - Comparison of Adjectives-(Practical)-Story Writing–Anecdote.

Text Book

1. M. Asraf Rizvi. Effective Technical Communication. Tata McGraw-Hill Publishers, 2005

Reference Material(s)

1. Meenakshi Raman and Sangeeta Sharma. Technical Communication: English Skills for Engineers. New Delhi: Oxford University Press, 2008R.
2. Oxford Advanced Learner's Dictionary. OUP, Latest Version
3. Raymond Murphy. Murphy's English Grammar. Cambridge University Press, 2004
4. Kavitha Tyagi and Padma Misra. Advanced Technical Communication. New Delhi: PHI press, 2011.
5. Clegg, Brain. Personal Development. New Delhi: Kogan Page India Private Limited, 2009.

HSS18R101 Soft Skills – I	L	T	P	Credit
	3	0	0	1
Pre-requisite: Nil	**Course Category:** Soft Skills **Course Type** :Theory			

Unit I: Effective Communication

Listening : Focus, Intuition about the speaker, Critical Listening, Writing : Reports, E-mail, Book & Movie Review, Notices & Advertisements, Speaking : Introducing Self, Just - a – Minute, Ad Zap, Story Telling

Unit II: Quantitative Ability

Introduction to Numerical Skills, Introduction to Logical Skills, Vedic Mathematics

Unit III: Time Management

Prioritization, Procrastination, Multi-Tasking

Unit IV: Social Media

Blog Writing, LinkedIn, Usage of messaging applications

Unit V: Soft Skills

Importance of Soft Skills, Lateral Thinking, Begin with the End in Mind, First things First, Think Win – Win

HSS18R102 Soft Skills – II	L	T	P	Credit
	3	0	0	1
Pre-requisite: Nil	**Course Category:** Soft Skills **Course Type**:Theory			

Unit I: Effective Communication
Reading : Speed Reading techniques, News Story Analysis, Presentation : Organizing Content, Use of fonts & animations, Mock Presentations

Unit II: Quantitative Ability
Number Properties, Averages, Progression

Unit III: Verbal Ability
Vocabulary Building Techniques, Analogy

Unit IV: Social Interaction
Interpersonal Skills, Dealing with difficult people, Stress Management

Unit V: Soft Skills
Seek first to understand, then to be understood, Synergy, Secret, Mind Maps, Creativity

HSS18R201 Soft Skills - III	L	T	P	Credit
	3	0	0	1
Pre-requisite: Nil	**Course Category:** Soft Skills **Course Type**:Theory			

Unit I: Effective Communication
Sentence Construction, Tenses, Verbal Communication, Parts of Speech, Framing effective Sentences

Unit II: Quantitative Ability
Percentages, Profit-Loss-Discount, Ratio & Proportion, Mixtures & Allegation, Interest Calculations, Data Sufficiency

Unit III: Logical Ability
Data Arrangements, Coding & Decoding, Ranking / Ordering, Venn Diagrams, Syllogisms, Introduction to Data Interpretation

Unit IV: Verbal Ability
Sentence correction, Sentence Completion, Idioms & Phrases, Articles, Analytical Writing, Descriptive Writing

Unit V: Soft Skills
Dining Etiquette, Hygiene , Team Work, Collaboration, Interdependence , Resume Building, Power Verbs, Group Discussion, Personal Interview

MEC18R151 Engineering Graphics & Design	Credits			
	L	T	P	Total
	3	0	2	3
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type**: Theory with Practical			

Course Objective(s)

This course aims to introduce the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products, Demonstrate skills in interpreting, and producing engineering drawings accurately and to give exposure to national standards relating to engineering drawing

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Create the projection of points in all quadrants and straight lines

CO2: Construct the projections of planes and solid objects with refer to reference planes

CO3: Illustrate the true shape of truncated solids in both the manual and computerized manner

CO4: Develop surfaces of truncated solids in both the manual and computerized man

CO5: Apply orthographic and isometric projections in both the manual and computerized man

Mapping of Course Outcome(s)

CO/ PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M		M									
CO2		H										L
CO3	M		H		H		H					M
CO4	L	M			H		H					H
CO5	H		H		H		H					H

Unit I: Projection of Points and Straight Lines **9 Hours**

Importance of graphics – use of drafting instruments – BIS conventions and specifications – size, layout and folding of drawing sheets – lettering dimensioning and scales - Projection of points, located in all quadrants - projection of straight lines located in the first quadrant, determination of true lengths and true inclinations

Unit II: Projection of Planes and Solids **9 Hours**

Projection of polygonal surface and circular lamina located in first quadrant inclined to one or both reference planes-Projection of solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method

Unit III: Section of Solids **9 Hours**

Section of simple solids like prisms, pyramids, cylinder and cone in vertical position by cutting planes inclined to any one of the reference planes, obtaining true shape of section

Unit IV: Development of Surfaces **9 Hours**

Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones

Unit V: Orthographic and Isometric Projection **9 Hours**

Orthographic principles – missing view - free hand sketching in first angle projection from pictorial views. Principles of isometric projection – isometric view and projections of simple solids, truncated prisms, pyramids, cylinders and cones. Introduction to CAD software – menus and tools – drafting platform demonstration

List of Experiments

1. Construction of conic sections using CAD software
2. Construction of simple planes using exclusive commands like extend, trim etc.,
3. Construction of 3D model – solids and sectional views
4. Generating 2D orthographic blue prints from 3D part models
5. Vectorization of simple building plan and elevation

Text Book(s)

1. Basant Aggarwal and C. Aggarwal, Engineering Drawing, McGraw-Hill, 2013.
2. N.S. Parthasarathy, Vela Murali, Engineering Drawing, Oxford University Press, 2015.
3. K. Venugopal, Engineering Drawing + AutoCAD, New Age; Fifth edition, 2011.

Reference(s):

1. Shah, M.B., and Rana, B.C., Engineering Drawing, Pearson 2009
2. Natarajan, K.V., A Text Book of Engineering Graphics, 21st Edition, Dhanalakshmi Publishers, Chennai, 2012.
3. Paul Richard, Jim Fitzgerald., Introduction to AutoCAD 2017: A Modern Perspective, Pearson, 2016.
4. Bhatt, N.D., Engineering Drawing, Charotar publishing House, New Delhi, 53trd Edition, 2014.
5. Luzadder and Duff, "Fundamentals of Engineering Drawing", Prentice Hall of India Pvt. Ltd., 2009.
6. Venugopal, K., Engineering Graphics, New Age International (P) Limited, 2009.

EEE18R171 Basic Electrical and Electronics Engineering	***Credits***			
	L	***T***	***P***	***Total***
	3	***1***	***2***	***5***
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type:** Integrated Course			

Course Objective(s)

To focus the fundamental ideas of the Electrical and Electronics Engineering by providing wide exposure to the basic concepts of Electrical and Electronics Engineering such as DC Circuits, AC Circuits, electrical machines, measuring instruments, Basic Electronic Devices and various electronic circuits such as rectifiers, amplifiers, oscillators, etc.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply the basic laws of electricity in DC and AC circuits
CO2: Describe the construction and operation of static and rotating electrical machines
CO3: Explain the functioning of measuring instruments and develop the basic domestic wiring circuit.
CO4: Describe the constructional features and operation of fundamental electronic devices
CO5: Explain the characteristics of electronic circuits

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	M	M		M	M	L		L	L	L		
CO2	M	M		M	M	L		L	L	L		
CO3	M			M	M	L		L	L	L		
CO4	H	M										
CO5	H	H	L	M	M	L	L	L	L	L		

Unit 1: DC Circuits and AC Circuits **12 Hours**

Electrical quantities - resistors - inductors - capacitors - Ohm's Law - Kirchhoff's Laws - series and parallel circuits - analysis of DC circuits - mesh, nodal - simple problems- Sinusoidal functions - phase representation - RMS and Average values - form and peak factors - RLC series circuits - power and power factor-concept of three phase system.

Unit 2: Electrical Machines **12 Hours**

Construction and principle of operation of DC machines - generator, motor - single phase transformers - alternators - three phase and single phase induction motors.

Unit 3: Measurement Instruments and Wiring Circuits **12 Hours**

Moving coil and moving iron instruments - dynamometer type wattmeter - induction type energy meter, Domestic wiring - accessories - types - staircase wiring - fluorescent tube circuits - simple layout –grounding

Unit 4: Electronic Devices **12 Hours**

Basic concepts of PN junction diodes - Zener diode - bipolar junction transistor - uni-polar devices - FET, MOSFET, UJT - Thyristor–SCR and Triac, Photoelectric Devices-Photo diode and Photo transistor

Unit 5: Electronic Circuits **12 Hours**

Half wave and full wave rectifier –Transistor as an amplifier –RC- phase shift oscillator - RC integrator and differentiator circuits - diode clampers and clippers - multi vibrators - Schmitt trigger

Text Book(s)

1. V.K. Mehta, "Principles of Electrical Engineering and Electronics", S. Chand & Company Ltd, 2012
2. Kothari D P and Nagrath I J, "Basic Electrical Engineering", McGraw Hill, 2009.
3. Mithal G K, Electronic Devices & Circuits, Khanna Publications, 1997

Reference(s)

1. T. Thyagarajan, "Fundamentals of Electrical and Electronics engineering", SciTech publications (Ind.) Pvt. Ltd., 3rd Edition, 2015.
2. Muraleedharan K.A, Muthususbramanian R and Salivahanan S, "Basic Electrical, Electronics and Computer Engineering" Tata McGraw Hill, 2006.
3. Shantha kumar S.R.J, Basic Mechanical Engineering, Third Revised Edition (Reprint 2009), Anuradha Publications, Kumbakonam, 1999.
4. Rajput R. K., Basic Mechanical Engineering, Fourth edition, Tata McGraw Hill Publishing Co., New Delhi, 2007.

List of Experiments

1. Verification of Kirchoff's Laws.
2. Verification of AC voltage measurements
3. Demonstration of DC Motor
4. Demonstration of Transformer
5. Demonstration of Induction Motor
6. Measurement of Voltage, Current and Power in AC Circuit
7. Wiring layout for Staircase
8. Wiring layout for Fluorescent lamp
9. Conduct a suitable experiment to demonstrate the VI characteristics of characteristics PN diode and Zener Diode
10. Design a diode based Half wave and Full wave rectifier

CSE18R171	Programming For Problem Solving	L	T	P	Credit
		3	1	2	5
Pre-requisite : Nil		**Course Category :** Basic Engineering **Course Type :** Integrated Course			

Course Objectives

To make the students to understand the basic concepts of programming language, rules to be followed while writing a program and how to compile and execute C programs.

Course Outcomes:

Understand the basic programming concepts and syntax of C language

CO1 : Develop efficient code using pointers, arrays and dynamic memory allocation
CO2 : techniques
CO3 : Create user defined data types and functions to solve given problems.
CO4 : Design an efficient algorithm for a given problem
CO5 : Build efficient code to solve the real world problem
CO6 : Elucidate the programming constructs of C during interviews

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H		H					M	M		
CO 2		H		H		M	M					
CO 3	H	H			M		H	H	M		M	M
CO 4	H	H	H								H	H
CO 5		H		H	H		M					
CO 6	H	H		M		H					H	M

Unit I: Introduction to Programming **12 hours**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudo code with examples, From algorithms to

programs; source code, variables (with data types) variables and memory, locations, Syntax and Logical Errors in compilation, object and executable code, Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops.

Unit II: Arrays and Strings **12 hours**

Introduction - One dimensional and two dimensional arrays – Declaration of arrays – Initializing and Accessing array elements – Strings: One dimensional character arrays - Declaration and String Initialization - String Manipulation - Multidimensional Arrays - Arrays of Strings

Unit III: Basic Algorithms **12 hours**

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit IV: Function **12 hours**

Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference, Recursion, Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Unit V: Structure, Pointers & File Handling **12 hours**

Structures, Defining structures and Array of Structures, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling (only if time is available, otherwise should be done as part of the lab)

Text Books

(i) Byron Gottfried, Schism's Outline of Programming with C, McGraw-Hill
(ii) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Reference Books

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

List Of Experiments **15 hours**

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures
Tutorial 12: File handling:
Lab 12: File operations

MEC18R204 Engineering and solid Mechanics	Credits			
	L	T	P	Total
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type:** Theory			

Objectives

Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force Systems, axioms, dynamics of rigid bodies. Second part of the course would be an introduction to Solid Mechanics and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and Applications to one/two dimensional problems.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Explain the basic concepts motion in Cartesian and cylindrical coordinates
CO2: Application of various loads in motion on bodies
CO3: Interpret the idea of motion and forces in bodies
CO4: Demonstrate mathematically of loads on columns
CO5: Analyze various beams and loads

Mapping of Course Outcome(s):

CO /	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H										L
CO2	H	H		M								L
CO3	H	H	M	M								M
CO4	H	H	M	M								M
CO5	H	H										L

Unit-I Motions Of Bodies

Introduction, Point Kinematics: Moving point in various coordinate systems (Cartesian, Cylindrical, Path) rigid body kinematics: Translation and rotation, relative motion, angular velocity, General motion of a rigid body, General relative motion

Unit-II Dynamic Analysis of Solid Bodies

Equivalent force systems, Resultant forces, Linear and Angular Momentum, Laws of motion (Euler's Axioms), Free Body Diagrams, Dynamics of point mass models of bodies. Equilibrium of rigid bodies, distributed forces, Analysis of structures: Trusses, Forces in Beams: Shear Force and Bending Moment

Unit-III Mechanical Motion of Solid Bodies

Frictional forces, Laws of Coulomb friction, impending motion. Inertia tensor, Principal Moments of Inertia, Moment of momentum relations for rigid bodies, Euler's Equations of Motion

Unit-IV Principal Stresses and Strains

State of stress at a point, equations of motion, principal stress, maximum shear stress, Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain.

Unit-V Deflection of Beams

Uniaxial stress and strain analysis of bars, thermal stresses, Torsion of circular bars and thin walled members, Bending of straight/curves beams, transverse shear stresses, deflection of beams, Buckling of columns

MEC18R152 Engineering Practice	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**2**	**3**
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type:** Theory with Practical			

Lectures & videos:

Detailed contents

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing Methods **(3 lectures)**

2. CNC machining, Additive manufacturing **(1 lecture)**

3. Fitting operations & power tools **(1 lecture)**

4. Carpentry **(1 lecture)**

5. Plastic moulding, glass cutting **(1 lecture)**

6. Metal casting **(1 lecture)**

7. Welding (arc welding & gas welding), brazing **(1 lecture)**

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and Publisher's private limited, Mumbai.

(ii) Kalpakjian S. And Steven S. Schmidt, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

(iii)Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.

(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

Course Outcomes

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

(ii) Workshop Practice:

1. Machine shop **(10 hours)**
2. Fitting shop **(8 hours)**
3. Carpentry **(6 hours)**
4. Welding shop **(8 hours (Arc welding 4 hrs + gas welding 4 hrs)**
5. Casting **(8 hours)**
6. Smith **(6 hours)**
7. Plastic moulding & Glass Cutting (6 hours)

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Laboratory Outcomes

- Upon completion of this laboratory course, students will be able to fabricate

Components with their own hands.

- They will also get practical knowledge of the dimensional accuracies and dimensional

Tolerances possible with different manufacturing processes.

- By assembling different components, they will be able to produce small devices of their interest

CHE18R271 Material Science	L	T	P	C
	3	0	2	4
Pre-requisite:	**Course Category:** Basic Engineering **Course Type:** Integrated Course			

Course Objective(s)

The objective of the course will be to give the students a basic introduction to the different classes of materials relevant to engineering in general, and Chemical Engineering in particular. The intent of the course will be to relate the underlying molecular structure of the materials to their physical and chemical properties, and their processing and performance characteristics.

Course Outcomes(s)

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

CO1: Explain the properties of material.

CO2: Describe the characteristics of solids.

CO3: Analyze Material structures and corrosion prevention.

CO4: Explain about semi-crystalline Materials.

CO5: Analyze the Experimental Techniques.

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M	L	H				M					
CO2		L			M		M					
CO3		L		M	H						M	
CO4		L	M									
CO5		L					M				M	H

Unit I: Introduction to Material **9Hours**

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships, Miller indices of directions and planes, packing of atoms inside solids, close-packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials.

Unit II: Imperfection in solids **9Hours**

Vacancies, equilibrium concentration of vacancies, interstitial and substitution impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults

Unit III: Structure of materials and Strength of Materials **9 Hours**

Yield strength, tensile strength and ductility of materials: stress strain behavior of metals, ceramics and polymers, tensile test, plastic deformation, necking, creep behavior and fatigue, Corrosion, Degradation and Recycling

Unit IV: Semi-crystalline material **9Hours**

Classification, structure and configuration of ceramics, polymers, copolymers, liquid crystals and amphiphiles, glass transition temperature, visco elasticity.

Unit V: Bio and Experimental Techniques **9 Hours**

Biomaterials, material related to catalyst such as zeolites, silica etc. and other selected materials, XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties

Total: 45Hours

Text Book(s):

1. V. Raghavan Materials Science and Engineering: A First Course, 5th Edition Prentice Hall India, 2004.

2. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007

Reference(s):

R. A. L Jones, Soft Condensed Matter, Oxford University Press, 2002.

William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.

B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and

Materials Engineers, John Wiley & Sons,2004..

CORE COURSES

CHE18R201 Chemical Process Calculation	L	T	P	C
	3	0	0	3

Pre-requisite: Nil **Course Category:** Program Core

Course Type: Theory

Course Objective(s)

To understand the fundamental calculation of chemical Engineering and their processes

Course Outcomes(s)

At the end of the course, students would be able to

CO1: Describe the fundamentals of stoichiometry

CO2: Apply material balances on unit operations and processes

CO3: Evaluate humidity with/without the use of psychometric chart

CO4: Apply simultaneous material and energy balances

CO5: Apply Energy and Material balance to industrial processes

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	M										
CO2			H									
CO3		M			H							
CO4											H	
CO5			L	L	M							M

Unit I: Introduction **9Hours**

Units and dimensions and conversions - Mass and volume relations -Stoichiometric and Composition relations, Degree of completion - Ideal gas law, Dalton's Law, Amagat's Law, average molecular weight of gaseous mixtures - Vapor Pressure, effect of temperature on vapor pressure, vapor pressure plot- Clasius-Clapeyron equation, Cox Chart,Duhring's Plot Raoult's Law

Unit II: Material Balance **9Hours**

Material balance without chemical reaction Drying, mixing, Crystallization, Extraction, Absorption, Distillation and evaporation, Analysis of system with bypass, recycle and purging, Psychometric, Humidification and dehumidification. Steady state and unsteady state material balances Material balances for systems with and without chemical reactions –Material balance applied to different unit operations- Analysis of systems with by-pass, recycle, and purge Orsat's analysis of solid, liquid, gaseous fuels - Steady state and unsteady state material balances

UNIT 3: Humidity and saturation **9Hours**

Material balance with chemical reaction Principles of Stoichiometry, Concept of limiting, excess reactants and inert, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems. Relative and percent sat^{3}u^{2}ration - Dew point - Dry and wet bulb temperatures - Use of humidity charts for engineering calculations

UNIT4: Energy balance **9Hours**

Heat capacity of gases, liquids and solutions, heat of fusion and vaporization - Steady state energy balance for systems with and without chemical reactions. Calculations and application of heat of reaction, combustion, formation, Neutralization. Calculation and application of heat of solution,Enthalphy concentration chart, Calculation of theoretical and actual flame temperature.

UNIT 5: Applications of Material and Energy Balances **9 Hours**

Applications of material and energy balances to various process industries especially combustion of solids, liquids and gaseous fuels.

Textbook(s):

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering" , Eighth Ed., Pearson India Education Services,2015.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.
3. K.V.Narayanan. "A Textbook of Chemical Engineering Thermodynamics", PHI Learning Pvt. Ltd., 2004.

Reference(s):

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons,2000
2. Hougen, O. A., Watson, K. M., Ragatz, R. A., " Chemical Process Principles, Part-I Material& Energy Balances", Second Edition, CBS Publishers & Distributors,2004
3. Venkataramani,V.,Anantharaman,N.,Begum,K.M.MeeraSheriffa, "ProcessCalculations", Second Edition, Prentice Hall ofIndia.
4. Sikdar, D. C., " ChemicalProcess Calculations", Prentice HallofIndia.

CHE18R202 Chemical Technology	L	T	P	C
	3	0	0	3

Pre-requisite: Nil **Course Category:** Program Core
Course Type: Theory

Course Objective(s):

To understand the basic process of chemical Engineering and its applications in various aspects

Course Outcome(s):

At the end of the course, the students would be able to
CO1: Explain the processing of natural products
CO2: Describe about microbial processes and edible oil refining process
CO3: Enumerate the manufacturing processes of chloro-alkali and sulfur chemicals
CO4: Explain the manufacturing processes of industrial gases and silicate chemicals
CO5: Describe the manufacturing processes of fertilizer and agrochemicals

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H		M				L					
CO2					M						M	
CO3		H						L				
CO4					H					L		
CO5			H			M						L

UNIT 1: Natural Products Processing **9Hours**

Production of pulp, paper and rayon, Manufacture of sugar, starch and starch derivatives, Gasification of coal and chemicals from coal.

UNIT 2: Fermentation Processes **9 Hours**

Industrial Microbial Processes and Edible Oils: Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics, Refining of edible oils and fats, fatty acids, Soaps and detergents.

UNIT 3: Chloro-Alkali & Sulfur Industry **9Hours**

Alkalies and Acids: Chloro - alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt, Manufacture of hydrochloric acid. Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid.

UNIT 4: Industrial Gases and Silicate Industry **9Hours**

Industrial gases: Oxygen - Nitrogen - Hydrogen - basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: C1, C2, C3, C4, benzene, toluene, xylene Silicate industry: Portland cement - Glasses – Ceramics

UNIT 5: Fertilizer and Agrichemical Industries **9Hours**

Fertilizers: Nitrogen Fertilizers; Synthetic ammonia, nitric acid, Urea, Phosphorous Fertilizers: Phosphate rock, phosphoric acid, super phosphate and Triple Super phosphate.

Total: 45 Hours.

Text Book(s):

1. George T. Austin -Shreve's Chemical Process Industries - McGraw-Hill International Editions, Singapore, 1998 (5th Edition)
2. GopalaRaoM.andMarshallSittig - Dryden'sOutlinesofChemicalTechnology - East-WestPress - NewDelhi - 1997(3rd Edition)

Reference(s):

1. Kent,J.A.(ed),Riegel's - HandBookofIndustrialChemistry - KluwerAcademicPress - NewYork-2003(10thEdition)
2. M. Farhat Ali and Bassam El Ali- Handbook of industrial chemistry – Mc Graw Hill, New York, 2004
3. Pandey,G.N - TextbookofChemical Technology - Vol.II,VikasPublishing House - NewDelhi1994(2ndEdition)

CHE18R203 Chemical Engineering Thermodynamics	L	T	P	C
	3	0	0	3

Pre-requisite: Nil **Course Category:** Program Core

Course Type: Theory

Course Objective(s)

To understand the basic principles and application of first and second law of thermodynamics, and phase equilibria.

Course Outcomes(s)

At the end of the course, the student would able to

CO1**:** Apply mass and energy balances to closed and open systems

CO2: Evaluate the properties of non-ideal gases

CO3: Apply second law of Thermodynamics

CO4: Explain the thermodynamic Relations

CO5: Solve problems involving liquefaction, refrigeration and different power cycles.

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H		M						M		
CO2	H	M						H				L
CO3			H	H				M				
CO4				H				M	H		L	
CO5					H					M		

UNIT 1: Introduction **9Hours**

scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat, Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P,V, T processes; Mass and energy balances for open systems.

UNIT2: PVT Behavior &Phase Transitions **9 Hours**

Ideal gas law, van der Waals, viral and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior, Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion

UNIT 3: Law of Thermodynamics **9 Hours**

Statements of the second law; Heat engines, Carnot's theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work

UNIT 4: Thermo dynamic Relations **9Hours**

Thermodynamic relations - Maxwell's relations - Jacobian algebra - estimation of thermodynamic properties.

UNIT 5: Phase Equilibria with solution thermodynamics **9 Hours**

Phase equilibria - pure component and mixtures - Latent heat correlation - van Laar, Margules equations - Gibbs' - Duhem equation - consistency tests - partially miscible and immiscible systems - Azeotropes - retrograde condensation - thermodynamic diagrams.

Text Book(s)

1. J. M. Smith and Van Ness - Introduction to Engineering Thermodynamics - McGraw Hill, New York, - 2004. (6th Edition)

Reference(s)

1. M J Moran, H N Shapiro, D.D.Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8thEdition, Wiley

CHE18R272 Mechanical Operations	L	T	P	C
	3	0	2	4

Pre-requisite: Nil **Course Category:** Program Core

Course Type: Integrated course

Course Objective(s)

To understand the characterization of a particle size analysis of a material.

Course Outcomes(s)

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

CO1: Characterize particles and perform size reduction and size analysis of particles

CO2: Identify conveyors & storage vessels for particular applications

CO3: Explain the principle, construction and operation of various classification equipments

CO4: Apply the principles of agitation and mixing

CO5: Evaluate the parameters of filtration

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	L		H					L			
CO2	H	L	H		M			L		M		
CO3		L	H	H	H						M	
CO4		L			H		M		M			
CO5		H	H	M								

UNIT1: Introduction **12Hours**

Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes, Solid particle characterization: Particle size, shape and their distribution; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area,Screen analysis,Screen Effectiveness.

UNIT 2: Size Reduction **12Hours**

Principles of size reduction - Specific properties of solids for size reduction - Energy required For size reduction - Crushing and grinding efficiency - Laws of crushing - Classification of crushing and grinding equipment - Construction and working principle of mostly used equipments - Size enlargement Size enlargement, Nucleation and growth of particles.

UNIT 3: Conveying **12Hours**

Conveying of bulk solids: Classification of conveyors - Selection of conveyors, Transport of fluid solid systems, Pneumatic and Hydraulic Conveying

UNIT 4: Sedimentation and separation **12Hours**

Free Settling, hindered settling, Richardson-Zaki equation, design of settling tanks Mechanical classification and classifiers-Rare and dense medium separation- Magnetic separation- Electrostatic separation - Centrifugal separation - Electrostatic precipitators - Impingement separators - Gas solids separation - Cyclone separators-Bag filters scrubbers

UNIT 5: Mixing, Blending and Filtration **12 Hours**

Mixing of solids, blending, kneading - Power for agitation -Correlations for power consumption- Filtration- Batch and continuous filtration, compressible and incompressible filter cakes- Calculations for specific cake resistance, filter medium resistance-Industrial filters-Centrifugal filtration

Text book(s):

1. McCabe, W.L., Smith, J.C., and Harriott, P - Unit Operations of Chemical Engineering, McGrawHill, New York, 2004 (7^{th}Edition)
2. Geankoplis, C.J–Transport Processes and Separation Process Principles (Includes Unit Operations) - Prentice Hall of India, New Delhi - 2003(4^{th}Edition)

Reference(s):

1. Coulson J.M., Richardson J.F., Buckhurst J.R. and Harker J.M - Coulson and Richardson's ChemicalEngineering - Volume I - Butterworth Heinemann – Oxford-2002(5^{th}Edition).
2. Coulson J.M. Richardson J.F., Buckhurst J.R. and Harker J.M - Coulson and Richardson's ChemicalEngineering - Volume II - Butterworth Heinemann - Oxford - 2002(5^{th}Edition

List of experiments:

1. Studies in an agitated vessel.
2. Drag studies
3. Particle size distribution
4. Screening Efficiency
5. Determination of specific surface area by air elutriation
6. Determination of area of a thickener by batch sedimentation test.
7. Size reduction using Jaw Crusher and Verification of crushing laws.
8. Size reduction using Ball Mill and determination of sp^3e^7cific surface area.
9. Drop weight crushing and verification of crushing laws.
10. Determination of specific cake resistance and filter medium resistance for leaf filtration

11. Determination of specific cake resistance and filter medium resistance for rotary vacuum
12. Determination of specific cake resistance and filter medium resistance for filtration in a plate and frame filter press.

CHE18R273 Fluid Mechanics	L	T	P	C
	3	0	2	4

Pre-requisite: Nil **Course Category:** Program Core

Course Type: Integrated course

Course Objective(s)

To understand the basic principles of fluid flow in pipes and momentum balance

Course Outcomes(s)

At the end of the course, the student would able to

CO1: Explain the basic principles of fluid statistics

CO2: Analyze fluid flow problems with the application of the momentum and energy equations.

CO3: Analyze pipe flows

CO4: Describe the basic principles of packed and fluidized beds

CO5: Analyze fluid machinery

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	L						M				
CO2	M	L					H		M			M
CO3	H	L			H					L		
CO4		H			M						M	
CO5		H					H		L			

UNIT 1: Fluid Statics **12Hours**

Properties of fluids and concept of pressure - Introduction - Nature of fluids - Physical properties of fluids - Types of fluids - Fluid statics - Pressure, density, height relationships - Pressure Measurement - Units and Dimensions- Dimensional analysis- Similarity, forces arising out of physical similarity - Dimensionless numbers

UNIT 2: Mass and Momentum Balance **12Hours**

Momentum balance and their applications - Kinematics of fluid flow, stream line, stream tube, velocity potential - Newtonian and non-Newtonian fluids, Time dependent fluids - Reynolds number, experiment and significance - Momentum balance - Potential flow - Euler's equation of motion- Bernoulli's equation.

UNIT 3: System and control volume approaches **12Hours**

Reynolds transport theorem, Flow of incompressible fluids in pipes turbulent flow through closed conduits, velocity profile and friction factor for smooth and rough pipes - Head loss due to friction in pipes, fitting, Moody diagram.

UNIT 4: Flow past Immersed Objects **12Hours**

Flow of fluids through solids - Form drag - Skin drag - Drag coefficient - Flow around solids and packed beds, Friction factor for packed beds, Ergun's Equation - Motion of particles through fluids - Motion under gravitational and centrifugal fields -Terminal settling velocity - Fluidization , mechanism, types, general properties and applications

UNIT 5: Transportation and Metering Of Fluids **12Hours**

Transportation and metering - Measurement of fluid flow, orifice meter, venturi meter, pilot tube, rotameter, weirs and notches, wet gas meter and dry gas meter, hot wire and hot film anemometers - Transportation of fluids, fluid moving machinery performance, selection and specification - Air lift and diaphragm pump, Positive displacement pumps, rotary pumps - Reciprocating pumps - Centrifugal pumps and characteristics.

Text Book(s):

1. M. White, Fluid Mechanics, 8th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Herriot, Unit Operations of Chemical Engineering, 7thEdition, McGraw-Hill International Edition2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
5. R.W.Fox, P.J.PritchardandA.T.McDonald, IntroductiontoFluidMechanics, 7th Edition, Wiley-India 2010.
6. Noel de Never - Fluid Mechanics for Chemical Engineers - McGraw-Hill -New York - International Edition - 2004 (3rd edition,)

Reference(s):

1. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India2010.
2. R. L. Panton, Incompressible Flow, 3rd Edition, Wiley-India2005.
3. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley-India 2002.
4. CoulsonJ.M.,RichardsonJ.F.,BuckhurstJ.R.andHackerJ.M.,CoulsonandRichardson's ChemicalEngineering - VolumeI - Butterworth Heinemann - Oxford -2002(5thEdition)

List of experiments

1. Experiment to determine pipefriction
2. Experiment to determine friction for flow in helicalcoil
3. Experiment to determine friction for flow in anannulus
4. Flow through fittings/valves
5. Flow through non-circular conduits.
6. Calibration of rotameter
7. Determination of coefficient of discharge of an orificemeter
8. Determination of coefficient of discharge venturimete
9. Flow through open orifice/weirs andnotches
10. Performance curves for a centrifugalpump
11. Performance curves for a Reciprocatingpump
12. Experiment to determine friction in PackedBe
13. Determination of minimum fluidization velocity in a fluidizedbed

CHE18R274 Heat Transfer	L	T	P	C
	3	0	2	4

Pre-requisite: Nil **Course Category:** Program Core

Course Type: Integrated course

Course Objective(s):

To understand the basic function of heat transfer through convection and conduction effort of an exchangers.

Course Outcomes(s):

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

CO1: Recognize and work out conduction effort

CO2: Recognize and work out convection effort

CO3: Recognize and work out radiation effort

CO4: Recognize and work out in heat transfer with phase change

CO5: Recognize and work out in Heat Exchanger without phase change

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	L	M									
CO2	H	H	L	H	M							L
CO3	H	H	L	H	M						L	
CO4	H	H	L	H	M							
CO5		L	L		H				H	M	M	

UNIT1: Conduction **12Hours**

Governing equation in Cartesian, cylindrical and spherical coordinates. 1-D steady state heat conduction with and without heat generation. Composite wall- electrical analogy – critical thickness of insulation – heat transfer from extended surface – effect of temperature on conductivity- 1-D transient analysis

UNIT 2: Convection **12Hours**

Review of basic equations of fluid flow – dimensional analysis- forced convection – laminar flow over flat plate and flow through pipes-flow across tube banks. Turbulent flow over flat plate and flow through pipes – free convection – heat transfer from vertical plate using integral method – empirical relations – types of heat exchangers – overall heat transfer coefficient – LMTD and NTU methods of analysis.

UNIT3: Radiation **12Hours**

Basic definitions – concept of black body – laws of black body radiation-radiation between black surfaces – radiation heat exchange between grey surfaces – radiation shielding – shape factor- electrical network analogy in thermal radiation systems.

UNIT 4: Heat transfer with phase change: **12Hours**

Boiling of liquids, Pool boiling curve, different types of pool boiling, condensation of vapor. Film wise & drop wise condensation.

UNIT 5: Heat exchanger Without Phase Change: **12Hours**

Design of heat transfer equipment - double pipe heat exchanger, concept of LMTD, DPHE sizing; shell

and tube heat exchanger - Kern's method for design, effectiveness-NTU method, construction aspects in brief, Bell Delaware Method, Design aspects of finned tube and other compact heat exchangers.

Total: 60 Hours

Text Book(s):

1. Holman,J.P - Heat Transfer - McGraw Hill - Singapore - 2002(9th Edition)
2. DonaldQ.Kern - ProcessHeatTransfer - TataMcGrawHill - New Delhi– 1997
3. Dutta, Binay K "Heat Transfer: Principles and Application" PHI Learning Pvt. Ltd., 01-Jan-2000.

Reference(s):

1. Incropera,F.P.,Dewitt,D.P.,Bergman,T.L.,Lavine,A.S - IntroductiontoHeatTransfer - JohnWiley and Sons – Singapore - -2006(10th Edition).
2. Bejan, A - Convective HeatTransfe - John Wileyand Sons - Singapore- 2005(4thEdition)
3. Kreith,F.AndBohn,M.S - Principles ofHeatTransfer - Brookes/Cole - California - 2001(7thEdition)
4. NecatiOzisik, M - HeatTransfer-Abasic Approac - McGrawHill - New York - 2002.

LISTOFEXPERIMENTS

1. Thermal Conductivity of metal rod
2. Thermal Conductivity of an insulating powder
3. Convective heat transfer-Forced and free convection
4. Transient heat conduction
5. Agitated vessel heat transfer
6. Heat TransferinJacketedKettle
7. Plate HeatExchanger
8. Double pipe HeatExchanger
9. ShellandTubeHeatexchanger
10. Verticaland HorizontalCondensers
11. Evaporator
12. RadiationHeatTransfer

CHE18R371Process Dynamics And Control	L	T	P	C
	3	0	2	4

Pre-requisite:MAT18R204–TransformsandpartialdifferentialEquation

Course Category: Program Core

Course Type: Integrated Course

Course Objective(s):

To understand the simulation process for an frequency system and come to know about the software related process.

CourseOutcomes(s):

At theend ofthe course, the studentwould be ableto

CO1: Analyze open-loopsystems

CO2: Analyze and applythe knowledge oflinearclosed loopsystems

CO3: Analyze the transient response of closed loop systems.
CO4: Developworking knowledgeofcontrolsystembyfrequencyresponse
CO5: Analyze Frequencyresponse andapplyitto advancedcontrol systems.

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2	M	L		M								
CO3		L	M									
CO4		L		H								
CO5		L					M					

Unit 1: Open Loop Systems **9 Hours**

Laplace Transforms- Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics

Unit 2: Closed Loop Systems **9 Hours**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, dead time.

Unit 3: Transient Response **9Hours**

Transient response of closed-loop control systems, Routh-Hurwitz and Root-locust ability of a control system

Unit 4: Frequency Response **9Hours**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, Principle of Nyquist diagram, stability criterion, tuning of controller settings

Unit 5: Advanced Control Systems **9 Hours**

Introduction to advanced control systems, cascade control, feed forward control, model predictive control, Control of distillation Column and heat exchanger. Adaptive controller, Supervisory controller and Ratio controller-Introduction to computer control systems.

Total: 45 Hours

Text Book(s):

1. Coughnowr,D.R& Le-Blanc - Process Systems Analysis and Control - McGraw Hill - New York - 1991(3rdEdition)

2. George Stephanopoulos - Chemical Process Control - Prentice-Hall of India Pvt-Ltd - New Delhi - 1990(3rdEdition)

3. Seborg, Edgar "Process Dynamics & Control" Prentice-Hall of India Pvt-Ltd - New Delhi

Reference(s):

1. Doeblin Ernest -Measurement Systems - Mc GrawHill - New York - 2005.

2. C.A.Smithand A.B.Corripiob - Principles and Practice of Automatic P roc ess Control - JohnWileyandSons - NewYork- 1997(2ndEdition)

3. Luyben,M.L. - Luyben,W.L - Essentials of Process Control - Mc Graw Hill - New York - 1997.
4. Eckman,D.P - Industrial Instrumentation - JohnWiley andSons - Singapore - 1990
5. Harriot,P - Process Control - Tata McGraw Hill - New Delhi - 1984

CHE18R372 Chemical Reaction Engineering	L	T	P	C
	3	0	2	4

Pre-requisite: **Course Category:** Program Core
Course Type: Integrated Course

Course Objective(s):

To understand the design concept of reactors and able to analyze the effect of temperature and pressure.

Course Outcomes(s):

At the end of the course the students would be able to
CO1: Explain the concepts of reactor design and reaction kinetics
CO2: Interpret reactor data
CO3: Identify ideal reactors and explain various aspects of design for single reactions
CO4: Explain various aspects of design for multiple reactions
CO 5: Analyze non ideal behavior of reactors with suitable models

Mapping of course outcomes:

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H			H					L	L		
CO2	H	H		H	M		L					L
CO3	H		H	H				M		L		L
CO4	H		H	H				M	M		L	
CO5	H		H	H				M			M	L

Unit 1: Reaction Kinetics **9 Hours**

Chemicalkinetics-Classificationofreactions,variablesaffectingrateofreaction,definitionofreactionrate-Kineticsofhomogeneousreactions-Concentrationdependanttermsofrateequation–Elementary and non-elementary reactions, kinetic view of equilibrium for elementary reactions-Molecularity and order ofreaction,representationofreactionrates-Testingkineticsmodels-Temperaturedependencyofrate-Rate of reaction predicted by theories

Unit 2: Interpretation of Reactor Data and Rate Equation **9Hours**

Interpretationsofreactordata-Constantvolumebatchreactor–Integralmethodsofanalysis- Autocatalytic reactions-First and second order reversible reactions- Differential method of analysis-Variable volume batch reactor-Temperature and reaction rate-Search for rate equation

Unit 3: Ideal Reactors **9 Hours**

Ideal Reactors -Reactor design, batch reactor, semi batch reactor, single ideal reactors-Performance equations for batch, plug, mixed reactor- Design for simple reactions - Size comparison of single reactors, general graphical comparison- Multiple reactor systems- Mixed flow reactor of different type in series-Reactors of different types in series-Recycle reactor-Autocatalytic reactions

Unit 4: Multiple Reactions **9 Hours**

Design of reactor for multiple reactions - Reaction in series and parallel-Qualitative and quantitative treatment about product distribution- Successive irreversible reactions of different orders-Semi-parallel

reactions, kinetics of series-parallel reactions

Unit 5: RTD Series **9 Hours**

Basics of non ideal flow- RTD in non ideal flow; non ideal flow models- Tank in series model and Axial Dispersion Model, conversion in non ideal reactors

Total :45 Hours

Text Book(s):

1. Levenspiel, O - ChemicalReaction Engineering - JohnWileyand Sons - New York - 1999(3rd Edition)

2. Froment G. F - Bischoff,K. B - ChemicalReactorAnalysisand Design - John Wileyand Sons - New York - 1999(3rd Edition)

3. Fogler, H. S - ElementsofChemicalReaction Engineering - Prentice HallofIndia – 2006(4thedition)

Reference(s):

1. Davis Mark, E., E - Davis Robert,J.J - FundamentalsofChemicalReactionEngineering - Mc Graw Hill - New York - 2003

2. Bruce, N - HandbookofChemicalReactorDesign Optimization and Scaleup - McGraw Hill - New York– 2002

CHE18R373 Process Equipment Design And Drawing	L	T	P	C
	3	0	2	4

Pre-requisite:CHE18R302Mass Transfer-II **Course Category:** ProgramCore

Course Type: Integrated course

Course Objective(s):

To understand the designing process and equipments of chemical Engineering and its applications in various aspects

Course Outcome(s):

At the end of the course, the student would be able to

CO1: Design pressure vessels

CO2: Design heat transfer equipments

CO3: Design mass transfer equipments

CO4: Design reactors

CO5: Design jacketed vessels

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M						M		L		
CO2	M			M			M					
CO3			M			M		L			M	
CO4				H					L			
CO5												M

UNIT 1:Pressure Vessels **12Hours**

Design of High Pressure Systems - Design of high pressure vessels (internal and external pressures) - Vessel accessories - Nozzles, flanges, openings and reinforcements and supports of vessels

UNIT 2: Heat Transfer Equipments **12Hours**

Process Design of Heat Exchangers - DPHE and types of heat exchanger - Shell and tube heat exchanger- Process design of evaporator, types of evaporator, methods of feeding evaporators Design of evaporator - Crystallizer design, types of crystallizer - Design of Crystallizer

UNIT 3: Mass Transfer Equipments **12Hours**

Design of mass transfer equipments - Distillation and absorption (plate and packed) - Extraction columns - Process Design of dryer, design of rotary dryer and cooling towers.

UNIT4: Design Of Reactors **12Hours**

Design of Reactors - Design and steady state operation of monolithic structures -Fixed bed - Fluidized bed- Gas liquid and slurry reactors

UNIT 5:JacketedVessels **12Hours**

Design of Process Equipments - Drawing of simple process equipments like jacketed reaction vessels and reboilers

Total: 60Hours

Text Book(s):

1.Walas, S. M - Process Equipment Selection and Design – Butterworths – London -1989

2.Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Sinott, Coulson andRichardson's Chemical Engineering, Volume VI - Butter worth Heinemann - Oxford – 2002(5thEdition)

Reference(s):

1.Perry, R. H - Chemical Engineers' Handbook - McGraw Hill - New York – 1998(7th Edition)

2.Timmerhaus, K. D., Peters, M. S., and West, R. E - Plant Design and Economics for Chemical Engineers - Mc Graw Hill, New York - 2002(5thEdition)

3. Rohsenow, W. M., Hartnett, J. P., Chou, Y. I - Handbook of Heat Transfer - Mc Graw Hill - New York - 1998(3rdEdition)

4. Douglas, J. M - Conceptual Design of Chemical Processes - Mc Graw Hill - New York -1988

	L	T	P	C
CHE18R301 Mass Transfer -I	**3**	**0**	**0**	**3**

Pre-requisite: Nil **Course Category**: ProgramCore

Course Type: Theory

Course Objective(s):

To understand the Calculation of Diffusion and the Phase Differences For a Liquid Solid Contraction.

CourseOutcomes(s):

At theend ofthe course thestudentswouldbe ableto

CO1: Understand and solve diffusionand diffusion related problems

CO2: Estimate mass transfercoefficientsforgas–liquid contactingsystems and know about various analogies

CO3:know and understand about theconceptsofdesigningtheabsorptioncolumn and the application of the same in numerical problems

CO4: Able to solve designproblems relatedto adsorption

CO5: To study about psychometric applydesign calculationsofcoolingtower

Mapping of course outcomes:

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H	M					L				L
CO2		H		H	M					L		
CO3		H	H	H	M		H		M		L	
CO4		H	H	H	M	M						
CO5		L	H	H	M							

UNIT 1: Diffusion **9 Hours**

Molecular and eddy diffusion in gases and liquids - Steady state diffusion under stagnant and laminar flowconditions-Diffusivitymeasurementandprediction-Multicomponentdiffusion- Diffusion in solids and its applications

UNIT 2: Mass transfer coefficients **9Hours**

Concept of mass transfer coefficients- Mass transfer under laminar and turbulent flow past solids- Boundary layers-Masstransferatfluidssurfacescorrelationofmasstransfercoefficients-jD –Theories of mass transferandtheirapplications-Interphasemasstransferandoverallmasstransfercoefficientsinbinary and multi-component systems-Application togas-liquid andliquid-liquid systems-Analogies in Mass Transfer, Reynolds, Chilton-Colburn-Prandtl,VonKarman Analogy.

UNIT 3: Design Calculation Of Distillation **9Hours**

Design calculations by McCabe-Thiele and Ponchon-Savarit-Methods; continuous contact distillation tower (packed tower) design –Extractive and azeotropic-Distillation low pressure distillation –Steam distillation

UNIT 4: Absorption **9Hours**

Equilibrium and operating line concept in absorption calculations -Types of contactors-Design of packed and plate type absorbers-Operating characteristics of stagewise and differential contactors, concepts of NTU-HTU and overall volumetric mass transfer coefficients-Multicomponent absorption, mechanism and model of absorption with chemical reaction -Thermal effects in absorption process

UNIT 5: Humidification **9Hours**

Basic concepts- psychrometric chart construction - Humidification and dehumidification operations, design calculations - Cooling towerprinciple andoperation,typesofequipment, design calculations

Total:45Hours

Textbook(s):

1. Treybal.R.E - MassTransferOperations - MG-GrawHillNewyork - 2011(3rdEdition)
2. Maddox, R., Hines, A - MassTransfer:Fundamentalsand Applications - PrenticeHall - New York - 1985

Reference(s):

1. Geankoplis,C.J - TransportProcessesandSeparationProcessPrinciples(IncludesUnitOperations) - Prentice HallofIndia - New Delhi- 2003(4thEdition)
2. RomanZarzytci - AndrzaiChacuk - Absorption:Fundamentalsand Application - Pergamon - Press - 1993
3. Strigle(jr),R.F - PackedTowerDesignandApplications - GulfPublishing - Company - USA– 1994(2ndEdition)
4. Wankat, P. C - Equilibriumstaged Separations - Prentice Hall - New York – 1989

CHE18R302 Mass Transfer-II	L	T	P	C
	3	0	0	3

Pre-requisite: CHE18R301 Mass Transfer -I **CourseCategory:** ProgramCore
Course Type: Theory

Course Objective(s):

To understand the basic principles of Mass transfer in various unit operations and process.

CourseOutcomes(s):

At theend ofthe course, the studentwouldbe ableto

CO1: Understand about the design procedure of distillation column and to estimate the numberof theoretical stages fordifferent types of distillation column

CO2: Able to understand and solve problems related to extraction, leaching and design of leaching equipments

CO3: Able to understand about the drying process design, drying equipments and solve problems related todrying

CO4: Understand about the crystallization process and the factors involved in Crystallization

CO5: Know and explainaboutmembrane separation operation

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H	H	H	M							
CO2		H		M	H				M			L
CO3		H		M	H					L		
CO4		H	H	H	M	H		L			L	
CO5		L	H	H	M		M					

UNIT1: Distillation **9 Hours**

Vapour-liquidequilibria-Raoult'slawanddeviationsfromideality- Methodsofdistillation- fractionationof binaryandmulticomponent system;

UNIT 2: Adsorption **9 Hours**

Theoriesofadsorption ofgases andliquids-Industrialadsorbents-Adsorptionequipment forbatchand continuousoperation-Design calculationofion-exchange resins, principle ofion-exchange,industrial equipment

UNIT3: Liquid liquid extraction andLeaching **9 Hours**

Equilibrium internary systems - Equilibrium stagewise contact calculati ons for batch and continuous extractors-Differentialcontactextractionequipment- Spray-packedandmechanicallyagitatedcontactorsand their design calculations - Pulsed extractors - centrifugal extractors - Solid-liquid equilibria; leaching equipment-Batch and continuous types;calculation ofnumberofstages

UNIT 4: Drying&Crystallization **9 Hours**

Theory andmechanismof drying -Drying characteristics of materials -Batch and continuous drying - Calculationforcontinuousdrying-Dryingequipment- Design and performance ofvariousdryingequipments Nuclei formation and crystal growth - Theory of crystallization -Growthcoefficientsandthefactors affecting these in crystallization - Batch and continuous industrial cr4y7stallizers - Principle of design of equipment

UNIT 5: Membrane Separation Processes **9 Hours**

Membraneseparationprocess-Solidandliquidmembranes-Conceptof osmosis- Reverse osmosis - Electrodialysis-theirapplications-Foamseparationprocess-Thermaland sweep diffusion process

Total: 45Hours

Text Book(s):

1. Treybal,R.E - MassTransferOperations - McGrawHill - New York - Recent print.(3rd Edition)
2. Maddox, R.Hines, A - MassTransfer: Fundamentals and Applications - Prentice Hall - New York - 2011.

Reference(s):

1. Geankoplis,C.J-TransportProcessesandSeparationProcessPrinciples(IncludesUnitOperations)-PrenticeHall of India - New Delhi - 2003(4th Edition)
2. Strigle(jr),R.F-PackedTowerDesignandApplications-GulfPublishing-Company-USA-1994(2nd Edition)
3. Wankat,P.C - SeparationProcessEngineering - PrenticeHall - New York - 2005
4. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M - CoulsonandRichardson'Chemical Engineering - Vol.IandII - Butterworth Heinemann - Oxford - 1999(6th Edition)
5. CharlesHolland - FundamentalsofMulticomponentDistillation - Mc Graw Hill - New York - 1997

CHE18R303 Numerical Methods for Chemical Engineers	**L**	**T**	**P**	**C**
	3	0	**2**	**4**

Pre-requisite:Nil **Course Category:** ProgramCore

Course Type: Theory with Practice

Course Outcome(s):

CO1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems

CO2: Apply numerical methods to obtain approximate solutions to mathematical problems

CO3: Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations

CO4: Analyze and evaluate the accuracy of common numerical methods

CO5:Develop Finite difference solution for one dimensional heat equation

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	H				M							
CO2	H		M		M				M			
CO3	H		M								L	
CO4	H									H		
CO5	M		M	H	H		M					H

UNIT 1: Solution of Equations and EigenValueProblems **12Hours**

Review of open end methods, bracketed end methods - The intermediate theorem (excluding proof) -Iterative method, False position method, Newton - Raphson method for single variable and for simultaneous equations with two variables - Solutions of a linear system by Gaussian, Gauss-Jordan, Jacobi and Gauss - Seidel methods - Eigen value of a matrix by Power Method

UNIT 2: Interpolation, Numerical DifferentiationandIntegration **12Hours**

Newton forward and backward difference formulae - Newton's divided difference formulae - Lagrange's polynomials - Numerical differentiation with interpolation polynomials - Numerical integration by Trapezoidal and Simpson's (both 1/3rd and 3/8th)rules

UNIT3: FiniteElementMethods **12Hours**

Line segment element - triangular element - rectangular element - quadrilateral element - tetrahedron element - hexahedron element - curved boundary element - Numerical integration over finite elements - Ritz finite element method - Least square finite element method - Galerkin finite element method - convergence analysis

UNIT4: **Initial Value Problems for OrdinaryDifferentialEquations** **12Hours**

Single step Methods - Taylor Series, Euler and Modified Euler, Runge - Kutta method of order four for first and second order differential equations - Multistep Method-Milne predictor and corrector method

UNIT5: **Boundary Value ProblemsforPDE** **12Hours**

Finite difference solution for the second order ordinary differential equations - Finite difference solution for one dimensional heat equation (both implicit and explicit), One-dimensional wave equation and two- dimensional Laplace and Poisson equation

TextBook(s):

1.Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.

Reference(s):

1.S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
2.R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
3. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
4.Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

CHE18R381 Mass Transfer Laboratory	**L**	**T**	**P**	**C**
	0	**0**	**3**	**2**

Co-requisite:CHE18R302-Mass Transfer-II **Course Category:** ProgramCore
Course Type: Lab

Course Objective(s)

To understand the performance relation by the contact of fluid flow across the system.

Course Outcomes(s)

At the end of the course, the student would be able to

CO1: Estimate Diffusivity

CO2: Perform Distillation Operations

CO3: Study Spray Column, Plate Column and Packed Column

CO4: Analyze Liquid-Liquid & Liquid-Solid operations

CO5: Apply simultaneous heat & mass transfer operations

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2		L		H								
CO3		L	M									
CO4		L		H								
CO5		L					M					

List of Experiments

1. Diffusivity measurement
2. Wetted wall column
3. Vapor Liquid Equilibria
4. Simple Distillation
5. Steam Distillation
6. Packed Column Distillation
7. Bubble Cap Distillation
8. Hold Up studies in Spray Column, Plate Column and Packed Column
9. Extraction single stage and Multi stage crosscurrent
10. Leaching single stage and Multi stage crosscurrent
11. Batch adsorption and adsorption equilibria
12. Surfaceevaporation
13. Drying curve in a Tray drier
14. Crystallization

CHE18R401 Transport Phenomena	L	T	P	C
	3	0	0	3

Pre-requisite:CHE18R272-Fluid Mechanics

Course Category: ProgramCore

Course Type: Theory

Course Objective(s)

To understand the properties of transport processes and to apply heat and momentum transfer analysis

CourseOutcome(s)

At theend ofthe course, the studentwouldbe ableto

CO1: Explainthepropertiesof transportprocesses

CO2: Analyze industrialproblemsalongwithappropriate boundaryconditions

CO3: Developsteadyand time dependentsolutionsalongwith theirlimitations

CO4: Applyheatand momentumtransferanalysis

CO5: Apply mass transfer analysis

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1					M							
CO2	H	M			H							
CO3					H							
CO4				H	M	M	M				M	M
CO5				H		M					M	

UNIT 1: Transport properties and Reynolds transport theorem **9 Hours**

Laminar Flow - Transport properties and mechanism - Rate process - flux -types of fluids – phenomenological laws- Rheology of non- Newtonian fluids- Flow through circular pipes- Mathematical foundation, types of timederivatives,divergenceoperators,controlvolume-Overallmass,energy and momentum balances-Extended Bernoulli's equation - Reynolds's transport equation - Mass balance with chemical reaction

UNIT 2: Equations of motion and boundarylayerTheory **9 Hours**

Equation of motion- E q u a t i o n of change based on differential balance Equation of continuity-Navier-Stokes equation, energy equation, application of Navier - Stokes equation to various flows through different geometric shapes, applications of energy equation- Potential, streamline, creeping and ideal flow

UNIT 3: Boundary Layer Theory **9 Hours**

Boundary Layer Theory - Flowaroundsubmergedsolids,flowpastflatplate-Boundarylayer-Prandtl equation - Expressions for viscous drag -Thermal boundary layer -Von Karman's integral momentum equation, analysis of integral equation, displacement thickness

UNIT 4: Turbulent Flow **9 Hours**

Turbulent Flow- Turbulent flow mechanism-Intensityofturbulence-Reynolds'sstress-Prandtlmixing length-Turbulent flow through circular pipes

UNIT 5: Heat and Mass Transfer Analysis **9 Hours**

HeatTransferAnalysis-Analogiesoftransferprocesses,profilesofgradients,Reynolds's-Prandtl,Von-Karman,Chilton-Colburnanalogies,j factors, Dittus- Boelter's equation. Mass Transfer Analysis-Review of classical mass transfer problems- Mass transfer in binary systems without chemical reactions-Theories of interphase mass transfer-Mass transfer analogie

Total: 45 Hours

Text Book(s):

1.Bird,R.B.,Stewart,A.,andLightfoot,E.N - TransportPhenomena - John Wiley andSons - Singapore-2007(Revised 2nd Edition)

2.Brodkey,R.S.,andHershey,H.C - TransportPhenomena-AUnifiedApproach - McGrawHill - NewYork - 1988

Reference(s):

1.C.J.Geankopolis - TransportProcessesinChemicalOperations- PrenticeHallofIndia,NewDelhi - 1996(3rdEdition)

2. Deen, W.M - AnalysisofTransport Phenomena - Oxford UniversityPress - New York - 1998

3. JamesR.Welty,CharlesE.Wicks andRobertE.Wilson - Fundamentalsofmomentum,heat andmass transfer - JohnWileyand sons - Singapore - 2001(4th Edition)

MAJOR ELECTIVES

CHE18R304 Heterogeneous Catalysis	L	T	P	C
	3	0	0	3

Pre-requisite: -Nil

Course Category: Program Core
Course Type: Theory

Course Outcome(s):

At the end of the course, the student would be able to

CO1: Explain the fundamentals of reaction mechanism & kinetics

CO2: Apply the perception of non catalytic fluid-solid reactions

CO3: Analyze the mechanism of non catalyticgas-liquid reactions

CO4: Design reactors for solid catalyzed reactions

CO5: Apply the kinetics of multiphase reactions

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	M		M								
CO2		H		H								
CO3			H	H				M				
CO4			H	H				M				
CO5					M							

UNIT 1:Transport Processes In Heterogeneous Catalysis **9 Hours**

Transport processes in heterogeneous catalysis - Interfacial gradient effects, reaction at a catalyst surface, concentration and temperature differences across the external - Film of a catalyst pellet, mass transfer on metallic surfaces - Intraparticle gradient effects - Catalyst internal structure – Pore diffusion, reaction and diffusion within a catalyst pellet - Effectiveness factor and generalized effectiveness factor, Temperature gradients within a catalyst pellet - Weisz-Prater criteria, combined interfacial and intra particle resistances

UNIT 2:Non-CatalyticFluid-SolidReactions **9 Hours**

Non-catalytic fluid-solid reactions - Total particle dissolution - Shrinking core model, reactor design- Fluidized bed reactors, fluidization principles, key applications - Two and three phase models, transport reactor design - Catalyst deactivation functions

UNIT 3:Non-CatalyticGas-LiquidReactions **9 Hours**

Absorption combined with chemical reactions - Mass transfer coefficients and kinetic constants - Application of two film and surface renewal theories - Hatta number - Enhancement number for first order reactions

UNIT 4:Fixed Bed Catalytic Reactor Design **9 Hours**

Pseudo-homogeneous PFR and axially dispersed PFR models - Heterogeneous models - Use of effectiveness factor - Use of intraparticle diffusion equations - Two dimensional models

UNIT 5:Multiphase Reactors **9 Hours**

Two-film theory, Hatta number - General design models, simplifications to design models, instantaneous, fast and slow reactions, solid catalyzed reactions, resistances in series chemical engineering and chemical technology approximation - Selection of gas-liquid contactors

Text Book(s)

1.Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry,2001.

Reference(s)

1. Elements of Chemical Reaction Engineering, Foggler H. S., Prentice Hall, 2001

2.Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, De Wilde, John Wiley & Sons, Incorporated,2010

CHE18R305: Process Modeling And Simulation	L	T	P	C
	3	0	0	3

Pre-requisite:CHE18R203-Chemical Engineering Thermodynamics

Course Category: Professional Core

Course Type: Theory

Course Objective(s):

To understand the working and design knowledge of an closed loop systems.

Course Outcomes(s)

At the end of the course, the student would be able to

CO1: Understand the concept of modeling & simulation

CO2: Analyze the steady state degree of freedom

CO3:Apply and solve unsteady state equations

CO4:Analyze the flow of boundary value problems

CO5:Analyze the lamina flow in partial differencial equation

Mapping of CourseOutcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2	M	L		M				H			L	
CO3		L	M						M			
CO4		L		H							M	
CO5		L					M					

UNIT 1:Introduction **4 Hours**

Introduction to modeling and simulation, classification of mathematical models, conservationequations and auxiliaryrelations.

UNIT 2: Steady State Lumped Systems **9 Hours**

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT 3: Unsteady State Lumped Systems **9 Hours**

Characteristics for through pipe analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations,

simulation of closed loop systems.

UNIT 4: Steady State Distributed System **6 Hours**

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary valueproblems.

UNIT 5: Unsteady State Distributed System **12 Hours**

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations.

Other Modeling Approaches **5Hours**

Empirical modeling, parameter estimation, population balance and stochastic modeling.

Total :45 Hours

Textbook(s):

1. Ramirez, W - Computational Methods in ProcessSimulation - Butterworths - New York – 2000(2ndEdn).

Reference(s):

Luyben, W.L - Process Modelling Simulation and Control - McGraw-Hill Book Co - 1990.

Felder, R. M. and Rousseau, R. W - Elementary Principles of Chemical Processes - John Wiley -2005

CHE18R306	**Interfacial Science AndEngineering**	L	T	P	C
		3	0	0	3

Pre- requisite:Nil **Course Category:-** Professional Core

Course Type:-Theory Course

Course Objective(s)

The objective of studying this course is to understand about what is colloid and colloidal state. It discusses about the preparation and properties of colloids. This chapter also discusses about the concepts in colloid and interfacial science, experimental techniques used to determine colloidal properties and interfacial phenomena. In overall this course highlight about the colloidal system in chemical engineering curriculum

Course Outcome(s):

At the end of the course, students would be able to

CO1: Describe the colloidal state, including colloids and their preparation and properties.

CO2: Ability to discuss the fundamental concepts in colloid and interface science

CO3: Understand the impact factors that will affect the colloidal systems

CO4: Discuss important factors on solid/liquid interactions

CO5: Explain experimental techniques and used to determine colloidal properties; interfacial phenomena

Mapping of Course Outcome (s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1			M							L		
CO2				L								
CO3		M	H			L						
CO4	H						M				L	
CO5							H					

UNIT I - Basic Concepts of ColloidsandInterfaces **9 Hours**

Introduction - Examples of Interfacial Phenomena - Solid-Fluid Interfaces - Colloids. Properties ofColloid Dispersion - Introduction-Sedimentation under Gravity - Sedimentation in a Centrifugal Field - Brownian Motion - Osmotic pressure - Optical properties - Electrical Properties - Rheological Properties of Colloid Dispersions.

UNIT II - Surfactants andTheirProperties **9 Hours**

Introduction - Surfactants and their Properties - Emulsions and Micro emulsion - foams. Surface and Interfacial Tension: Introduction - Surface tension - Interfacial Tension - Contact Angle and Wetting - Shape of the Surfaces and interfaces.

UNIT III - Surface and Interfacial Tension **9 Hours**

Measurement of Surface and Interfacial Tension - Measurement of Contact Angle- Intermolecular and Surface Forces - Introduction, Vander walls Forces - Intermolecular and Surface Forces - Electrostatic double layer force the DLVO theory - Non-DLVOforces.

UNIT IV – Adsorption at Interfaces **9Hours**

Introduction - The Gibbs Dividing surface - Gibbs Adsorption Equation - Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state (EOS) - Effect of Salt on Adsorption of Surfactants.

UNIT V – Adsorption at Isotherms **9 Hours**

Adsorption Isotherms incorporating the Electrostatic Effects - Calculation of Free energy of Adsorption - Adsorption of inorganic salts at interfaces - Dynamics of Adsorption of Surfactants at the interfaces - Adsorption at Solid - Fluid interfaces.

Total: 45 Hours

Text Book (s):

1. Pallab Ghosh, - Colloid and Interface Science - PHI - New Delhi,2012.
2. R. J. Hunter - Foundations of Colloid Science - Oxford University Press, USA - 2013(2nd Edition)

Reference Book (s):

1. Paul C.Hiemenz and Raj Rajagopalan - Principles of Colloid and Surface Chemistry- Revisedand Expanded, 1997(3rd Edition)
2. A. Adamson - Physical Chemistry of Sciences2013 (6thEdition)
3. G.Barnes, I. Gentle - Interfacial Science: An Introduction - Oxford University Press- USA-2012.

CHE18R307	Process Utilities And PipelineDesign	L	T	P	C
		3	0	0	3

Pre- requisite:-CHE18R373–Process Equipment Design and drawing

Course Category:-Professional core

Course Type:-Theory Course

Course Objective(s)

Process Utilitiesand Pipeline Design is a Chemical Engineering subject which discusses about the various facilities required to carry out the Unit Operation and Unit Processes in a process industry. This chapter highlights the transport of process liquids water, air for pneumatic control in a pipeline and other auxillaries like steam, process water, blowers and compressors.

Course Outcome(s)

After learning the course the students should be able to:

CO1: Learn about the overall knowledge about the process plant.

CO2: Understand the importance of process auxiliaries

CO3: Understand the significance of utilities in processindustries.

CO4: Learn the conceptual design of chemical processequipment.

CO5: Build a bridge between theoretical and practical concepts used for process auxiliaries and utilities in any process industry.

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	L										
CO2		H			M							
CO3					M		L					
CO4	H			H								
CO5	M		H		M							

UNIT 1: -Process Water **9Hours**

Process Water: Sources of water, hard and soft water, Requisites of industrial water and its uses, Methods of water treatment, Chemical softening, Demineralization, Resins used for water softening, Water for boiler use, cooling purposes, cooling towers, drinking and process water treatment, reuse and conservation of water, 27.50% water resources management, waste water treatment and disposal.

UNIT2:-Steam **9Hours**

Steam: Steam generation and its application in chemical process plants, distribution and utilization, boilers, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization

UNIT 3: -Pipeline Design **9Hours**

Piping design: Selection of material, pipe sizes, working pressure, Basic principles of piping design, piping drawings, pipe installations, overhead installations, Process steam piping, selection and determination of steam – pipe size, Piping insulation, application of piping insulation, weather proof and fire resisting pipe insulation jackets, piping fittings, pipe joints.

.UNIT4: Compressors and Vacuum Pumps **9 Hours**

Compressors and Vacuum Pumps: Types of compressors and vacuum pumps and their performance characteristics, Methods of vacuum development and their limitations, materials handling undervacuum, lubrication and oil removal in compressors and pumps, instrumentair.

UNIT 5: - Process Control **9Hours**

Process control and instrumentation diagram, control system design for process auxiliaries, Refrigeration and Chilling systems Oil heating systems, Nitrogen systems- Valves: Types of valves, selection criteria of valves for various systems.

Textbook (s):

1. M.S. Peters and Timmerhaus - Plant design and Economics for Chemical Engineers", Mc Graw Hill (3rdedition)
2. F.C. Vibrandt and C.E. Dryden - Chemical Engineering Plant Design - McGraw Hill,(5th Edition)

Reference (s) :

1. Roger Hunt and Ed Bausbacher, "Process Plant layout and Piping Design" PTRPrentice-Hall Inc.,
2. Jack Broughton; Process utility systems; Institution of Chem. Engineers,U.K.

CHE18R308 Boundary Layer Theory	L	T	P	C
	3	0	0	3

Pre- requisite:-CHE18R272FluidMechanics **Course Category:** Professional Core

CourseType : TheoryCourse

Course objective(s):

The objective of the course is to apply the basic laws of fluid flow in process condition, boundary layer equations, the different of flow of fluids using Reynolds number, momentum integral equation and heat transfer in boundary layers.

Course outcome(s) :

At the end of the course, the students would be able to

CO1: Apply the basic laws of fluid flow

CO2: Analyze boundary layer equations

CO3: Differentiate laminar and turbulent flows

CO4: Apply momentum integral equation

CO5: Explain heat transfer in boundary layers

Mapping of Course Outcome (s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H			L								
CO2		H										
CO3			H									
CO4			M								M	
CO5		L		H								M

UNIT 1: Basic laws ofFluidFlow **9Hours**

Basic laws of fluid flow - Continuity, momentum and energy equations applied to system and control volume - Concepts of flow fields - Flow around bodies - Moment of momentum theorem and its application to fixed and moving vanes - Hot wire and laser Doppler anemometry

UNIT 2: - Development ofBoundary Layer **9 Hours**

Development ofboundarylayer- Estimation of boundary layer thickness, Displacement thickness, Momentum and energy thicknesses for twodimensionalflow- Discussion of Navier Stokes equations - Two dimensional boundary layer equations - Blasiussolution.

UNIT 3:- Laminar andTurbulent Flows **9 Hours**

Laminar and turbulent flows on a flat plate - Laminar and turbulent boundary layers - Transition from laminar to turbulent boundarylayers

UNIT 4: - MomentumIntegralEquation **9 Hours**

Momentum Integral Equation for boundary layer flow - Introduction to ax symmetric and three dimensional boundary layer equations - Von Karman -Polhausenmethod

UNIT 5: Introduction To Heat Transfer InBoundaryLayers **9Hours**

Introduction to heat transfer in boundary layers - Thermal boundary layer - Turbulent boundary layer on a flat plate - Flows in pressure gradient - Boundarylayercontrol

TextBook(s):

1.Panton, Ronald L -Incompressible Flow - John Wiley and Sons – Singapore 2013 (4th Edition)

2. Anderson, D - Fundamentalsof Aerodynamics - McGraw Hill Science - New York, 2005. (4th Edition)

Reference (s):

1. Tuncer Cebeci, Peter Bradshaw- Momentum transfer in boundary layers - Hemisphere Publishing Corporation – Washington-1977.

2. Herrmann Schlichting - Boundary Layer Theory - Springer, 2004(8thEdition)

CHE18R309 Nanoscience And Technology	L	T	P	C
	3	0	0	3
Pre- requisite:Nil	**Course Category:-**Professional Core			
	Course Type:- Theory Course			

Course Objective (s):

The objective of the course is to understand about the nanomaterials, nanodevices and nanostructure characteristics identify about the electron microscopic techniques, the mechanism of mesoscopic magnetism, application of nanotechnology in nanoelectronics, biomolecular motiors and drug delivery nanodevice.

Course outcome (s) :

At the end of the course, the students would be able to

CO1: Explain the characteristics of nanomaterials, nanodevicesandnanostructures

CO2: Identify various Electron MicroscopyTechniques

CO3: Describe the mechanism of Mesoscopic magnetism

CO4: Elucidate the applications of nanotechnology in nanoelectronics

CO5: Suggest a suitable Bio molecular motors & drug delivery nanodevice

Mapping of Course Outcome (s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1					M			M				
CO2					M	H			L			
CO3		L			M	H						
CO4		M	M	M	H						M	
CO5	L	M		M	H			M				

UNIT 1: Nanomaterials **9Hours**

Nanomaterials - Types, nanowires, nanotubes, fullerenes, quantum dots, dendrimers, Nanocomposites - Properties - Methods of preparation -Top down, bottom up.

UNIT2: ElectronMicroscopyTechniques **9 Hours**

Electron Microscopy Techniques - SEM, TEM, X-ray methods - Optical Methods Fluorescence Microscopy - Single molecule Surface Enhanced Resonance Raman Spectroscopy - Atomic Force Microscopy, MRI, STM andSPM

UNIT3:Mesoscopic Magnetism **9Hours**

Mesoscopic magnetism - Magnetic measurements miniature hall detectors, Integrated DC SQUID Microsusceptometry - Magnetic recording technology - Biological Magnets

UNIT4: BasicsofNanoelectronics **9 Hours**

Basics ofnanoelectronics - Single Electron Transistor , Quantum Computation - Parallelarchitecture for nanosystems - Nanolithography, basic structures and integrated structures - MEMSandNEMS - Dynamics of NEMS - Limits of integratedelectronics.

UNIT 5: BioMolecularMotors **9 Hours**

Biological structures and functions - Biomolecular motors, drug delivery systems - Nan fluidics

Text Book (s):

1. Steed, J. W - Supramolecular Chemistry - Wiley, New York, 2009. (2nd edition)
2. Israelachvilim, J.N - Intermolecular and Surface Forces with applications to Colloidal and Biological systems (Colloid Science), Academic Press, London, ,1992
3. Katsuhiko Ariga. - Supramolecular Chemistry, Fundamentals and Applications Advanced Textbook, Springer, London, 2006. (1st Edition)

Reference (s) :

1. Rowlinson, J.S - A Scientific History of Intermolecular Forces - Cambridge University - U.S.A2002
2. Jean,MarieLehn - Supramolecu lar C he mistr y Co ncept s and Perspectives – Wiley - Singapore, 1995

CHE18R310 Green Technology	L	T	P	C
	3	0	0	3

Pre-requisite:Nil **Course Category:** Professional core

Course Type: Theory

Course objective(s):

This course gives an exposure to Green Technology concepts and evolution; to understand the concepts of CSR and CER ;The students can learn the environmental acts and its applications.

Course outcome(s):

CO1: The Student can learn Green Technology concepts and relevance in Twenty First Century requirements.

CO2: The knowledge of how to go Green in organization and sustainability issues.

CO3: Ability to know the ecosystem balance

CO4: Ability to know about ISO 14001 and ISO 14064

CO5: Understand about finance aspects of green technology

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1		H			H							
CO2							L					
CO3	L		M					H				
CO4					H							
CO5		H										

UNIT1:Introduction **9Hours**

The concept of green Technology; evolution; nature, scope, importance and types; developing a theory; green Technology in India; relevance in twenty first century.

UNIT2: Sustainability&Environment **9Hours**

Organizational environment; internal and external environment; Indian corporate structure and environment; how to go green; spreading the concept in organization; Environmental and sustainability issues for the production of high-techcomponents and materials, life cycle analysis of materials, sustainable production and its role in corporate social responsibility (CSR) and corporate environmental responsibility(CER).

UNIT3:EcosystemApproaches **9Hours**

Approaches from ecological economics; indicators of sustainability; ecosystem services and their sustainable use; bio-diversity; Indian perspective; alternate theories.

UNIT 4: Acts ofGreenTechnology **9 Hours**

Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy Technology; green product Technology.

UNIT5:GreenEconomics **9Hours**

Definition; green techniques and methods; green tax incentives and rebates (to green projectsand companies); green project Technology in action; business redesign; eco-commercemodels.

Text Book(s)

1. Jazmin Seijas Nogarida-Green Technology and Green Technologies:Exploring the Causal Relationship -2008(3rd edition).

1. John F. Whaik -Green Marketing and Technology: A global Perspective- 2005(3rd edition)..

Reference(s)

1.Leo A. Meyer - The Green Energy Technology Book- 2007(4thedition).

2.Richard Maltzman And David Shiden - Green Project Technology – 2006 (3rdedition).

CHE18R311 Petroleum Refinery Engineering	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite:Nil	**Course Category:** Professional core **Course Type**: Theory			

Course objective(s):

To acquire basic knowledge in separation of products from crude and its various applications as fuel in major engineering sectors.

Course outcome(s):

At the end of the course, the students would be able to

CO1: Explain Petroleum refining and thermal cracking processes

CO2: Detail Catalytic cracking and catalytic reforming processes

CO3: Produce fuels such as aviation gasoline, motor fuel, kerosene, jet fuel

CO4: Manufacture lubricating oil

CO5: Store and transport petroleum products

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1			H		H				L			
CO2												
CO3	L		M									
CO4					H							
CO5		H										

UNIT1: Introduction **9Hours**

Introduction- Origin, occurrence of petroleum, elementary ideas of gasand liquidreservoirs

-Petroleum refining processes- General processing, topping and vacuum distillations - Thermal cracking in vapor, liquid and mixed phase - Thermal reforming and polyforming

UNIT 2:Catalyticcracking **9Hours**

Catalytic cracking- Fixed bed, fluidized bed, T.C.C - Houder flow etc - Catalytic reforming - Conversion of petroleum gases into motor fuel with special reference to alkylation polymerization, hydrogenation and dehydrogenation - Blending of petroleum products

UNIT 3: Production ofvariousfuels **9Hours**

Production - Aviation gasoline, motor fuel, kerosene, diesel oil, tractor fuel and jet fuel, hydrodesulphurization

UNIT 4:Lubricating oil **9Hours**

Lubricating oil manufacture - Vacuum distillation, solvent extraction and uses of lubricating oil- Petroleum waxes and asphalts - Elementary study of multi component distillation as applied to petroleumindustry

UNIT 5: Storage and transportation ofpetroleumproducts **9Hours**

Octane number, Cetane number, Diesel index, their determination and importance - Storage of petroleum products tanks, bullets, special types of spheres etc - Transportation of petroleum products road, rail, sea and pipeline - Importance of pipelinetransportation

Text Book(s):

1.Meyers, R.A-Handbook ofPetroleumRefiningProcesses-McGraw-Hill,New York-2013(6th Edition,)

2.BhaskaraRao,B,K.-ModernPetroleumRefiningProcess-OxfordandIBH,New Delhi,-, 2015(7thEdition)

Reference(s):

1 Hobson, G, D and Pohl, W- Modem Petroleum Technology-Gulf Publishers-2007(6th Edition)

2.Nelson, W.L- Petroleum Refinery Engineering- McGraw Hill, New York,- 2013(6th Edtion)

CHE18R402-ProcessInstrumentation	L	T	P	C
	3	0	0	3

Pre- requisite: Nil **Course Category:-**Professional core

Course Type:- Theory Course

Course Objective (s):

In process industry we need to measure the various parameters like pressure, temperature, flow, level etc in a closed place where the process fluids are present in the industry. For this purpose we need study about the instruments used to measure these parameters. This chapter discusses about the response of instruments and the knowledge about measurement of these parameters.

Course Outcome (s):

At the end of the course, students would be able to

CO1: Analyse the response of instruments.

CO2: Ability to integrate knowledge about the instrument used for Temperature.

CO3: Ability to assimilate the facts about instruments used for pressure.

CO4: Analyze the different flow of fluids based on its Concentration.

CO5: Evaluate the supporting process and its effects

Mapping of Course Outcome (s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1				M				L				
CO2		L		M	H							
CO3				M	H							
CO4	H						L					
CO5		M		L								

UNIT1: PrinciplesofMeasurement **9Hours**

Analysis: Measurement ofForce,StrainandTorque- Use of strain gauges. Transducers - Resistive, capacitive, Inductive and piezoelectric pickups. Staticand Dynamic response of Instruments. Errors inmeasurements.

UNIT 2:TemperatureMeasurement **9Hours**

Liquid filled, Gas filled and Vapour pressure Thermometers. Bimetallic and Resistance thermo meters. Thermocouples and Thermistors. Optical and Radiation pyrometers.

UNIT3:PressureMeasurement **9Hours**

Manometers, Bourdon gauge and Bellows gauge. Measurement of pressure and Vacuum. Use of Transducers

UNIT4: Flow, Density andLevelMeasurements **9Hours**

Variable he a d flo w met er s.Area flo w me t e r s . Positive d is p la c e me nt me t e r s . Pressure P ro be s . Level measurements - Direct and Inertial types. Measurement of density and specific gravity. Instruments for weighing and feeding.

UNIT5: MiscellaneousMeasurements **9 Hours**

Analysis of gas mixtures. Thermal conductivity, Viscosity and Electrical conductivity. Supporting instrumentation - Standard cells,Gas Sensors, PH Measurement, Principles of Telemetering. P and Idiagram.

Text Books (s) :

1. Eckman, D.P, Industrial Instrumentation, Wiley Easte6r2n, New Delhi,2006.
2. Jain, R.K, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi, 2011(9th Edition)

Reference Book (s):

1. Perry,R.H.,Green,D.W-Perry'sChemicalEngineer'sHandbook,,McGrawHill(ISE),2007(8th Edition)
2.Considine, D.N., Process Instruments and Controls Handbook, McGraw Hill. New York, 1997. (5th Edition)
3.Benedict,R.P,Fundamentalsoftemperature,PressureandFlowmeasurements,,JohnWiley,New York. 1984 (3rdEdition)
4.Notlingk. B.E., Jones' Instrument Technology, Vol. I and II, ELBS, 1987. (4thEdition)
5.Patranabis. D., Principles of Instrumentation, ,Tata-McGraw Hill, New Delhi, 2007. (2ndEdition)

CHE18R403 Colloids And SurfaceScience	L	T	P	C
	3	0	0	3
Pre-requisite:Nil	**Course Category:-** Professional core **Course Type:-**Theory Course			

Course Outcome(s):

At the end of the course, students would be able to

CO1: To provide the basic forces and Theories in collision

CO2: To analyze the role of Surface Chemical Models

CO3: To understand the role of Electric double coating hypothesis.

CO4: To Analyse the Stabilization of particles with non-ionic polymers and interpolate with models.

CO5: To Understand the dispersing power of polyelectrolyte and its activity.

Mapping of Course Outcome (s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12
CO1	H											
CO2	M				M							
CO3			H	M								
CO4				H								
CO5				M	M							

UNIT 1:Introduction **9Hours**

Hamaker's analysis for interparticle attractive forces, Experiments verifying van der Waals interactions between surfaces, Lifshitz macroscopic theory for the Hamaker constant, Parsegian, Ninham's approximation to Lifshitz theory, Casimir and Polder's correction for relaxation effects, Example calculations of Hamaker constants for several specific metal, polymer, and ceramic systems, the influence of other types of interparticle forces

UNIT2:Hierarchy Of SurfaceChemicalModels **9 Hours**

The hierarchy of surface chemical models for surface charging - Monoprotic surface charging systems Lattices and Organic acids, Metallic and Non,oxide Systems - The role of surface oxygen in dictating surface charge for metal and non-oxide ceramicsystems

UNIT 3:ElectricDoubleLayer **9Hours**

The isolated electric double layer - Overlap of the double $^{6}1^{3}$ayer for interacting particles, free NRGs of isolated and interacting double layers, Repulsive NRG due to overlapping double layers - Derjaguin approximation for the interaction of spherical particles - Concept of the critical

coagulation concentration, Influence of salt concentration, ionic strength, and ionic size - Influence of surface charge for monoprotic surface charge systems - The role of surface charging in the dispersion of solids in non,aqueoussystems

UNIT4:Stabilization Of Particles With Non-IonicPolymers **9Hours**

Criteria for stabilization of particles with non,ionic polymers - The role of polymer solubility in stabilization-The role of co, and ter, polymers in providing stabilization reconciling surface attachment with polymer extension from the surface, the impenetrable barrier model for polymeric stabilization - The compression model by Bagchi for polymeric dispersion, the interpenetration and compression model for polymericdispersion,OtherassumptionswithrespecttotherelativecontributionoftheHamakerconstant toward stabilization with polymers - Selection criteria for polymeric dispersants for specific types of material systems, Polymeric dispersion of nanometer size particles

UNIT5:FeaturesOfPolyelectrolyte **9Hours**

Features of polyelectrolyte that contribute to their dispersing power - pKa, molecular size and distribution, type of polymer - Criteria for polyelectrolyte adsorption to charged surfaces - The role of pKa - Monitoring adsorption via solution depletion, EM scattering, and zeta potential measurements, polyelectrolyte conformation at charged surfaces - Thecombinedelectrostaticand impenetrable barriermodel for dispersion of particles with polyelectrolytes - Some other concepts regarding "nonionic" dispersants in aqueous systems, interaction of polyelectrolytes with ionic species in solution

TextBook(s):

1.Hiemenz, P.C, Raj Rajagopalan., Principles of Colloids and Surface Chemistry, MarcelDekker, New York,1997

2.De Keizer, Johannes Lyklema, Hans Lyklema., Fundamentals of Interface and Colloid Science,Elsevier, New Delhi,1995

Reference(s):

1.Milling,A.J.,Surface CharacterizationMethods, Principles, Techniques and Applications,(Surfactant Science Series- V, 87) , CRC, New York1999

CHE18R404 Multiphase Flow	L	T	P	C
	3	0	0	3
Pre-requisite:-CHE18R272-Fluid Mechanics	**Course Category:-** Professional core **Course Type:-**Theory Course			

Course Outcome(s)

At the end of the course, students would be able to

CO1: To Provide general introduction to the theory of multiphase flow

CO2: To understand the dynamics of two phase flow

CO3: To Analyze the problems involved in multiphase flow dynamics.

CO4: Reinforce knowledge through practice with realistic problems

CO5: To provide the design, and develop the software programme in multiphase flow

Mapping of Course Outcome (s):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12
CO1	H	M	M	M	M							
CO2	M	H		M								
CO3	M	H	H	M								
CO4		M	M								M	
CO5				H	H							M

UNIT1:Fluid-SolidSystems **9Hours**

Fluid-Solid systems - Mobile and stagnant solids, Flow through porous media, Capillary Tube model, Application for flow through packed bed, filters, fluidized beds, Solid-Fluid Convening, Settling and Sedimentation, Fluid-Fluid systems - Flow patterns and flow regimes - Analysis of annular, stratified and bubble flow - Formation of bubbles and drops - Their size distribution and volumedistribution

UNIT2:Two –PhaseFlow **9Hours**

Two-phase cocurrent flow of gas liquid, Gas/Solid and Liquid/Liquid, Upward and Downward Flow in vertical pipes - Suspensions of sand, gravel coal etc., and their transport in horizontal Pipes - Drag reduction phenomena, Laminar, Turbulent, Creeping flow regimes - Suspension Rheology - Residence Time Distribution studies, Deterministic and stochastic flow system Models for chemical reactors, Prevention of circulatory flow - Role of draft tubes and wall baffles, Diffusion model and bubbling bed model for gas interchange and gas mixing - Axial mixingcorrelations

UNIT3:Theories Of Intensity And ScaleOfTurbulence **9 Hours**

Theories of intensity and scale of turbulence - Calculation of circulationvelocitiesandpower consumption in agitated vessels for Newtonian/ Non Newtonian fluids - Blending and Mixing of phases - Power required for aeration to suspend to an immiscible liquid or solids in Slurry reactors - Segregation phenomena - Prediction of optimum speed of impeller rotor and Design criteria for scale up

UNIT4:Bubble Size inPipeFlow **9Hours**

Prediction of holdup and pressure drop of volume fraction, Bubble size in pipe flow, Lockhart - Martinelli parameters - Bubble Column and its Design aspects - Minimum carryover velocity, Holdup ratios, Pressure drop and transport velocities and theirprediction

UNIT5 :Flow through Porous Media ofCompositeMixtures **9Hours**

Gas, Solid and Liquid composite slurries in horizontal and vertical pipes - Flow through Porous media of composite mixtures - Prediction of holdup, pressure drop and through put Velocities in 3 - Phase system -Designof multiphase contactors involvingfluidization,prevaporation, lyophilisation and permeation for solids, liquids and gases - Design and Development of Software programmes in multiphase flow - Simulation in packed and fluidized beds and Stirred tank process equipment - Selection of equipment for gaseous, particulate and liquid effluents of various industries such as scrubbers, Stacks and Chimneys, Absorbers, Combustion devices, Electrostatic precipitators and filtration / reverse osmosisdevices

Text Book(s):

1.Brodkey, R.S., The Phenomena Of Fluid Motion, Mc Graw Hill, New York,2004

2.Schlichting, H., Boundary layer theory, Springer Verlag, London, 8th revised edition,2006

Reference(s):

1.GadHestsroni.,HandbookofMultiphase systems, Hemispherepublishing Corporation, Washington,1982

2.Govier, G.W ,Aziz, K., The Flow of complex Mixture in Pipes , Van Nostrand Reinhold Co, New York,1972Wallis, G.B., One Dimensional Two Phase Flow, McGraw Hill Book Co, New York,1969

CHE18R405 Computer Aided Process Plant Design	L	T	P	C
	3	0	0	3

Pre-requisite:-CHE18R373-Process Equipment Design and drawing

Course Category:-Professional core

Course Type:-Theory Course

Course outcome(s):

At The End of the Course, The Students Would Be Able To

CO1: Evaluatetransportpropertiesandthermodynamic Properties

CO2: Develop Basic Model for Chemical Engineering Operations

CO3: Develop CAD Model for Fluid Moving Machinery

CO4: Develop CAD Model for Heat Transfer Equipment

CO5: Develop CAD Model for Mass Transfer Equipment

CO/PO	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12
CO1	M	M										
CO2				H	M							
CO3			M	H	M							
CO4			M	H	M							
CO5			M	H	M							

UNIT 1:Introduction AndPropertiesEvaluation 9Hours

Introduction And Properties Evaluation - Spread sheeting, hierarchy ofprocess design and the Onion model Flow sheeting, typical unit of CAD system - Process Synthesis - Physical properties evaluation- Transport properties and thermodynamic properties of gases and binary mixtures

UNIT 2: BasicModelDevelopment 9Hours

Basic model development for preliminary systems , methods of calculating vapour liquid equilibrium data for ideal and non ideal mixtures, bubble point and dew point, flash and distillation calculations, equipment design, development of software progammes for the following systems, piping system- Single phase and twophases

UNIT3: FluidMovingMachinery 9Hours

Cad Model for fluid moving machinery and storage design - Separator system - Two phase and three phase - Storage system - Atmospheric, pressurizedcryogenics

UNIT 4: HeatTransferEquipment **9Hours**

CAD model for heat transfer equipment design - Double Pipe, Shell and tube heat exchanger - PHE - Air cooler - Heat integration ofevaporators

UNIT5: MassTransferEquipment **9Hours**

Cad Model for mass transfer equipment and safety devices design - Binary mixtures - Pseudo binary, multistage distillation system - Heat integration of distillation columns - Absorber and strippers - Liquid Liquid extractor - Safety devices-pressure safety valve and flare system

Text Book(s):

1. Bhattacharyya, B.C, Narayanan, C.M., Computer aided design of Chemical Process Equipment,New Central Book Agency (P) LTD, New Delhi, 1st Edition ,1992

2.Robin Smith, Chemical Process Design, McGraw Hill Inc, New York,1995

Reference(s):

1.Hussein, A., Chemical Process Simulation, Wiley, Singapore,1986

2.Coker, A.K., FORTRAN programme for chemical process design, analysis and Simulation,Gulf Publishing Co,1995

3.Mc Gee Y.A, Robert E Peerly, W., Recent developments in chemical process and plant design, John Wiley, NewYork,1987.

4.Lesley, M. L., Computer Aided Process Plant Design,1982

5.Douglas, J.M., Conceptual Design of Chemical Processes, McGraw Hill, New York,1981

CHE18R406 Fertilizer Technology For Chemical Engineers	L	T	P	Credit
	3	0	0	3
Pre-requisite:Nil	**Course Category:** Professional core **Course Type**: Theory			

Course Objective(s):

Indian economy is dominated by agriculture sector. Synthetic fertilizers are must for producing good crops.Hence it is needed to provide comprehensive and balanced understanding of essential link between chemistry and the synthetic fertilizer industry. It is therefore vital for chemical engineers to understand for each fertilizer product, its flow diagram for Industry production.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the global outlook of fertilizer resources

CO2: Elaborate the production processes of nitrogenous fertilizers

CO3: Understand the about phosphate fertilizer production

CO4: Understand the production processes of NPK fertilizers

CO5: Understand about the mixed fertilizers

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2				H								
CO3			L				67					
CO4				H								
CO5							M					

UNIT 1: Global Outlook Of Fertilizer Resources **9 Hours**

Role of organic manures and Chemical Fertilizers - Types of Chemical fertilizers, growth of fertilizer industry in India, their location, energy consumption in various fertilizer processes - materials of various fertilizer processes, materials consumption in fertilizer industry

UNIT 2: Nitrogenous Fertilizers **9 Hours**

Feed stock for production of Ammonia, Natural gas, associated gas, Coke oven gas A m m o n i u m S u l p h a t e , A m m o n i u m N i t r a t e , U r e a , Calcium Ammonia Nitrate, Ammonium chlorides - Methods of Production, characteristics and specification - Storage and handling

UNIT 3: Phosphate Fertilizer **9 Hours**

Raw materials for the manufacture of Phosphate fertilizer - Phosphate Rock, Sulphur, Pyrites etc - Processes for the production of Sulfuric and Phosphoric acid - Phosphate fertilizers, ground rockphosphate, bone meal, methods of production, characteristics and specifications for single super phosphate,triple super phosphate

UNIT 4: NPK Fertilizers **9 Hours**

NPK Fertilizers - Methods of production, Characteristics and specifications for complex fertilizers, methods of production of Ammonia phosphate, Sulphate, Di-ammonium phosphate and Nitro phosphates - NPK Fertilizers - Urea, Ammonium Phosphate, Monoammonium Phosphate and various grades of NPK fertilizers produced in the country

UNIT 5: Mixed Fertilizers **9 Hours**

Mixed fertilizers - Granulated mixtures - Biofertilizers - Secondary and Micro Nutrients, Fluid Fertilizers - Controlled release fertilizers - Pollution from fertilizer industry - Solid, liquid and gaseous pollution standards

Total: 45 Hours

Text Book(s):

1. Slack. A. V - Chemistry and Technology of Fertilizers – Interscience - New York - 2005
2. Pozin. M. E - Fertilizer Manufacture - MIR Publishers – Moscow - 2006

Reference(s):

1. Carpentire. L. J - New Developments in Phosphate Fertilizer Technology – Elsevier - New Delhi - 2001
2. Strelzoff - Technology and Manufacture of Ammonia - John Wiley and Sons - New York – 2004(8th edition).

	L	T	P	C
CHE18R407 Environmental Engineering	**3**	**0**	**0**	**3**

Pre-requisite: Nil **Course Category**: Professional core

Course Type: Theory

Course Objective(s):

To understand the basic water quality criteria and standards, and their relation to public health and Requirement distribution of water quality

CourseOutcomes(s):

At theend ofthe course thestudentswouldbe ableto

CO1: An insight into the structure of drinking water supply systems.

CO2: Ability to Including water transport, treatment and distribution

CO3: An understanding of water quality criteria and standards, and their relation to public health

CO4: Ability to design and evaluate water supply project alternatives on basis of chosen selection criteria

CO5: Requirement distribution of water quality

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1			H		M							
CO2						H		L				
CO3		M		H			L					
CO4							H		M			
CO5		H			M					L		

UNIT 1: Planning For Water Supply System **9Hours**

Public water supply system -Planning – Objectives -Design period – Population forecasting Water demand - Sources of water and their characteristics -Surface and Groundwater- Impounding Reservoir Well hydraulics - Development and selection of source – Water quality – Characterization and standards- Impact of climate change.

UNIT 2: Conveyance System **9Hours**

Water supply -intake structures -Functions and drawings -Pipes and conduits for water- Pipe materials – Hydraulics of flow in pipes -Transmission main design -Laying, jointing and testing of pipes – Drawings appurtenances – Types and capacity of pumps -Selection of pumps and pipe materials.

UNIT 3: Water Treatment **9Hours**

Objectives –Unit operations and processes – Principles, functions design and drawing of Chemical feeding, Flash mixers, flocculators, sedimentation tanks and sand filters – Disinfection- Residue Management – Construction and Operation & Maintenance aspects of Water Treatment Plants.

UNIT 4: Advanced Water Treatment **9Hours**

Principles and functions of Aeration – Iron and manganese removal, Defluoridation and demineralization - Water softening – Desalination – Membrane Systems – Recent advances.

UNIT 5: Water Distribution and Supply to Buildings **9Hours**

Requirements of water distribution -Components -Service reservoirs -Functions and drawings -Network design -Economics -Computer applications -Analysis of distribution networks -Appurtenances -operation and maintenance -Leak detection, Methods. Principles of design of water supply in buildings -House service connection -Fixtures and fittings -Systems of plumbing and drawings of types of plumbing.

Total :45 Hours

Text Book(s):

1. Garg, S.K. - Environmental Engineering - Vol.1 Khanna Publishers - New Delhi - 2005.
2. Modi, P.N - Water Supply Engineering - Vol. I Standard Book House - New Delhi - 2005
3. Punmia, B.C - Ashok K Jain and Arun K Jain - Water Supply Engineering - Laxmi Publications Pvt Ltd - New Delhi - 2005

Reference(s):

1. Government of India - Manual on Water Supply and Treatment - CPHEEO - Ministry of Urban Development - New Delhi - 2003
2. Syed R. Qasim and Edward M. Motley Guang Zhu - Water Works Engineering Planning - Design and Operation - Prentice Hall of India Private Limited - New Delhi – 2006

CHE18R408 Chemical Process in Pulp and Paper Technology	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Professional core

Course Type: Theory

Course Objective(s):

To increase awareness of the factors that drive industry trends and to review industry statistics about the major grades of paper and board.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Apply basic concepts of pulp and paper technology to produce paper.

CO2: Apply reactions and unit operations steps to manufacture pulp.

CO3: Apply reactions and unit operations steps appropriately in manufacturing of paper.

CO4: Apply reactions and unit operations appropriately in manufacturing cellulose and various lignin chemicals.

CO5: Apply waste disposal techniques.

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	L		H	M								
CO2	L		H	M	M							
CO3		H	M			L						
CO4				H								
CO5	M		L			H						

UNIT 1 Basics of Pulp andPaperTechnology **9 Hours**

Describe the consumption pattern of different types of paper, Describe cellulose raw material, Identify problems and scope inIndia.

UNIT2Pulp **9Hours**

Explain various raw materials. Differentiate the various pulping processes; describe the Kraft pulping process with flow diagram. Compare various types of pulps, Explain chemical recovery process.

UNIT3Paper **9Hours**

Differentiate the features f various raw materials used in paper manufacture, describe the Wet process for paper Manufacture with flow diagram Describe Fourdrinier machine, and describe the economics in paperindustry.

UNIT 4 Cellulose andLignin Chemicals **9 Hours**

Describe the properties of cellulose, Prepare chemical cellulose, Describe the characteristics of Lignin chemicals, Select cellulose and ligninchemicals.

UNIT 5 WasteDisposalTechniques **9Hours**

Analyze pollution potentials of Indian pulp and paper industry, Apply bio-technical approach for pollution, Apply Lignin waste treatment.

Text Book(s):

1. Dryden - Outlines of Chemical Technology - Marshall Affiliated East-West Press Pvt. Ltd – 2000(3rd Edition)

2. Shreves - Chemical Process Industries - McGraw-Hill - New Delhi – 2000(5thEdition).

Reference Book(s):

1.Bhatia, S.C. - Environmental Pollution and Control in Chemical Process Industries 2011(2nd Edition)
2.Trivedi, R.K - Pollution Management in Industries Environmental Publication – Karad – India -2009

CHE18R409 Electrochemical Engineering	L	T	P	Credit
	3	0	0	3

Pre-requisite:Nil **Course Category:**Professional core

Course Type: Theory

Course Objective(s):

The objective of this course is to acquire fundamental knowledge of electrochemistry/electrochemical engineering including electrokinetic phenomena. The knowledge is applied to understand general methodologies for analysis and design of electrochemical systems.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand basic laws of Electrochemical Processes.

CO2: Apply Mass transfer over Electrochemical Reaction.

CO3: Understand the Metallic Surface against corrosion

CO4: Understand about primary and secondary batteries

CO5: Apply metal finishing techniques

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	M							L		L	
CO2			H	L								
CO3	H				H			M		M		L
CO4					H		L					
CO5			H									

UNIT 1Introduction **9Hours**

Introduction - Faraday's law, Nernst potential, galvanic cells, polarography - Electrical double layer, its role in electrochemical processes, electro capillary curve, Helmholtz layer, Guoy-Steven's layer, fields at the interface

UNIT 2 Diffusion ControlledElectrochemicalReaction **9 Hours**

Diffusion controlled electrochemical reaction, the importance of convection and the concept of limiting current - Mass transfer over potential or concentration polarization - Secondary current distribution - Rotating discelectrode

UNIT 3 Introduction of MetallicSurfacePreparation **9 Hours**

Metallic surface preparation - Phosphating - Inhibitors in acid media - Engine cooling systems – Control measures - Industrial boiler water corrosion control - Protective coatings- Vapor phase inhibitors - Cathodic protection- Sacrificial anodes - Paintremovers

UNIT 4 Primary andSecondaryBatteries **9 Hours**

Primary And Secondary Batteries - Lechlanche dry cell, Alkaline manganese cell, mercury cell, air depolarised cell, sea, water cell, reserve electrolyte cells like Mg,CuCl2, Zn, PbO, Secondary cells like lead acid, Ni, Cd, Ni, Fe, AgO, Zn, AgO, Cd, Sodium, Sulphur, Li, S, Fuelcells

UNIT 5 Metals andMetalFinishing **9Hours**

Metals - Graphite, lead dioxide, titanium substrate insoluble electrodes, iron oxide, semi conducting type etc -Metal finishing - Electrodeposition, electro refining, electroforming, electro polishing, anodizing, selective solar coatingsText Book(s):

1.John Newman - Electrochemical Systems - Wiley- Interscience - New York – 2004 (3rdEdition)

2.Geoffrey. A - Electrochemical Engineering Principles - Prentice Hall - New Jersey – 2007(3rd Edition)

3.Wendet.H and Kreysa.G - Electrochemical science and technology in chemical and other industries – Springer – London – 2004(2ndEdition)

Reference(s):

1.Mantle, C - Electrochemical Engineering - McGraw Hill - New York – 2006(3rdEdition)

2.Kuhn, A.T - Industrial Electrochemical Process – Elsevier - New Delhi – 2008(2ndEdition)

3.Ewald Heitz and Gerhard Kreysa - Principles of Electrochemical Engineering - VCH publishers – 2001(2ndEdition)

4.Fahidy, T.Z - Principles of Electrochemical Reactor Analysis – Elsevier – NewDelhi - 2005(3rdEdition)

CHE18R410 Chemical Process Plant Safety	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: **Course Category:**Professional core **Course Type**: Theory				

Course Objective(s):

This course fully examines the diverse regulatory, design and operational issues related to process plant safety and will develop the arsenal of proven tools and techniques for implementing safety and risk management in various segments of the CPI.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the Indian and International Safety standards

CO2: Analyze the causes of accident and explain various engineering control methods

CO3: Understand the storage, handling and transportation of hazardous materials.

CO4: Understand the fire extinguishing agents and methods

CO5: Understand the risk assessment methods

Mapping of Course Outcome(s):

CO/PO	**PO**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	M						L					
CO2			H									
CO3		H			M							
CO4			H									
CO5			H	L		M						

UNIT 1 Introduction to Industrial SafetyandHazards **9 Hours**

Describe importance of safety in Industry; classify the hazards, Explain Indian and International safety standards

UNIT 2 Chemical Hazards andTheirControl **9 Hours**

Classify chemical hazards & their control, .Explain occupational diseases and poisoning, Apply preventive measures of diseases, Describe safety aspects in plant layout, different color codes for chemical plants, Describe safety aspects in plant layout, Identify different color codes for chemical plants

UNIT 3 Safe Handling ofHazardousChemicals **9 Hours**

Discuss characteristics of hazardous chemicals, Handle hazardous chemicals for Storage, Handling & Transportation

UNIT 4 Fire Hazards andTheirPrevention **9 Hours**

Describe Fire hazards; List the causes of Fire hazards, Explain fire triangle, Describe Classes of fire, Describe fire extinguishers, and List types of extinguishers, Describe Construction and working of fire extinguishers, Describe Methods of their applications for fireextinguishers.

UNIT 5 Hazard Identification andRiskAssessment **9 Hours**

Explain hazard identification methods, Hazard identification methods, List risk assessment methods, Explain risk assessmentmethods.

Text Book(s):

1. Chemtech-I and D.Venkateswarlu- Manual of Chemical Technology - Chemical Engineering Education Development Centre – IIT – Madras -2012
2. Dr. K. U. Mistry Siddharth Prakashan - Fundamentals of Industrial Safety & Health -Ahmadabad.
3. Daniel A. Crowl and Joshef F. Louvar - Chemical Process Safety: Fundamentals with application - Prentice Hall – USA 2011(3rdEdition)

Reference Book(s):

1.N. K. Tarafdar andK. J. Tarafdar Dhanpatrai Co.Ltd - Industrial Safety Management New-Delhi – 2012(1st Edition)
2.L M Deshmukh - Industrial safety management - Tata McGraw Hill - New Delhi –2006.

OPEN ELECTIVES

PHY18R301	**Photonics and Optoelectronic Devices**	L	T	P	C
		3	0	0	3

CO-1: Know the fundamentals of fibre based optical devices
CO-2: Understand the basic of integrated optical devices
CO-3: Learn about the opto electronic devices
CO-4: Understanding of nanostructured materials
CO-5: Understanding of quantum devices with applications

Unit – I : Optical Fibre based Devices :

Fused single mode fibre directional coupler, Polished single mode fibre directional coupler ;Fibre polariser; Polarisation splitters based on fibre; Single mode fibre filter; Polarisation controller; Wavelength multiplexer and demultiplexer; Optical fibre switches and intensity modulators; Optical fibre phase modulator; Optical fibre frequency modulator; Optical fibre amplifiers

Unit – II : Integrated Optic based Devices :

Optical directional coupler: directional coupler wavelength filter, polarisation splitting directional coupler; Polarisers : leaky mode polariser , metal clad polariser; Phase modulator; Optical switch; Acousto-optic devices : mode converter , tunable wavelength filter, Bragg type modulator , Bragg type deflector; Magneto-optic devices : TE-TM mode converter, modulators and switches, SiO_2 / Si based thin film devices , Ti / $LiNbO_3$ based optical devices, Proton exchange based optical devices .

Unit – III : Optoelectronic Devices

Semiconductor Lasers: heterojunction and surface emitting lasers , quantum well lasers; Modulation of lasers; Photodetectors: PIN, MSM, Avalanche photodiodes; Optoelectronic modulation and switching devices ; Electro-optic Devices; Optoelectronic Integrated circuits

Unit – IV: Nanostructures

Nanocrystals: Electronic states, properties and fabrication; Nanomaterials – preparation methods - Chemical vapour deposition- Sol-gel methods - Optical properties of nanostructures; nano photodetector, nano transistor

Unit – V :Quantum Devices

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots; Density of states in low-dimensional structures; Resonant tunneling phenomena and applications in diodes and transistors; Applications of quantum devices: quantum well and quantum dot lasers, ultra-fast switching devices, high density memories, dc and rf squids, multi-state logic circuits, long wavelength detectors

Reference Books:

1. Joachim Piprek, Semiconductor optoelectronic devices, Academic press Hardbound, 2003
2. A.K. Ganguly, Optoelectronic devices and circuits, Narosa publication, 2007

3. Shun Lien Chuang, Physics of Optoelectronic Devices, Wiley-Interscience; 1st ed., 1995
4. Goure and I Verrier, Optical Fibre Devices, Taylor & Francis; 1st ed., 2001
5. Ray Tricker, Optoelectronics and Fiber Optic Technology, Newnes, 2002
6. K Krishna Reddy M Balakrishna Rao, Nanostructures & Quantum Devices, Campus Books International,2007
7. Rahman Faiz, Nanostructures in Electronics and Photonics, pan stallion press
8. Guozhong Cao, Nano structures & nano materials: synthesis, properties & applications, Imperial College Press, 2004
9. Todd D. Steiner, Semiconductor nanostructures for optoelectronic application, Artech House, INC.,2004
10. Jia- Ming Liu, Photonic Devices, Cambrige University Press, 2005

CHE18R312 Corrosion Science and Engineering	L	T	P	Credit
	3	0	0	3

Pre-requisite:Nil **Course Category:**Program OpenElective
Course Type: Theory

Course Objective(s):

Provide fundamental understanding of aspects of electrochemistry and materials science relevant to corrosion phenomena, provide methodologies for predicting, measuring, and analyzing corrosion performance of materials and Identify practices for the prevention and remediation of corrosion.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand about corrosion and its forms

CO2: Understand the requirement for protection of boiler against corrosion

CO3: Understand the various corrosion test and its ASTM standards

CO4: Understand Polarization and Effect of oxidizing agents oncorrosion

CO5: Understand the Corrosion prevention methods and its applications

Mapping of CourseOutcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H		M									
CO2			H									
CO3				H								
CO4					L							
CO5			H									

UNIT 1Corrosion **9Hours**

Corrosion - Definition, classification, forms of corrosion, expressions for corrosion rate, emf and galvanic series , merits and demerits, Pourbaix diagram for iron, magnesium and aluminium - Forms of corrosion, Uniform, pitting, intergranular, stress corrosion - Corrosion fatigue - Dezincification - Erosion corrosion - Crevice corrosion - Cause and remedial measures, Pilling Bedworth ratio, High temperatureoxidation

UNIT 2Boilers **9Hours**

Boiler water corrosion by carbon dioxide and unstabl7e5 salts - Corrosion prevention methods by treatment cooling water, specification, types of scales and causes, use of antiscalant - Water treatments – Maintenance of boilers - Protection of boilers during off loading, high temperature, corrosion, turbine

corrosion – Corrosion inhibitors, principles and practice, inhibitors for acidic neutral and other media - Corrosion failure – Inspection and analysis of corrosiondamage

UNIT 3CorrosionTesting **9Hours**

Purpose of corrosion testing, classification, susceptibility tests for intergranular corrosion, stress corrosion test, salt spray test, humidity and porosity tests, accelerated weathering tests - ASTM standards for corrosiontesting

UNIT 4Polarization **9Hours**

Polarization - Exchange current density, Activation polarization, Tafel Equation ,Passivating metals and nonpassivating metals, Effect of oxidizing agents

UNIT 5 Electroless Platingand Anodising **9 Hours** Electroless plating and Anodizing - Cathodic protection, metallic, organic and inorganic coatings, corrosion inhibitors - Special surfacing processes - CVD and PVD processes, sputter coating - Laser and ion implantation, arc spray, plasma spray, flame spray,HVOF.

Text Book(s):

1. Fontana and Greene - Corrosion Engineering - McGraw Hill Book Co - New York -2006
2. Raj Narayan - An Introduction to Metallic Corrosion and its prevention - Oxford and IBH- New Delhi –2002.

Reference(s):

1. Budinski. K.G - Surface Engineering for Wear Resistance - Prentice Hall Inc - Engelwood Cliff - New Jersey – USA –2005.
2. Uhlig. H.H - Corrosion and Corrosion Control - John Wiley and Sons - New York -2001.

CHE18R313 Separation Techniques	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**

Pre-requisite: Nil **Course Category:** Program OpenElective
Course Type: Theory

Course Objective(s):

The main objective of this course is to familiarize students with the fundamental principles of separation processes used in analytical chemistry such as various extraction techniques, gas and liquid chromatography, size and ion chromatography and electrophoresis.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the equilibrium state
CO2: Understand the Prospects of ionic separation
CO3: Understand the various separation techniques and its standards
CO4: Understand the chromatographic techniques and its applications
CO5: Understand the need of various separation techniques

Mapping of Course Outcome(s):

CO/PO	**PO**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1		H										
CO2												
CO3			M	M								
CO4				M		L						
CO5				H								

UNIT 1ThermalSeparation **09Hours**

Thermal Diffusion: Basic Rate Law, phenomenological Theories of Thermal Diffusion for gas and liquid mixtures, Equipments design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications.

UNIT 2AdsorptionTechniques **09Hours**

Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, types and Retention theory mechanism Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

UNIT 3 MembraneSeparation Processes **09Hours**

Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultra filtration, Concentration Polarization in Membrane and Economics of Membraneoperations.

UNIT 4IonicSeparation **09Hours**

Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes.

UNIT 5OtherTechniques **09Hours**

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 Controllingfactors.

Text Book(s):

1.H.M.Schoen-New Chemical EngineeringSeparationTechniques-InterScience Publications - New York -2002.

2.C.LoebandR.E.Lacey-IndustrialProcessingwithMembranes-Wiley Inter Science -2002.

3.B.Sivasankar - Bioseparations – Principles and Techniques - Prentice Hall of India Pvt. Ltd - New Delhi -2005.

Reference(s):

1.R.H. Perry and D.W. Green -Perry's Chemical Engineers Hand book - McGraw Hill - New York – 2007(8th Edition)

2.J. M. Coulson and J. F. Richardson - Chemical Engineering - Vol.II - Butterworth –Heinemann – London – 2004(5th Edition)

CHE18R314 Fertilizer Technology	L	T	P	Credit
	3	0	0	3
Pre-requisite:Nil	**Course Category:** Program OpenElective **Course Type**: Theory			

Course Objective(s):

Indian economy is dominated by agriculture sector. Synthetic fertilizers are must for producing good crops. Hence it is needed to provide comprehensive and balanced understanding of essential link between chemistry and the synthetic fertilizer industry. It is therefore vital for chemical engineers to understand for each fertilizer product, its flow diagram for Industryproduction.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the global outlook of fertilizer resources

CO2: Elaborate the production processes of nitrogenous fertilizers

CO3: Understand the about phosphate fertilizer production **CO4:**

Understand the production processes of NPK fertilizers

CO5: Understand about the mixed fertilizers

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M										
CO2				H								
CO3			L									
CO4				H								
CO5							M					

UNIT 1 Global Outlook OfFertilizerResources **9 Hours**

Role of organic manures and Chemical Fertilizers - Types of Chemical fertilizers, growth of fertilizer industry in India, their location, energy consumption in various fertilizer processes - materials of various fertilizer processes, materials consumption in fertilizerindustry

UNIT 2NitrogenousFertilizers **9Hours**

Feed stock for production of Ammonia, Natural gas, associated gas, Coke oven gas A m m o n i u m S u l p h a t e , A m m o n i u m N i t r a t e , U r e a , Calcium Ammonia Nitrate, Ammonium chlorides - Methods of Production, characteristics and specification - Storage and handling

UNIT 3PhosphateFertilizer **9Hours**

Raw materials for the manufacture of Phosphate fertilizer - Phosphate Rock, Sulphur, Pyrites etc - Processes for the production of Sulfuric and Phosphoric acid - Phosphate fertilizers, ground rockphosphate, bone meal, methods of production, characteristics and specifications for single super phosphate,triple super phosphate

UNIT 4NPK Fertilizers **9Hours**

NPK Fertilizers - Methods of production, Characteristics and specifications for complex fertilizers, methods of production of Ammonia phosphate, Sulphate, Di-ammonium phosphate and Nitro phosphates - NPK Fertilizers - Urea, Ammonium Phosphate, Monoammonium Phosphate and various grades of NPK fertilizers produced in thecountry

UNIT 5MixedFertilizers **9Hours**

Mixed fertilizers - Granulated mixtures - Biofertilizers - Secondary and Micro Nutrients, Fluid Fertilizers - Controlled release fertilizers - Pollution from fertilizer industry - Solid, liquid and gaseous pollutionstandards

Total: 45 Hours

Text Book(s):

1.Slack. A. V - Chemistry and Technology of Fertilizers – Interscience - New York -2005

2.Pozin. M. E - Fertilizer Manufacture - MIR Publishers – Moscow -2006

Reference(s):

1. Carpentire. L. J - New Developments in Phosphate Fertilizer Technology – Elsevier - New Delhi - 2001

2. Strelzoff - Technology and Manufacture of Ammonia - John Wiley and Sons - New York – 2004(8^{th} edition).

CHE18R315 Membrane Science and Technology	L	T	P	C
	3	0	0	3

Pre-requisite: Nil

Course Category: Program OpenElective

Course Type: Theory

Course Objective(s):

To gain knowledge on basic principles of membrane process; To design membrane modules for Reverse osmosis, Ultracentrifugation and gas separation process; To understand the various applications of membranes in medical field

Course Outcome(s):

At the end of the course, students should be able to

CO1: Elaborate the types of membrane, its Structure and theory

CO2: Explain different types of membranes and its modules

CO3: Detail various flow processes using Membranes

CO4: Analyze membrane filtration, applications and its design

CO5: Apply Membranes in medical applications

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1			M			H						
CO2			M	M								
CO3				M		H						
CO4			H	M	M							
CO5			H		L		L					

UNIT1:Membranes **6hours**

Membranes - Types, membrane process, membrane transport theory, solution diffusion model - Structure, permeability relationships, pore, flow membranes

UNIT 2:LiquidMembranes **6hours**

Membranes and modules, isotropic membranes, anisotropic membranes, metal membranes and ceramic membranes, liquid membranes, hollow fibre membranes, membrane modules

UNIT 3:Concentration polarization **10hours**

Concentration polarization - Liquid separation process, gas separation process, cross flow, co-flow and counter flow - Reverse osmosis, theoretical background, membrane selectivity, module, fouling

UNIT4:Ultracentrifugation **12hours**

Ultracentrifugation membranes - Characterization of ultra filtration membranes - Modules, System design - Micro filtration, background and applications - Pervaporation, membrane materials, process design - Ion exchange membrane, chemistry of ion exchange membranes, transport in electro dialysis membrane, system design

UNIT 5:MedicalApplications **11hours**

Medical Applications - Haemodialysis - Blood oxygenators, control drug delivery, membrane processes dialysis - Donan dialysis and diffusion dialysis - Charge mosaic membranes and piezo dialysis, membrane contractors and membrane distillation, membrane reactors

Text book(s):

1. Baker, R.W - Membrane Technology and Applications - Wiley Interscience, Singapore-2012(3rdEdition)
2. Strathmann, H - Ion, Exchange Membrane Separation Processes - Volume 9 - Elsevier Science - 2004(1st Edition)

Reference(s):

1. Vieth, W.R. - Membrane Systems Analysis and Design Applications inBiotechnology, Biomedicine and Polymer Science - Wiley Interscience, Singapore -1994
2. Timashev, S.F, Kemp T.J. - Physical Chemistry of Membrane Process - Prentice Hall, New Jersey -1991
3. Marcel Mulder - Basic Principles of Membrane Technology - Kluwer Academic Publishers, New York - 1996(2ndEdition)

CHE18R316 Process Industrial safety	L	T	P	C
	3	0	0	3

Pre-requisite:Nil **Course Category**: Program OpenElective
Course Type:Theory

Course Objective(s):

To familiarize basics of Industrial safety principles; To know the various aspects of health hazards and Industrial accidents in Chemical Industries

Course Outcome(s):

At the end of the course, the students would be able to

CO1: Identify, Explain and Handle Different safety principles

CO2: Identify Different Hazards And their Fire protection agency's

CO3: Analyze various health hazards

CO4: Identify Safety aspects of reactive chemicals

CO5: Identify Hazards Safety in operations and processes

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M		H				L					
CO2			H									
CO3			H									
CO4			H									
CO5			H	L								

Unit1:Introduction **9hours**

Introduction - Industrial safety principles, Site selection and plant layout, Legal Aspects, design for ventilation - Emergency response systems for hazardous goods basic rules and requirements which govern the chemical industries

Unit2:Hazards **9hours**

Chemical hazards - Classification, Hazards due to fire, explosion and radiation - Reduction of process hazards by plant condition monitoring - Materials Safety Data sheets and National Fire protection agency's classifications

Unit3:Diseases **9hours**

Dangerous occupational diseases, poisoning, dust effect – Biomedical and engineering response to health hazards

Unit 4: ControlofHazards **9hours**

Control of Hazards Engineering control of plants instrumentation - Colour codes for pipe lines - Safety aspects of reactivechemicals

Unit 5: Operation andProcessHazards **9hours**

Operation And Process Hazards Safety in operations and processes - Runaway reactions - unstable products

Text book(s):

1.Daniel, A, Crowl, Joseph, F, Louvar - Chemical process safety :Fundamentals with applications - Prentice Hall - New Jersey - 2011(2nd Edition)

2.John Barton, Richard Rogers - Chemical Reaction Hazards - John Wiley and Sons – Singapore - 1997(2nd Edition)

Reference(s):

1.Yoshida, T - Safety of Reactive Chemicals - Vol. I – Elsevier - New Delhi -1987

2.William - Industrial Safety Handbook - McGraw Hill - New York – 1968(2nd Edition)

3.Fawcett, H.H, Wood, W.S - Safety and Accident Prevention in Chemical Operation, - Wiley Interscience - Singapore – 1982(2ndEdition)

CHE18R317-Fuel and Combustion Engineering	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite:Nil	**Course Category:** Program OpenElective **Course Type**: Theory			

Course Objective(s):

To understand the basic principles and calculations involved in combustion process; To know the different aspects of combustion appliances and processing techniques in detail.

Course outcome(s):

At the end of the course, the students would be able to

CO1: To analyze the fuel process

CO2: To apply the thermodynamic combustion systems

CO3: Ability to understand the furnace process inindustries

CO4: To understand the purpose of flame propagation

CO5: Ability to require the processing ofburner

Mapping of Course Outcome(s):

CO/PO	PO											
	1	**2**	**3**	**4**	**5**	**6**		**8**	**9**	**10**	**11**	**12**
CO1				H	M		81			L		
CO2	H		M				L					
CO3		L					H	M				
CO4					L		M	H				
CO5			H		M							

Unit1:Introduction **9hours**

Fuels & Fuel Analysis-Combustion Stoichiometry, theoretical & actual combustion processes – Air fuel ratio.

Unit2:Combustion **9hours**

Combustion Thermodynamics- calculation of heat of formation & heat of combustion – First law analysis of reacting systems

Unit 3:Furnaces **9hours**

Heat Treatment Furnaces- Industrial furnaces – process furnaces – Kilns – Batch & continuous furnaces

Unit4: Flame **9hours**

Flame, Flame Structure, Ignition and Igniters – flame propagation – deflagration – detonations-flame front – Ignition – self & forced ignition – Ignition temperature

Unit5:Burners **9hours**

Combustion Appliances- Gas burners- Functional requirement of burners – Gas burner Classification –Stoker firing –pulverized system of firing

Total hours: 45

Text book(s)

1.S.P. Sharma & Chander Mohan - "Fuels & Combustion" - Tata McGraw Hill Publishing Co. Ltd-1984

2Dr. Samir Sarkar - "Fuels & Combustion" - Universities press – 2010(3rdEdition)

Reference(s)

1.BlokhA.G- "Heat TransmissioninSteamBoilerfurnaces"-Hemisphere PublishingCorpn - ISBN-089-116-626-2

2.Gupta O.P - "Elements of Fuels, Furnaces & Refractories" – Paperback - Published-2014 - ISBN-10: 8174090886, ISBN-13: 9788174090881.

3.Roger A. Strehlow - Combustion Fundamentals – McGraw-Hill, New York -1984

4.Shaha A.K - Combustion Engineering and Fuel Technology – Oxford and IBH -1974.

5.Kenneth K. Kou - Principles of Combustion – John Wiley & Sons - 2005(2ndEdition)

CHE18R318 Pulp and Paper Technology	L	T	P	C
	3	0	0	3

Pre-requisite:Nil **Course Category:** Program OpenElective

Course Type: Theory

Course Objective(s):

To introduce the working principle of various machines used for the production of paper To understand the paper manufacturing process in detail

Course outcome(s):

At the end of the course, the students would be able to

CO1: Apply different machines in Paper Industry

CO2: Function and maintain Foudriner

CO3: Apply driers in Paper and Pulp Industry

CO4: Describe about special paper machines

CO5: Detail various processes of paper finishing

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1			H	L								
CO2			H	M	M							
CO3		H	L									
CO4				H								
CO5						H						

Unit 1: Basics of Pulp andPaperTechnology **9 Hours**

Describe the consumption pattern of different types of paper, Describe cellulose raw material, Identify problems and scope inIndia.

Unit 2:Pulp **9Hours**

Explain various raw materials. Differentiate the various pulping processes; describe the Kraft pulping process with flow diagram. Compare various types of pulps, Explain chemical recovery process.

Unit 3:Paper **9Hours**

Differentiate the features f various raw materials used in paper manufacture, describe the Wet process for paper Manufacture with flow diagram Describe Fourdrinier machine, and describe the economics in paperindustry.

Unit 4: Cellulose andLignin Chemicals **9 Hours**

Describe the properties of cellulose, Prepare chemical cellulose, Describe the characteristics of Lignin chemicals, Select cellulose and ligninchemicals.

Unit 5 :WasteDisposalTechniques **9Hours**

Analyze pollution potentials of Indian pulp and paper industry, Apply bio-technical approach for pollution, Apply Lignin waste treatment.

Total hours: 45

Text Books

1. Bearce, George D - Manufacture ofPulp and Paper - Volume V - Mc Graw Hill - New York - 2008
2. MacKinney**,** R.W.J **-** Technology of Paper Recycling - Springer publishers, London -1994

References

1. Sabit Adanur, Asten - Paper Machine Clothing: Key to the Paper Making Process - CRC Press, New York -1997
2. Allison Stark Draper - Paper and Pulp Industry - Rosen Publishing Group -2001

CHE18R319 Treatment of Industrial Effluents	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Pre-requisite: Nil **Course Category:** Program OpenElective

Course Type: Theory

Course Objective(s):

To acquire in depth knowledge of waste water treatment and characterization methods; To introduce the hazardous nature of effluent and water tr[8]e[3]atments methods followed in various industries.

Course Outcome(s):

At the end of the course, students would be able to

CO1: Describe the nature and composition of industrial pollutants, their origin and their impact on the environment

CO2: Explain the principles of various processes available for wastewater treatment

CO3: Choose methods for waste minimization and water conservation

CO4: List the problems associated with the operation of industrial wastewater treatment facilities and provide an explanation of the causes and possiblesolutions

CO5: Determine the toxicity levels of industrial effluents

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M						L					
CO2			M									
CO3			H	L								
CO4				M	H							
CO5												

Unit 1: Characterization ofwastewaters **5 hours**

Quality of various industrial effluents; permissible limits; Fundamentals of wastewater treatment technologies; water treatmentequipments;

Unit 2:Biologicaltreatment: **10hours**

Biological fluidised bed reactors for treatment of sewage and industrial effluents - anaerobic digestion and anaerobic contact process - denitrification - fluidised bed anaerobic reactors - anaerobic down flow stationary fixed film reactors.;

Unit 3: Biological wastewatertreatment **10 hours**

Completely mixed aerated lagoons, oxidation ditches and waste stabilisation ponds - activated sludge - microbial community in activated sludge - aerobic digestion, trickling filters - rotating biological contactors - nitrification

Unit 4:Application Of Biological Treatment in Industries **10hours**

Waste water treatment and disposal of tannery-dye factory-sugar industry-pulp and paper industry -viscose industry - agro chemical industries- fertilizer industries - petro chemical industry and pharmaceutical industries.

Unit 5: Treatment ofgaseouspollutants: **10 hours**

Ambient air sampling, analysis methods and measuring devices; air pollution standards, air pollution control equipments; Case studies of gaseous effluent treatment in typical industries: steel plants, power plantsetc.

Total hours: 45

Text book(s):

1. N. W. Jern - Industrial waste water Treatment - Imperial College Press - 2006.

Reference book(s):

1.R. S. Ramalho - Introduction to Waste Water Treatment Process - Academic press Imprint. New York – 2013(2nd Edition)

2.S. D. Lin and C. C. Lee - Water and Waste Water Calculation Manual - McGraw-Hill - 2014(3rdEdition)

CHE18R321 Coal Processing Technology	L	T	P	C
	3	0	0	3

Pre-requisite:Nil **Course Category:** Program OpenElective

Course Type: Theory

Course Objective(s):

To introduce the importance of coal and its processing method;

To understand the principle of coal refining and utilization process in detail.

Course Outcomes:

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

CO1: To Understand the role& importance of Coal

CO2: Able to understand the production methods of coal & also the concepts of modeling

CO3: To provide the application of coal in power generation & various kinetics of solvent extraction.

CO4: To understand the different refining process

CO5: To Analyze the impacts of various process on Environment

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M	H	M									
CO2	H	H	M	M								
CO3	H	M	H	L	L							
CO4	M	M	H	H								
CO5			M		M		L					

Unit 1: Role ofcoal **9Hours**

Role of coal in the overall energy situation; Recent advances in coal preparation methods including fine coal treatment;

Unit 2: Simulationandmodeling **9Hours**

Simulation and modelling of coal beneficiation circuits; Thermodynamics and kinetics of coal gasification reactions;Fluidized bed coal gasification processes;

Unit 3:Powergeneration **9Hours**

Combined cycle power generation; Coal liquefaction: Various methods,kinetics of solvent extraction, Catalytic hydrogenation and other liquefaction processes;

Unit4:Refining **9Hours**

Absorptive and adsorptive purification, sulphuric acid purification, Concept of coal refinery and coal plex;

Unit 5:Environmentalimpact **9Hours**

Analysis of coal utilization methods such as carbonization, gasification, etc.

Text book(s):

1. H. L. Lowry - Chemistry of Coal Utilization - Vol. I & Vol. II - John Wiley & Sons - New York - 1963

Reference book(s):

Mangold - Liquefaction and Gasefication of Coal - Ann Arbor Science Publishers, Inc.,Ann Arbor, M - United States-1982

Wilson and Wells - Coal, Coke and Coal Chemicals - Ann ArborUniversity Microfilms International -1977

CHE18R322 Batteries And Fuel Cells	L	T	P	C
	3	0	0	3

Pre-requisite: Nil **Course Category:** Program OpenElective

Course Type: Theory

Course objective(s):

To gain basic knowledge on batteries ; introduce alternate sources for fuels and identify their applications in various fields

Course outcome(s):

At the end of the course, the students would be able to

CO1: Understand the importance of cell and batteries.

CO2: Explain the characteristics of electromagnetic reactions.

CO3: Explain the concept of batteries and their applications.

CO4: Evaluate the fundamental principles of fuel cells.

CO5: Describe industrial oriented application of fuel cells.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1					H				L			M
CO2							L					
CO3	L		M							M		
CO4					H							M
CO5		H										

Unit1: Introduction **9Hours**

Concepts – Components of cells and batteries, Classification of cells and batteries, Operation of a cell, Specifications – Free energy, theoretical cell voltage, specific capacity, specific energy, energy density, memory effect, cycle life, shelf life, state of charge (SOC) and depth of discharge (DOD), internal resistance and coulombicefficiency.

Unit2: Characteristics ofelectrochemicalreaction **9 Hours**

Electrochemical principles and reactions – electrical double layer, discharge characteristics of cell and polarization, Electrode processes and Tafel polarization, thermodynamic background and Nernstequation.

Unit 3:Batteries **9Hours**

Primary and secondary batteries – Zn/C, Zn/air, alkaline cells, lithium primary batteries, lead- acid, Ni/Cd, Ni/MH and Lithium secondary batteries (Components, Chemistry and Performance characteristics). Applications of storage batteries.

Unit4: Fuelcells **9Hours**

Fuel cell fundamentals, The alkaline fuel cell, Acidic fuel cells, SOFC (components, chemistry and challenges) - Emerging areas in Fuel cells

Unit5: Applications offuelcells **9Hours**

Fuel cell outlook, Applications of fuel cells – Industrial and commercial.

Text Book(s)

1.David Linden and Thomas. B. Reddy - Hand Book of Batteries and Fuel cells - McGraw Hill Book Company, N.Y - 2005 (3rdEdition).

2.John O'M Bockris, Amulya K. N. Reddy and Maria Gamboa-Aldeco - Modern Electrochemistry- Kluwer Academic Publishers, Newyork8-62006 (2ndEdition,).

Reference(s)

1. Xianguo Li - Principles of Fuel Cells- -Taylor & Francis –2006
2. Viswanathan, B. and Scibioh, Aulice M - Fuel Cells, Principles and Applications - Universities Press- 2006 (3rd edition)

CHE18R411 Drugs and Pharmaceuticals Technology	L	T	P	C
	3	0	0	3

Pre-requisite:Nil **Course Category:** Program OpenElective
Course Type: Theory

Course objective(s):

To introduce basic concepts regarding drug engineering which serves as the backbone of medical and pharmaceutical industry

Course outcome(s):

CO1 : By knowing the basics of drugs and pharmaceutical technology
CO2: chemical conversion processes and their equipments.
CO3 : To understand basic unit operations
CO4 : Understands the basic idea for design of processes and equipments used for drug manufacturing.
CO5 : To study various pharmaceutical products

Mapping of Course Outcome(s):

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1		H			M							
CO2					M		L					
CO3	H		L									
CO4					M				H			
CO5		H										

Unit1:Introduction **9Hours**

Development of Drugs and Pharmaceutical Industry; Organic Therapeutic agents, Uses and Economics.

Unit2: Drugs metabolismandpharmacokinetics **9 Hours**

Drugs metabolism; Physio - Chemical principles; Radio Activity; Pharma Kinetics; Actions of drugs onhumanbodies.

Unit 3: Important unit processes andtheirapplications **9 Hours**

Chemical conversion processes; Alkylation; Carboxylation; Condensation and Cyclisation; Dehydration;Esterification (Alcoholysis); Halogenation; Oxidation; Sulphonation;Complex chemical Conversion;Fermentation.

Unit4: Pharmaceuticals, microbiological andanimalproducts **9 Hours**

Vitamins; Cold remedies; Laxatives; Analgesics; Non - steroidal contraceptives; External Antiseptics;Antacids and Others.Antibiotics; Biologicals; Harmones; Vitamines and Preservation Pharmaceutical Analysis. Analyticalmethods and test for v[8]a[7]rious drugs and pharmaceuticals.

Unit 5:Manufacturingprinciples **9Hours**

Compressed tables; Wet granulation; Dry granulation or Slugging; Direct compression; Tablet presses;Formulation; Coating; Pills; Capsules; Sustained action dosage forms; Parental solutions; Oral liquids;Injectibles; Ointments; Standard of hygiene and good manufacturing practice as per Drugs and CosmeticsAct as amended update, Packing; Packing techniques; Qualitycontrol

Text Book(s)

1. Tyagi O.D, Yadav M, A -Text Book of Synthetic Drugs- Anmol Publications, New Delhi- 2011(3rdedition).
2. Chatwal G.R- Synthetic Drugs- Himalaya Publishing House, Delhi- 2009(3rdedition).

Reference(s)

1. Rawlins E.A, Bentleys- Text Book of Pharmaceutics- A.I.T.S.S. Publisher and Distributor, Delhi- 2006(5thedition).
2. Remingtons -The Science Practice of Pharmacy- Pharmaceutical Press- 2012(5thedition).

CHE18R412 Polymer Science And Technology	L	T	P	C
	3	0	0	3
Pre-requisite:Nil	**Course Category:** Program OpenElective **Course Type**: Theory			

Course outcome

At the end of the course, students would be able to

CO1: Ability to identify the common commercial polymers by their names, properties and syntheses

CO2: Understand the properties and applications of polymers processing methodology

CO3: Apply the mechanisms of polymer degradation

CO4: Analyze the polymer additives and their role in the control of desired properties

CO5: Perform various polymer fabrication methods of extrusion, moulding and conversion of fibres to fabrics

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

Unit 1:Introduction **9Hours**

Classification and characterization of polymers - Thermal analysis, Morphological characterization, Physical testing

Unit 2:Properties Of Polymer **9Hours**

Morphology and order in crystalline polymers - Rheology and mechanical properties of polymer structure and physical properties

Unit 3:Polymerization **9Hours**

Polymerization - Step reaction polymerization, Chain reaction polymerization, free radical, anionic, cationic, coordination - Copolymers and Copolymerization - Polymerization conditions

Unit 4:Plastics And Resins **9Hours**

Hydrocarbon plastics and elastomers - Other carbon chain polymers - Heterochain thermoplastics - Thermosetting resins Types of deformation

Unit 5:Technologies **9Hours**

Plastic technology - Fiber technology- Elastomer technology

Text Books

1. Billmeyer, F.W., Text book of Polymer Science, 3rd Edition, Wiley Publishers, Singapore, 1994
2. Rudin, A., Elements of Polymer Science and Engineering an Introductory Text and Reference forEngineers, Elsevier, New Delhi, 2nd Edition, 1998

References

1. Anil Kumar, Gupta, R.K., Fundamentals of Polymers McGraw Hill, New York, 1998
2. Cheremisinoff, N.P., Polymer Mixing and Extrusion Technology, Marcel Dekker, NewYork
3. Rodriguez, F., Principles of polymer systems, Taylor and Francis, Washington, 1996

CHE18R413 Pharmaceutical Engineering	L	T	P	C
	3	0	0	3
Pre-requisite:Nil	**Course Category:** Program OpenElective **Course Type**: Theory			

Course outcomes

At the end of the course, students would be able to

CO 1: Apply the principles of pharmacokinetics and pharmacodynamics

CO 2: Analyze the mechanisms of chemical conversion processes

CO 3: Apply the manufacturing processes of various pharmaceutical products

CO 4: Describe various antipyretic and anti inflammatory agents

CO 5: Apply analytical techniques of pharmaceutical products and their quality control

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

Unit 1:Development Of Drugs And Pharmaceutical Industry **9Hours**

Development of drugs and pharmaceutical industry - Organic therapeutic agents uses and Economics - Drug Metabolism and Pharmaco Kinetics - Drug Metabolism Physio Chemical principle Radioactivity, Pharma kinetic reaction of Drugs on Human bodies

Unit 2:Chemical Conversion Processes **9Hours**

Chemical conversion processes - Alkylation, carboxylation, condensation and cyclisation, dehydration, esterification, halogenations, oxidation, sulfonation, complex chemical conversions, fermentation

Unit 3:Granulation **9Hours**

Compressed Tablets - Wet granulation - Dry granulation or slugging - Direct compression Tablet Presses,Formulation, Coating Pills, Capsules, Sustained dosage Forms, Parental Solution - Oral liquids - Injections External preparations - Ointments - Standard of Hygiene and Good Manufacturing practice as per Drugs and Cosmetics Act as amended update

Unit 4: Antipyretic and Anti Inflammatory **9Hours**

Based on Antipyretic and anti inflammatory, respiratory, cardio intestinal and liver, hormones, Stimulants, histamine and anti histamine, vitamins and other nutrients, sedatives, analgesics Aerosols: mode of operations, propellants- container-, valves- actuators and buttons- dip tubes, packing, application and testing Liposome- fundamentals of manufacturing, evaluation, advantages & limitations, application. Noisome & their fundamentals- Iontophoresis & sonophoresis- fundamentals- evaluation & applications.

Unit 5:Antibiotics **9Hours**

Antibiotics - Anti infective, biological, hormones, vitamins and preservation, pharmaceutical analysis,Analytical methods and tests for various drugs and pharmaceuticals, packing techniques, quality control

Text Books

1. Rawlins E.A., Bentleys Text Book of Pharmaceutics, A.I.T.B.S. Publisher and Distributors, Delhi, 2008
2. Remingtons, Alfonso R.Gennaro., The Science Practice of Pharmacy, Mack Publishing Company of Eastern, Pennsylvania, 2006

References

1. Berry, I.R.A.R, Robert A. Nash., Pharmaceutical process validation, 2011
2. Hickey, A.J, David Handerton., Pharmaceutical Process Engineering, 2014
3. Turner, S.G., Pharmaceutical Engineering Change Control, 2nd Edition, 2012

CHE18R414 Disaster Management In Chemical Industries	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite:Nil	**Course Category:** Program OpenElective **Course Type**: Theory			

Course outcomes

At the end of the course, students would be able to

CO 1: To understand the basic concept in Disaster Management

CO 2: Discuss the consequences and control factors of Disaster

CO 3: To undertake Mitigation & Risk Reduction steps

CO 4: To understand the institutional and legal framework for India

CO5: To induce knowledge to create appropriate planning, preparation and response for emergency treatment in disaster situation.

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

Unit 1:Understanding Disasters **9Hours**

Disaster and Development, and disaster management Chemical hazards: Classification of chemical hazards, Chemical as cause of occupational diseases – dust, fumes, gases and vapours; Hazard analysis and health management; Engineering control of chemical plant hazards – Plant layout, ventilation and lighting, Pressure vessels, Storage, Handling, Transportation, Electrical systems, Instrumentation; Emergency planning, Personal protective devices, Maintenance procedure

Unit 2:Control Of Disasters **9Hours**

Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclon, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man- made Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change

and Urban Disasters

Unit 3:Disaster Management Cycle And Framework 9Hours

Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR,Yokohama Stretegy, Hyogo Framework of Action

Unit 4:Disaster Management In India 9Hours

Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter-Governmental Agencies

Unit 5:**Applications Of Science And Technology For Disaster Management 9Hours**

Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India

Text Books

1.H. H. Tawcatt & W S Wood, Safety and Accident Prevention in Chemical Operations.,2008

Reference Books

1.R. V. Betrabet and T. P. S. Rajan in CHEMTECH-I, Safety in Chemical Industry, Chemical Engineering Development Centre, Madras, 2010

2.Disaster Management Guidelines. GOI-UNDP Disaster Risk Reduction Programme (2009-2012.)

CHE17R415 Computational Heat Transfer	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite:Nil	**Course Category:** Honors **Course Type**: Theory			

Course outcomes

At the end of the course, the students would be able to

CO1: Apply governing Differential Equation for various physical phenomena

CO2: Analyze parabolic equations

CO3: Provide algorithm for Conduction and Convection

CO4: Analyze general application of various solution methods

CO5: Apply software packages to heat transfer and diffusion

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

Unit 1: Introduction

Physical phenomena governing differential Equation - Energy equation - Momentum Equation - Nature ofCoordinates, Discretization Methods

Unit 2: Parabolic Equations

Parabolic Equations - Explicit, Implicit and Crank Nicholson Methods - Cartesian and Polar Co-ordinates - Mixed Boundary Condition – Jacobi - Gauss,siedel and SOR Methods

Unit 3: Heat Conduction and Convection

Heat Conduction and Convection - **Control** volume approach - Steady and Unsteady One dimensional conduction - Two and three dimensional - Power law scheme – Simple algorithm

Unit 4: General Applicability Of The Method

General applicability of the method - Approximate analytical solution - Raleigh's method -Galerkin Method, solution methods

Unit 5: Conduction and Diffusion Equations

Isoparametric element formulations conduction and diffusion equations, heat transfer packages, Heat 2, HEATAX, RADIAT, ANSYS

Text Books

. 1. Muralidhar, K., Sundararajan, T., Computational fluid flow and heat transfer, Narosa publishing house, New Delhi, 2nd edition, 2003

2. Anderson, D.A., Tannehill, J.C and Pletcher, R.H., Computational fluid mechanics and heat Transfer, Hemisphere publishing corporation, New York,2009

References

1. Mitchell, A.R, Grifths, D.F., Finite Difference Method in Partial Differential Equations, John Wiley and Sons, Singapore, 2006

2.Suhas Patankar., Numerical Heat Transfer and Fluid Flow, (Hemisphere Series on ComputationalMethods in Mechanics and Thermal Science), Taylor and Francis,4st Edition,2011

3.Jaluria and Torrance. Computational Heat Transfer, Hemisphere Publishing Corporation, New York, 2012

CHE17R416 Computational Fluid Dynamics	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite:Nil	**Course Category:** Honors **Course Type**: Theory			

Course outcomes

At the end of the course, the students would be able to

CO1: Apply equations of fluid flow and heat transfer for turbulence models

CO2: Apply finite difference, finite volume and finite element methods to fluid flow problems

CO3: Apply finite volume to solve fluid flow problems

CO4: Analyze issues surrounding two-phase flow modeling

CO5: Analyze grid generation

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

Unit 1: Conservation Laws and Turbulence Models **9Hours**

Governing equations of fluid flow and heat transfer –mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form. Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence models-one and two equation, Reynolds stress, LES and DNS

Unit2: FiniteDiffernce Approximation **9Hours**

Mathematical behavior of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods, error and stability analysis

Unit 3: FiniteVolumeMethod **9Hours**

Diffusion problems – explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes; Solution of discredited equations.

Unit 4: FlowField Computation **9Hours**

Pressure velocity coupling, staggered grid, and SIMPLE algorithm, PISO algorithm for steady and unsteady flows

Unit 5: Grid Generation **9Hours**

Physical aspects, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

Text Books

1. Anderson Jr ., Computational Fluid Dynamics, John Wiley, Singapore, 2010
2. Chow, C.Y., Introduction to computational fluid dynamics, John Wiley, Singapore 2008
3. Hirsch, A. A., Introduction to computational fluid dynamics, McGraw Hill, New York,2007

References

1. Wirz, H.J, Smeldern, J.J., Numerical methods in fluid dynamics, McGraw-Hill, New York, 2009
2. Ferziger, J.H,Milovan Peric , Computational Methods for fluid dynamics, Springer Verlag ,London, 3rd Edition, 2010
3. Pozrikidis, C., Introduction to Theoretical and Computational Fluid Dynamics, Oxford University Press, London, 2012
4. Bose, T.K., Computation Fluid Dynamics, Wiley Eastern Ltd, Singapore, 2008

CHE17R417 Fluidization Engineering	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite:Nil	**Course Category:** Honors **Course Type**: Theory			

Course outcomes

At the end of the course, the students would be able to

CO1: Explain fluidization behavior

CO2: Estimate pressure drop, bubble size, TDH, voidage, heat and mass transfer rates for the fluidized beds

CO3: Write model equations for fluidized beds

CO4: Design gas-solid fluidized bed reactors

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

Unit 1: Fundamentals of Fluidization **9Hours**

Introduction and applications, Introduction to fluidized bed systems - Fundamentals of fluidization - Industrial applications of fluidized beds, Physical operations - Synthesis reaction, cracking and reforming of hydrocarbons, gasification, carbonization, gas-solid reactions , calcining and clinkering

Unit 2:Design Of Fluidized Bed **9Hours**

Gross behavior of fluidized bed - Minimum and terminal velocities in fluidized beds -Types of fluidization - Design of distributors - Voidage in fluidized beds - TDH - Variation in size distribution with height, viscosity and fluidity of fluidized beds - Power consumption

Unit 3:Analysis Of Bubble And Emulsion Phase **9Hours**

Analysis of bubble and emulsion phase - Davidson's model, frequency measurements, bubbles in ordinary bubbling bed model for bubble phase and emulsion phase - Experimental findings - Turn over rate of solids- Bubbling bed model for emulsion phase - Interchange coefficient

Unit 4:Flow Pattern In Fluidized Beds **9Hours**

Flow Pattern Of Gas , Heat and Mass Transfer In Fluidized Beds - Flow pattern of gas through fluidized beds - Experimental findings - The bubbling bed model for Gas inter change Interpretation of Gas mixing data - Heat and Mass Transfer between fluid and solid Experiment findings on Heat and Mass Transfer - Heat and Mass Transfer rates from bubbling bed model

Unit 5:Heat Transfer In Fluidized Beds **9Hours**

Heat transfer between fluidized beds and surface - Experiment finding theories of bed heat transfer comparison of theories - Entrainment above TDH - Model for entrainment and application of the entrainment model to elutriation

Text Books

1. Zenz, F.A, Othmer, D.F., Fluidization and Fluid Particle Systems (Chemical Industries), CRC, New York, 2003
2. Levenspiel, Octave, Daizeo, Kunii., Fluidization Engineering (Chemical Engineering Series), Second edition 2001

References

1. Davidson, J.F., Harrison.D. Fluidization, Academic Press, California 2009.

CHE17R418 Optimization For Chemical Engineers	L	T	P	C
	3	0	0	3
Pre-requisite:Nil	**Course Category:** Honors **Course Type**: Theory			

Course outcomes

At the end of the course, the students would be able to

CO1: Ability to fit data to linear and nonlinear functions

CO2: Ability to formulate chemical processes as optimization problems

CO3: Ability to solve linear convex objective functions

CO4: Ability to simplify and solve complex chemical engineering processes.

CO5: understanding the Optimal Control and Dynamic optimization

CO/P	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		M	M			H						
CO2				M		M	L					
CO3				H		M						
CO4					H		L					
CO5			M			M					L	

Unit 1:Problem Formulation **9Hours**

Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods Lagrange multiplier methods.

Unit 2:Numerical Methods **9Hours**

Unimodal functions; Newton's quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; random, grid. Hooke's Nelder and Mead methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant methods.

Unit 3:Linear Programming **9Hours**

Review on basic concepts of LP formulations; Simplex methods; Duality in linear programming

Unit 4:Non-Linear Programming **9Hours**

The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming.

Unit 5:Applications **9Hours**

Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale system

Textbooks:

1. Edgar, T.F, Himmelblau, D.M, Ladson, L.S., Optimization of Chemical Practice, McGraw HillInternational , New York, II Edition., 2003
2. Diwaker, U.M., Introduction to Applied optimization, Kluwer Academic Publication, London, 2003
3. Joshi, M.C, Moudgalya, K.M., Optimization, Theory and Practice, Narsoa Publication, New Delhi, 1st Edition, 2004.

References

1. Singiresu, S.Rao., Engineering optimization - Theory and practices, John Wiley and Sons, Singapore,4th edition,2009.
2. Ravindran, Phillips, Solberg., Operations Research, Principles and Practice, John Wiley and Sons, Singapore, 2nd Edition, 2007.
3. Fredick, S.H, Liberman, G.J., Introduction to Operations Research, McGraw Hill Inc, New

HSS18R001 Management Concepts And Techniques	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objecctive(s):

This course addresses the definition of management, its characteristics, evolution and importance as well as the functions performed by manages-planning, organizing, directing and controlling. The course also intends to show students the applications of management functions in various enterprises such as marketing, finance, personnel, production, etc.

Course Outcome(s):

The students will be able to:

CO1: Explain the historical backdrop and fundamentals of Management thoughts vital for understanding the conceptual frame work of Management as a discipline

CO2: Discuss about the various concepts of planning, decision making and controlling to help solving managerial problems

CO3: Understand concepts of Ethics, Delegation, Coordination and Team work

CO4: Study and understand the management concepts and styles in Global context

CO5: Develop an understanding about emerging concepts in management thought and philosophy

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1			H	L	M		M				L	
CO2		H	M				L	H			L	
CO3					M			L	H		M	
CO4		H					L		M		L	
CO5						H				M		

UNIT 1: Development of Management Thoughts **9 Hours**

Scientific Management Movement - Administrative Movement - Human Relations Movement -Decision Movement - Behavioral Science Movement - Systems Movement - Contingency Movement

UNIT 2: Essentials Of Planning **9 Hours**

Planning Objectives – Goals - Programmed Decisions and Un programmed Decisions; Decision – Making - Creativity in Decision - Making, Forecasting and Strategy to Formulation

UNIT 3: Effective Organizing **9 Hours**

Span of Control – Departmentation - Authority; Responsibility - Bureaucracy and Adhocracy; Group Dynamics

UNIT 4: Staffing and Directing **9 Hours**

Staffing: Manpower Planning – Recruitment Sources – Selection Procedure – Training Methods – Performance Evaluation Methods – Executive Development Programs - Directing: Communication Process and Barriers – Motivation Techniques – Financial and Non – Financial Motivation- Leadership Qualities and Styles

UNIT 5: Controlling and Recent Concepts **9 Hours**

Controlling: Meaning and Process - Requisites of Effective Control - Control Techniques. Emerging Issues in Management: Japanese and American Management – Management by Objectives – Knowledge Management – Technology Management – Business Process Outsourcing- Social Responsibility and Business Ethics.

Text Book(s):

1.Harold Koontz & Heinz Weihrich - Essentials of Management: An International, Innovation and Leadership Perspective –McGraw Hill Education (India) Private Ltd. New Delhi - 2016. (10th Edition)

2. Stephen P. Robbins, Mary A. Coulter – Management - Pearson Education Limited, New Delhi - 2016 (13th Edition)

Reference(s) :

1. C.B.Gupta - Management Theory and Practice - Sultan Chand & Sons - New Delhi. - 2017. (19th Revised Edition)

2. L.M.Prasad - Principles and Practices of Management - Sultan Chand and Sons Private Limited - 2015. (9th Edition)

3.K.Aswathappa - Essentials of Business Environment: Text Cases and Exercises - Himalaya Publishing House – Mumbai - 2014 (12th edition)

4.Tripathi & Reddy - Principles of Management - Tata McGraw Hill publishing company Ltd, New Delhi - 2012 (5th Edition)

HSS18R002 Marketing Management	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objective(s):

This course develops students understanding of how organizations match the requirements of consumers in competitive environments, and develop strategies to create the competitive edge. It covers areas such as analysis, planning, implementation, and control, as well as the marketing mix, exportation, and the social aspects of marketing.

Course Outcome(s):

The students will be able to:

CO1: To Develop understanding of marketing concepts, philosophies and historical background

CO2: To Develop understanding of marketing operations and complexities for students to apply in practical business situations.

CO3: To Understand concepts related to Segmentation, Targeting and Positioning, product attributes, and pricing strategies prevalent in domestic and international scenario.

CO4: To Study various tools and techniques of promoting the products in ethical manner.

CO5: To Understand emerging concepts of marketing in the emerging global markets

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	H		M									
CO2		L	H				M					
CO3			H			M	L		H			
CO4		M	H					L				
CO5				L		L	M					

UNIT 1: Marketing **9 Hours**

Meaning - concept - functions - marketing Planning & implementation marketing Programmes - Marketing environment – Market Segmentation and consumer behaviour – Influencing factors, Decision process – Marketing mix – Marketing department.

UNIT 2: Product **9 Hours**

Meaning - Product planning - policies - positioning - New product development Product life cycle – BCG Matrix - branding. Packing, labeling.

UNIT3 : Pricing **9 Hours**

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing.

UNIT 4: Distribution **9 Hours**

Nature of Marketing channels - Types of Channel flows – Channel functions - Channel co-operation, conflict and competition - Direct Marketing Telemarketing, Internet shopping.

UNIT 5: Promotion **9 Hours**

Promotion Mix - Advertisement - Message - copy writing – Advertisement - budgeting - Measuring advertisement effectiveness - Media strategy - sales promotion - Personal selling steps, publicity and direct marketing.

Text Book(s):

1. Philip.T.Khotler, Kevin Lane Keller - Marketing Management - Pearson Education, New Delhi - 2016. (15th Edition)
2. Ramaswamy.VS & Namakumari. S - Marketing Management – Global Perspective, Indian Context - McGraw Hill Education (India) Private Limited, New Delhi - 2013.

Reference(s):

1.Rajan Saxena, Dorector, Jain S.P., Marketing Management, 1st edition, Tata McGraw Hill, New Delhi, 2006

2.K.S.Chandrasekar, Marketing Management, Text & Cases, 1st edition, Tata McGraw hill Education Pvt. Ltd. 2013. 3.Tapan K.Panda, Marketing Management Text and Cases, 2nd Edition, Excel Books.2008.

HSS18R003 Organizational Psychology	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objective(s):

This course aims to clarify the principles and basic concepts of organizational psychology. Including organizations and understanding its business design based on efficiency and quality of employee life. It also aims at enhancing the quality of life of employees. When organization's aspects are gauged in terms of psychological assessment, personnel decisions in line with training and development, organizational change and organizational health in specific the intrinsic problems are understood paving way towards standards that are high.

Course Outcome(s):

The students will be able to

CO1: To learn basic concepts of industrial and organizational psychology
CO2: To illustrate different ways of achieving organizational effectiveness through individual behaviour
CO3: To learn the concepts relating to individual behavior to achieve group target and achieve leadership position in organization
CO4: To understand the organizational changes and means to evaluate based on nature of organizations
CO5: To learn implications of changes aligning the interest of individual, group and organization as a whole.

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	H							M	L	H	L	
CO2			H				L		M		L	
CO3			M			H		H		L	M	
CO4					L	M		L				
CO5	H				L							L

UNIT 1: Focus and Purpose **9 Hours**

Organizational Behaviour - Need and importance, nature and scope, framework.

UNIT2 : Individual Behaviour **9 Hours**

Personality – types – factors influencing personality – theories – learning – types of learners – learning theories – organizational Behaviour modification. Attitudes – characteristics –components – formation – measurement. Perceptions – importance – factors influencing perception – interpersonal perception.

UNIT 3: Group Behaviour **9 Hours**

Organization structure – formation – groups in organizations – influence – group dynamics – emergence of informal leaders and working norms – group decision making techniques – interpersonal relations – communication process and Group Communication.

UNIT 4: Leadership **9 Hours**

Leadership styles – theories – Qualities - leaders Vs managers – sources of power – power centers – power and Organisational Politics- Motivation.

UNIT 5: Organisational Development **9 Hours**

Organizational development - Importance, characteristics, objectives, stability Vs change, proactive vs reaction change, the change process, resistance to change, managing change, team building - Organizational effectiveness, perspective, effectiveness Vs efficiency, approaches, the time dimension, achieving organizational effectiveness

Text Book(s) :

1. Stephen P.Robins and Timothy A . Judge, Organisational Behavior, Pearson Education, 2017.

2. Fred Luthans, Organisational Behavior, McGraw Education, 12th Edition, 2010.

Reference(s):

1. Aswathappa - Organisational Behavior - Himalaya Publishing House –2016. (12th edition)

2. P.Subba Rao - Management and Organisational behavior: Text, Cases and Games - Himalaya Publishing House - 2010. (1st edition)

3. Mullins - Organisational Behavior - Pearson Education Limited - 2010 (9th edition)

4.L.M.Prasad - Organisational Behaviour –Sultan Chand and Sons - New Delhi - 2014. (5th edition)

HSS18R004 Project Management	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective
Course Type : Theory

Course Objective (s):

This course describes concepts relating to project management and enable students to evolve project objectives appropriately with relevance to business proposals. It covers the required dimensions relating to evaluation of project by testing the technical feasibility, financial viability, market acceptability and social desirability of projects. It gives an account on risk and profitability analysis that facilitates the making of the effective project proposal and guides learners in project planning, implementation and control. It also emancipates the scope of project management in undertaking foreign collaboration projects.

Course Outcome(s) :

The students will be able to:
CO1: Familiarizes the concept of project and steps in project management.
CO2: Understand the basics stages involved in preparing business proposals.
CO3: Evaluate the technical feasibility, financial viability, market acceptability and social desirability of projects.
CO4: Enabled to analyse the Risk and profitability of the project proposals
CO5: Act effectively as project managers and as part of project teams
Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	H				M		L			L		
CO2		H					M	L	M			
CO3	H		M			M		L				
CO4		M	L	H			M					
CO5		H		L					H		M	

UNIT 1: Introduction to Project Management **9 Hours**
Projects - Project ideas and preliminary screening. Developments - Project planning to Project completion - Pre-investment phase, Investment phase, operational phase - Governmental Regulatory framework. Capital Budgeting.

UNIT 2: Stages of Project Management **9 Hours**
Opportunity studies - prefeasibility studies, functional studies or support studies, feasibility study expansion projects, data for feasibility study. Market and Technical Appraisal : Market and Demand analysis, Market Survey, Demand forecasting. Technical analysis- Materials and inputs, Choice of Technology, Product mix, Plant location, capacity, Machinery and equipment.

UNIT 3: Appraisal Process **9 Hours**
Concepts. Time value of money - Present and future value - Appraisal criteria - Urgency, Payback period, Rate of return, Debt service coverage ratio, Net present value, Benefit cost ratio, Internal rate of return, Annual capital charge, Investment appraisal in practice.

UNIT 4: Risk and Profitability Analysis **9 Hours**

Risk analysis- Measures of risk, Sensitivity analysis, and Decision tree analysis. Means of financing, Term Loans, Financial Institutions. Cost of capital. Profitability - Cost of Production, Break-even analysis. Assessing the tax burden and financial projections.

UNIT 5: Project Planning, Implementation, And Control **9 Hours**

Forms of Project Organization, Project Planning, Implementation, and Control - Network construction, CPM, PERT, Development of Project schedule, Crashing of Project Network. Introduction to Foreign collaboration projects - Governmental policy framework, Need for foreign technology, Royalty payments, Foreign investments and procedural aspects.

Text Books (s):

1. Prasanna Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation,, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2014. (8th Edition)

2. M.R. Gopalan, Project Management CoreTextbook,(Paper Back) Wiley India, 2015 . (2nd edition)

Reference(s) :

1. Harold Kerzne - Project Management - Best Practices: Achieving Global Excellence - Wiley Publications, 2013 (3rd edition)

2. George Ritz,Sidney Levy - Project Management in Construction - Mc. Graw Hill Education, 2011. (6th Edition) 3.Gary Heerkens - ProjectManagement - Mc. Graw Hill Education, 2013 (2nd Edition)

4. P.Gopalakrishnan and V.E.Rama Moorthy - Text Book of Project Management - Macmillan India Ltd., New Delhi, 2014. (1st Edition)

5. Nicholas, Herman - Project Management for Engineering, Business and Technology,, Routledge, 2016. (5th Edition)

HSS18R005 Stress Management And Coping Strategies	L	T	P	Credit
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type** : Theory			

Course Objective (s) :

Stress has become an integral part of every professional's life. Approaching the stress in the right manner has become imperative as it has become an unavoidable one. The stress and its effect over performance has also become notable in today's organization. In order to cope well and to sustain in market, for that the skills are required to understand and to overcome the same. This course helps in understanding the intricacies of stress and overcoming the stress through appropriate approaches.

Course Outcome(s):

The students will be able to:

CO1: The students understand the responsibility of tackling stress

CO2: The students identify and modify the approaches of stress accordingly while dealing with team in workplace

CO3: Those students who are prone to face high- pressure working conditions will be in a position to tackle stress appropriately without ignoring.

CO4: The students will implement a stress -free work environment.

CO5: The students will enrich their way of behavior and personality as a whole and ensure professional

working condition and balanced quality of life.

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	H		M			L						
CO2		M		H		L			M		M	
CO3	M	H			L		L					
CO4			M		H	L	M					
CO5			H	M		M	L	L				

UNIT 1 - Understanding Stress **9 Hours**

Meaning - Symptoms: Biological and Behavioural - Work Related Stress - Individual Stress – Reducing Stress – Burnout.

UNIT 2 - Common Stress Factors Time **9 Hours**

Common Sources of Stress Biological, Personality and Environmental – Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organizing the Work Area - Prioritizing – Beginning at the start – Techniques for conquering procrastination – Sensible delegation – Taking the right breaks – Learning to say 'No'

UNIT 3 - Crisis Management **9 Hours**

Implications – People issues – Structure issues, environmental issues, psychological fall outs – Learning to keep calm – Preventing interruptions – Controlling crisis – Importance of good communication – Taking advantage of crisis – Pushing new ideas – Empowerment

UNIT 4 - Work Place Humour **9 Hours**

Developing a sense of Humour – Learning to laugh, role of group cohesion and team spirit, using humour at work, reducing conflicts with humour. Coping Styles Defensive Behaviours and Problem-Solving

UNIT 5 - Self Development **9 Hours**

Improving Personality – Leading with Integrity, enhancing creativity – Effective Decision Making – Sensible Communication – The Listening Game – Managing Self - Meditation for Peace – Yoga for Life

Text Book (s) :

1. D. Girdano and G. Everly. - Controlling Stress and Tension – Prentice-Hall - 2013. (9th Edition)
2. Greenberg Jerrold S. - Comprehensive Stress Management –McGraw Hill Education – 2017 (14th Edition)

Reference (s):

1. Dr. P.K.Dutta -Stress Management - Himalaya Publishing House, 2010 (1st Edition)
2. Schafer, Stress Management-, Cengage Learning, Delhi - 2008**.** (4th Edition)
3..Wolfgang Linden - Stress Management, Sage Publication - 2005 (1st Edition)
4. Daniel Girdano, Dorothy Dusek and George S. Everly – Controlling Stress and Tension – Pearson Education - 2009. (8th Edition)
5. Brian Luke Seaward - Essentials of managing Stress - Jones & Bartlett Publishers, 2013. (1st edition)

HSS18R006 Engineering Economics	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective
Course Type : Theory

Course Objective(s):

This course provides an introduction to a broad range of economic concepts, theories and analytical techniques. It considers both microeconomics - the analysis of choices made by individual decision making units (households and firms) - and macroeconomics - the analysis of the economy as a whole. Demand and market structure will be analysed at the firm level. Macroeconomic issues regarding National Income, Inflation, labour and money at an aggregate level will be modelled. The role of government policy to address microeconomic market failures and macroeconomic objectives will be examined.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Identify and learn economic concepts into market economies.

CO2: Understand the pricing methods, interpret the market factors to determine the price for products or services and to making decisions based on demand factors.

CO3: Understand the major characteristics of different market structures and the implications for the behavior of the firm.

CO4: Measure living standards, inflation, and unemployment for use as economic indicators. Understand the role of International Trade.

CO5: Analyze the determinants of the relative strengths of monetary policy for sustainable growth of our nation and International Trade.

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	M		M			L	L					
CO2	M	M		H			L					
CO3	M	H			L		L					
CO4	M		M		H							
CO5			H			M	M					

UNIT 1: Definition and Scope of Economics **9 Hours**

Definitions by A. Smith, A. Marshal and L. Robbins, P.Samuels on and their critical examination - Nature and scope of Economics - Micro-economics in relation to other branches of Economics.

UNIT 2: Pricing and Law of Demand **9 Hours**

Demand, Factors influencing demand, Elasticity of demand - price, income and cross, concepts and measurement - Break Even Analysis – Law of Demand - Price, income and substitution effects - Giffen goods- Pricing Methods.

UNIT 3: Market Structure **9 Hours**

Definition of market. Concepts of product and factor markets. Different types of market: perfect competition, monopoly, imperfect competition, monopolistic, competition and oligopoly. Demand and Supply schedules. Price determination under perfect competition in long and short run. Price determination under monopoly. Discriminating monopoly.

UNIT 4: Macro-Economics **9 Hours**

Meaning, Macro-economic Policy and Its Objectives and Instruments - National Income and Social Accounting - Concepts, components, and measurement - Basic circular flow of income model, Unemployment, trade cycle, Inflation - causes, types, effects and control.

UNIT 5: Commercial and Central Banks **9 Hours**

Credit creation, monetary policy and tools - Balance of payments - Items in the balance of payments account, equilibrium in the balance of payments.

Total: 45 Hours

Text Book(s):

1. Gupta, S.B. - Monetary Economics - S. Chand & Co., New Delhi – 2009 (2nd Edition).
2. Ruddar Datt and K.P.M.Sundharam - Indian Economy - S.Chand & Company Ltd., New Delhi – 2013 (70th Edition).

Reference(s):

1. D.N.Dwivedi - Managerial Economics - S.Chand & Company Ltd., New Delhi – 2005 (8th Edition).
2. Gupta, G.S. - Macroeconomics, Theory and Applications - Tata McGraw-Hill Publishing Company Ltd., New Delhi – 2004 (2nd Edition).
3. D.N. Dwivedi – Macroeconomics: Theory and Policy - Tata McGraw-Hill publishing company Ltd., New Delhi – 2010 (3rd Edition).
4. Andreu M. Colell, Michael D. Whinston and Jerry R. Green – Microeconomic Theory – Oxford Press, New Delhi – 2012 (1st Edition).

HSS18R007 Human Resource Management And Labour Law	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objective(s):

This course aims at exploring key issues related to the management, performance, and development of human resources in the workplace. It places special emphasis on making decisions and developing plans that will enable managers to make the best possible use of their human resources, and covers areas such as: manpower planning, analysis and evaluation, recruitment and selection, wages and salaries, training and management development, performance appraisal, and industrial relations.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: To provide the basic knowledge on developing the employment relations and to resolve the issues.

CO2: To design an appropriate and suitable role of HR specialist for implementing Human Resource Management Policies.

CO3: To Manage the manpower to motivate and attract them to retain in the organization.

CO4: To develop the responsibility of employer and legal system to manage the employment relations.

CO5: To provide more insights on the applicability of business law on various functional domains this in turn enhances a strong human relation.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	L	M			M		L					
CO2			M			L				M		
CO3	M	M		L						M		
CO4	M			H						L		
CO5		H		M			L					

UNIT 1: Fundamentals of HRM **9 Hours**

Human Resource Development Systems-HR environment in India-Functions and Operations of a Personnel Office - Emerging HR Trends - HR information system.

UNIT 2: HRM Functions **9 Hours**

Job analysis and job design - HR planning – Recruitment - selection and induction- Staff Training and Development-Career planning and Development- Job Evaluation-Performance Appraisal and Potential Evaluation-Wage determination; salary structure-Wage policies and Regulations-Employee benefits and services.

UNIT 3: Motivating Human Resources **9 Hours**

Team and Team work - Collective Bargaining Employee Morale – Participative Management – Quality Circle – Empowerment –counseling and mentoring.

UNIT 4: Maintenance of Workers **9 Hours**

Compensation Management- Reward system – Labour relations –Employee Welfare, Safety and Health – Employee benefits and services – Promotion , Transfers and separation – Ethical issues in HR Management and International Human Resource Management - Legal Aspect of Labour.

UNIT 5: Business Law **9 Hours**

Factories Act, 1948 - Industrial Dispute Act, 1947 – Industrial employment – Standing Orders Act, 1946 – Trade Union Act, 1926 - Workmen Compensation Act, 1923, Employees State Insurance Act, 1948, Employees Provident Fund and Miscellaneous Provision Act, 1952, Payment of Gratuity Act, 1972. Payment of Wages Act 1936, Minimum wages Act, 1948– Payment of Bonus Act, 1965.Tamil Nadu Shops and Establishments Act.

Total: 45 Hours

Text Book(s):

1. Decenzo and Robbins - Human Resource Management – Wilsey - 2015 (12th Edition)
2. Prasad L.M. - Human Resource Management - Sultan Chand, New Delhi – 2014 (3rd Edition).

Reference(s):

1.Biswajeet Pattanayak - Human Resource Management - Eastern Economy Edition, New Delhi, 2010 (3rd Edition).

2.C.B. Gupta - Human Resource Management - Sultan Chand, New Delhi 2011,(13th Edition).

3.V.S.P. Rao - Human Resource Management - Excel Books, New Delhi – 2010,(3rd Edition).

4.Frank B. Cross and Roger LeRoy Miller – The Legal Environment of Business Text and Cases - Cengage Learning – 2015 (9th Edition).

HSS18R008 Entrepreneurship Development	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil

Course Category: Humanities Elective

Course Type : Theory

Course Objective(s):

This course focuses on the entrepreneurial process and the different kinds of entrepreneurial outcomes. Topics covered include opportunity identification through analysis of industry niches, skills needed in order to turn an opportunity into reality, business plans, launch decisions, and obtaining risk capital. This course deals with the problems and challenges facing the management of businesses in raising funds, marketing products and services, improving effectiveness and flexibility, and achieving growth.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the concept of entrepreneurship and which in turn leads to think creatively for new business opportunities to sustain individual as well as social goals.

CO2: Promote entrepreneurial spirit and provide a framework of successful business world with relation to agencies to promote employment opportunities.

CO3: Understand women entrepreneurship and promote a successful business models and explains operational implementations for investment details.

CO4: Understand the role of government in promoting the entrepreneurship among the individuals and organizations as a whole

CO5: Understand emerging concepts of marketing in the emerging global markets and provide more insights into project management and venture promotion.

Mapping of course outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	L		M		M		L			L		
CO2			M			L	L	L		M		
CO3	L					L	M	M		H		
CO4	M					M	L		L	H		
CO5			M			L	M	H		M	L	

UNIT 1: Introduction **9 Hours**

Concepts of entrepreneur, entrepreneurship and entrepreneur - Characteristics and competencies of a successful entrepreneur - General functions of an entrepreneur - Type of entrepreneurs - Role of entrepreneur in economic development - Distinction between an entrepreneur and a manager - Entrepreneur and Intrepreneur.

UNIT 2: Growth Of Entrepreneurship **9 Hours**

Emergence of entrepreneurship - Economic and non economic factors for stimulating entrepreneurship development - Obstacles to entrepreneurship development in India - Growth of entrepreneurship in India.

UNIT 3: Women And Entrepreneurship **9 Hours**

Concept of women entrepreneurship - Reasons for growth of woman entrepreneurship - Problems faced by them and remedial measures.

UNIT 4: Role Of The Government In Entrepreneurship Development **9 Hours**

Concept and meaning of entrepreneurship development - Need for entrepreneurship development programmes (EDPs) - Objectives of EDPs - Organizations for EDPs in India; NIESBUD, SISI – their roles and activities.

UNIT 5: Venture Promotion And Project Formulation **9 Hours**

Concept of projects classification of projects and project report - Project identification and selection - Constraints in project identification - Techniques of Project Identification, Significance – contents - formulation of project report - Need for Project Formulation - Elements of project Formulation.

Total: 45 Hours

Text Book(s):

1. Michael H Morris - Corporate Entrepreneurship and Innovation in Corporations - CENGAGE Learning, Delhi – 2010 (7th Edition).
2. Jerry Katz - Entrepreneurship Small Business - Tata McGraw-Hill Publishing Company Ltd., New Delhi – 2007 (5th Edition).

Reference(s):

1. Khanka S.S. - Entrepreneurial Development - S.Chand and Company Limited, New Delhi – 2013 (1st Edition).
2. Prasama Chandra - Projects: Planning, Analysis, Selection, Implementation and Reviews - Tata McGraw-Hill Publishing Company Limited, New Delhi – 1996 (2nd Edition).
3. Robert D. Hisrich – Entrepreneurship - Tata McGraw-Hill Publishing Company Limited, New Delhi – 2017 (10th Edition)

. **HSS18R009 Cost Analysis And Control**	**L**	**T**	**P**	**Credit**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course objective(s):

This course in meant to exhibit the concepts on costing by describing its elements, types and cost sheet preparation. It also encompasses the analytical framework that can be applied in cost analysis like Marginal costing, CVP analysis, Break even analysis, etc enabling the students to make decisions on cost parameters. Students are enabled to apply techniques like standard costing, activity based costing, etc to manage and control cost effectively.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Understand the basics of costing and preparation of cost sheet.

CO2: Analyse the cost by applying tools like Marginal costing, CVP analysis and other applications.

CO3: Prepare budgets for controlling cost in manufacturing or production centres.

CO4: Define cost standards and critically examine the application of Standard costing in a production centre.

CO5: Understand the application of various strategic cost alternatives including activity based costing.

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	H		M	M	H							
CO2	M	H	M	M	L						L	
CO3	M		H	M	H				L			
CO4			H	L			L					
CO5	L				M				L			

UNIT 1: Introduction To Costing **9 Hours**

Costing, Elements of costing, Types of cost, Preparation of cost sheet.

UNIT 2: Cost Analysis **9 Hours**

Marginal costing, Cost - volume – Profit analysis, Break-Even- Analysis, Break –Even - Chart, Applications.

UNIT 3: Control Techniques **9 Hours**

Budgeting and Budgetary control, Types of Budgets , Preparation of purchase Budget, Flexible budgets, Cash Budget, Sales Budget, Materials Budget, Master Budget, Zero based Budgeting.

UNIT 4: Standard Costing **9 Hours**

Types of Standards, Setting up of standards, Advantages and Criticism of Standard Costing –Control through variances.

UNIT 5: Activity Based Costing **9 Hours**

Transfer Pricing, Target costing, Life Style Costing, Activity Based Costing (only theory).

Total: 45 Hours

Text Book(s):

1. K.Saxena& C.D. Vashist - Advanced Cost Accounting and Cost Systems - V.Sultan Chand & Sons Publishers, 2014 (2nd Edition).
2. S.P. Jain & K. L. Narang - Advances Cost Accounting - Kalyani Publishers – 2017 (1st Edition).

Reference(s):

1. J. Blocher, K. H. Chen, G. Cokins and T. W. Lin - Cost Management: A Strategic Emphasis - Irwin/McGraw-Hill – 2008 (3rd Edition).
2. Don R. Hansen&Maryanne M. Mowen - Cornerstones of Cost Management - Cengage Learning – 2015 (6th Edition).
3. Roger Hussey & Audra Ong - Strategic Cost Analysis - Business Expert Press – 2012.

HSS18R010 Product Design And Development	L	T	P	Credit
	3	0	0	3

Pre-requisite: Nil **Course Category**: Humanities Elective

Course Type : Theory

Course Objective(s):

1. To understand the basic characteristics of design of product and its evolution.
2. To be aware of the various approaches related to new product development process.
3. The student will learn about the need for industrial design and its impact on the market.
4. To gain insights about Failure Mode Effective Analysis.
5. To understand the methodologies and tools related to design of new product and the concepts associated to Value engineering.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Learn basic conscepts related to design and development of new product.

CO2: Understand the structured approach towards incorporating quality, safety and reliability into design.

CO3: Learn the concepts relating to simulating product performance and manufacturing processes.

CO4: Understand the technologies related to computer aided group technology.

CO5: Learn implications of changes related to economic analysis.

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	L	H	L		M		M					
CO2	L	M	M	M	M	L						
CO3	H	M	L	L	L							
CO4	M		M	H	L							
CO5		H		M			H					

UNIT 1: New Product Idea **9 Hours**

Definition – Design by Evolution and by Innovation - factors to be considered for product design – Production-Consumption cycle – The morphology of design – Primary design Phases and flowcharting. Role of Allowance, Process Capability, and Tolerance in Detailed Design and Assembly Product strategies, Market research – identifying customer needs – Analysis of product – locating ideas for new products, Selecting the right product, creative thinking, curiosity, imagination and brain storming - product specification.

UNIT 2: New Product Designing **9 Hours**

Task - Structured approaches – clarification – search – external and internal – systematic exploration – conception, selection - methodology benefits. The value of appearance - principles and laws of appearance – incorporating quality, safety, and reliability into design. Man-machine considerations – Designing for ease of maintenance.

UNIT 3: Role Of Technology In Designing **9 Hours**

Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing process – Needs for industrial design-impact – Industrial design process – Technology driven products - user driven products – assessing the quality of the product.

UNIT 4: Methods And Principles Of Designing **9 Hours**

Methodologies and tools - Design axioms - Design for assembly and evaluation - Minimum part assessment - Taguchi Method - Robustness assessment - Manufacturing process rules - Designer's tool kit - Computer aided group process rules - Designer's tool kit - Computer aided group technology - Failure Mode Effective Analysis – Design for minimum number of parts – Development of modular design – Minimising part variations – Design of parts to be multifunctional, multi-use, ease of fabrication – Poka Yoka principles.

UNIT 5: Feasibility Analysis **9 Hours**

Estimation of manufacturing cost – cost procedures – Value Engineering - reducing the component cost and assembly cost – minimizing the system complexity – Basics and Principals of prototyping – Economic Analysis: Break even analysis. Classes of exclusive rights – Patents – Combination versus aggregation – Novelty and Utility – Design patents – Paten disclosure – Patent application steps - Patent Office prosecution - Sales of paten rights - Trade marks – Copyrights.

Total: 45 Hours

Text Book(s):

1. Karl.T.Ulrich and Steven D.Eppinger - Product Design and Development - McGraw Hill International – 2016 (6th Edition).
2. A.K.Chitale and R.C.Gupta - Product Design and Manufacturing - Prentice Hall of India Private Limited, New Delhi – 2005 (3rd Edition).

Reference(s):

1. Richard Crowson - Product Design and Factory Development - CRC Press – 2005 (2nd Edition).
2. Thomke, Stefan, and Ashok Nimgade - IDEO Product Development Boston, MA: Harvard Business School Case 9-600-143 - June 22, 2000.
3. George E.Dieter and Linda C. Schmidt - Engineering Design - McGraw-Hill Higher Education – 2012 (4th Edition).
4. Kevin Otto & Kristin Wood - Product Design, Indian Reprint - Pearson Education – 2004

HSS18R011 Business Process Reengineering	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type** : Theory			

Course Objective(s):

This course aims to clarify the principles and basic concepts of Business Process Engineering. This course focuses on both quantitative and qualitative analytical skills and models essential to operations process design, management, and improvement in both service and manufacturing oriented companies. The main objective of the course is to prepare the student to play a significant role in the management of a world class company which serves satisfied customers through empowered employees, leading to increased revenues and decreased costs.

Course Outcome(s):

The students will be able to

CO1: Learn the basic concepts related to Business Process Reengineering

CO2: Understand the methodologies and tools used for Business Process Reengineering

CO3: Learn the concepts relating to benefit/cost analysis and its impact on the business organizations.

CO4: Understand the need for assessment of business re-engineering and the factors contributing to its success.

CO5: Learn the best practices used in Business Process Reengineering with illustrations from corporate world

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	H			M			L					
CO2		M										
CO3	H			M								
CO4		H				L						
CO5	H					M						

UNIT 1: Basic Concepts **9 Hours**

Introduction to BPR Definition; the paradigm shifts in production; the positioning concept; the reengineering visions; the benefits of business re-engineering.

UNIT 2: Methodologies For BPR **9 Hours**

Methodologies and Tools for BPR, Process management; dynamic business re-engineering change framework; steps to reengineer the process.

UNIT 3: Modelling the Business **9 Hours**

Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering.

UNIT 4: Change Management **9 Hours**

Change Management, Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business reengineering.

UNIT 5: Best Practices in BPR **9 Hours**

Best Practices in BPR, Case studies: Bell Atlantic, Nissan, Chrysler, Xerox, and Hewlett Packard etc.

Total: 45 Hours

Textbook(s):

1. Ali K. Kamrani, Maryam Azimi-New Methods in Product Design: New Strategies in Reengineering (Engineering and Management Innovation) - CRC Press- 2011(1st edition)
2. Bassam Hussein, VDM Verlag Dr. Muellere. K -PRISM: Process Reengineering Integrated Spiral Model. -2008

Reference(s) :

1. Harmon. P -Business Process Change : A Guide for Business Managers and BPM and Six Sigma Professionals- Elsevier/Morgan Kaufmann Publishers-2007.
2. R. Anupindi et al-Managing Business Process Flows: Principles of Operations management-Pearson Education Inc-2006

HSS18R012 Political Economy	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objective(s):

This course provides an introduction to the political economy of India. It examines the interplay of politics and economics. Some of the key themes to be explored are globalization, economic reform, poverty, redistribution, federalism, political protest, public goods delivery, gender, and ethnic politics. Although this class focuses specifically on India, a number of the themes discussed in this course are functions of institutions, rights, Party Systems and challenges.

Course Outcome(s):

The students will be able to

CO1: Explain the key concepts of political economy analyse the significant developments in the political ideologies.

CO2: Describe the salient features of the constitution of India and its functions and also interpret, integrate and critically analyse the fundamental rights duties and responsibilities.

CO3: Understand the Political party system their evolution and role in the economy

CO4: Understand the various ideological of Indian Political Thoughts

CO5: Have a deep understanding and appreciation of India undergoing major economic and social transformation

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	L	H			M							
CO2			M			L						
CO3	H	M		L								
CO4	M			H								
CO5		H		M								

UNIT 1: Introduction to political Economy **9 Hours**

Political Economy as a Method, perspectives, Politics as Reproduction of Social Relations, State and Social Opportunity, Politics of Rent Seeking -Evolution of State in India: Historical Roots of planning, Redistribution.

UNIT 2: Indian Constitution **9 Hours**

The Pre-ample- Fundamental rights and duties, Directive Principles- Offices of the President, Prime Minister, Cabinet Government, Chief Election Commissioner, and Governor – Parliamentary system and Procedures - The Judiciary system.

UNIT 3: Party System **9 Hours**

National and regional political parties, ideological and social bases of parties; patterns of coalition politics; Pressure groups, trends in electoral behaviour; changing socio- economic profile of Legislators.

UNIT 4: Indian Political Thought **9 Hours**

Political Ideologies**:** Liberalism, Socialism, Marxism, Fascism, Gandhism and Feminism - Dharamshastra, Arthashastra and Buddhist traditions; Sir Syed Ahmed Khan, Sri Aurobindo, M.K. Gandhi, B.R. Ambedkar, M.N. Roy.

UNIT 5: Challenges to Indian Democracy **9 Hours**

Uneven Development of Regions in India – Communalism – Regionalism – Violence – Corruption – environmental degradation- illiteracy –Population.

Text Book(s):

1. Charles Sackrey,Geoffrey Schneider,Janet Knoedler- Introduction to Political Economy- Dollars & Sense-2016(8th Edition).

2. Robert. S.Dimand, Routledge - Review of Political Economy: An Introductory Text - 2008 (1st Edition).

Reference(s) :

1. Barry R. Weingast and Donald A. Wittman-Handbook of Political Economy- Oxford University Press, New York- 2006(1st Edition).

2. Ed. Sanjay Ruparelia; Sanjay Reddy; John Harriss & Stuart Corbridge-Understanding India's New Political Economy: A Great Tranformation, Routledge- 2011(1st Edition).

3. M.Laxmikanth-Indian Polity,- McGraw Hill Education, New Delhi-2017(4th Edition).

4. Niraja Gopal Jayal, Pratap Bhanu Mehra-The Oxford Companion to Politics in India: Student Edition-Oxford Press-2011.

HSS18R013 Professional Ethics	L	T	P	C
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objective(s):

It is essential for professionals in any field to have an understanding of the ethical problems and principles in their field. The general principles of professional ethics will be examined, as well as the distinctive problems. This course is presented in three parts: theory; case studies; and research and presentation. Theory includes ethics and philosophy of engineering. Historical cases are taken primarily from the scholarly literatures on engineering ethics, and hypothetical cases are written by students. It will allow students to explore the relationship between ethics and engineering and apply classical moral theory and decision making to engineering issues encountered in academic and professional careers.

Course Outcome(s):

The students will be able to

CO1: Identify the multiple ethical interests at stake in a real-world situation or practice

CO2: Assess their own ethical values and the social context of problems

CO3: Develop critical thinking skills and professional judgement and understand practical difficulties of bringing about change

CO4: Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work

CO5: Manage differing opinions on complex ethical scenarios. It's important for those confronted with ethical challenges to be able to hold multiple conflicting points of view, without necessarily adhering to any of them

Mapping of Course Outcome(s):

CO / PO	PO 1	2	3	4	5	6	7	8	9	10	11	12
CO1	L	H			M							
CO2			M			L						
CO3	H			L			M					
CO4	M			H								
CO5		H		M								

UNIT 1: Engineering Ethics **9 Hours**

Functions of Being a Manager – Stock holder and stakeholder management – Ethical treatment of employees - ethical treatment of customers- supply chain management and other issues.

UNIT 2: Engineering as Social Experimentation **9 Hours**

Senses of Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional ideals and virtues – Theories about right action – Self-interest – Customs and religion – Use of Ethical Theories.

UNIT 3: Engineer Responsibilty for Safety **9 Hours**

Corporate social responsibility - Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

UNIT 4: Responsibility and Rights **9 Hours**

Moral imagination, stake holder theory and systems thinking - One approach to management Decision – making Leadership.

UNIT 5: Global Issues **9 Hours**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample code of conduct.

Text Book(s):

1. Mike Martin and Roland Schinzinger, Introduction to Engineering Ethics, 2nd Edition, McGraw Hill Higher Education, New Delhi, 2010.
2. Charles D Fledderman, Engineering Ethics, 4th Edition, Pearson Education, Delhi, 2011.

Reference(s) :

1. R.S.Naagarazan-Text book on Professional Ethics and Human Values- New Age International- 2007.
2. Gail Baura- Engineering Ethics- An Industrial Perspective- Academic Press- 2006 (1st Edition).
3. Charles e. Harris , Michael s. Pritchard and Michael J. Rabins Texas- Engineering Ethics: Conecpts and Cases- Cengage Learning- 2009(4th Edition).
4. Charles Byms Fleddermann-Engineering Ethics-Pearson Prentice Hall- 2008 (3rd Edition).
5. Govindarajan M, Natarajan S, Senthil Kumar V. S- Engineering Ethics- Prentice Hall of India, New Delhi- 2013.
6. Dr.V.Jeyakumar- Professional Ethics in Engineering- Lakshmi Publication,Chennai- 2014.

HSS18R014 Operations Research	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type** : Theory			

Course Objective(s):

This subject will provide students with ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively. It also provides the knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry. It enhances the skills in the use of Operations Research approaches and computer tools in solving real problems in industry.

Course Outcome(s):

The students will be able to

CO1: Identify and develop operational research models from the verbal description of the real System.

CO2: Able to build and solve Transportation Models and Assignment Models

CO3: Use mathematical software to solve the proposed models.

CO4: Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision making processes in Management Engineering.

CO5: Be able to design new simple models, like: CPM, MSPT to improve decision –making and develop critical thinking and objective analysis of decision problems.

Mapping of Course Outcome(s):

CO / PO	**PO**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	L	H			M							
CO2			M			L						
CO3	H			L				M				
CO4	M			H								
CO5		H		M								

UNIT 1: Introduction to Linear Programming **9 Hours**

Introduction to applications of operations research in functional areas of management - Linear Programming - formulation, solution by graphical and simplex methods (Primal - Penalty, Two Phase), Special cases - Dual simplex method.

UNIT 2: Transportation Models and Assignment Models **9 Hours**

Transportation Models (Minimising and Maximising Cases) – Balanced and unbalanced cases – Initial Basic feasible solution by N-W Corner Rule, Least cost and Vogel's approximation ethods - Check for optimality - Solution by MODI / Stepping Stone method - Cases of degeneracy - Transshipment Models - Assignment Models (Minimising and Maximising Cases) – Balanced and Unbalanced Cases - Solution by Hungarian and Branch and Bound Algorithms - Travelling Salesman problem - Crew Assignment Models.

UNIT 3: Integer Linear Programming and Game Theory **9 Hours**

Solution to pure and mixed integer programming problem by Branch and Bound and cutting plane algorithms - Game Theory - Two person Zero sum games - Saddle point, Dominance Rule, graphical and LP solutions.

UNIT 4:- Replacement Models and Decision Theory **9 Hours**

Replacement Models-Individuals replacement Models (With and without time value of money) – Group Replacement Models - Decision making under risk – Decision trees – Decision making under uncertainty.

UNIT 5: Project Management Method and Simulation **9 Hours**

PERT / CPM – Drawing the network, computation of processing time, floats and critical path. Resource leveling techniques - Application of simulation techniques for decision making.

Text Book(s):

1. Kalavathy S-Operations Research-Vikas Publishing House-2013(4th Edition).
2. Paneerselvam R- Operations Research- Prentice Hall of India- 2006(2nd Edition).
3. Tulsian P.C, Vishal Pandey-Quantitative Techniques (Theory and Problems)Pearson Education, Asia- First Indian Reprint -2002.

Reference(s):

1. D.S.Hira- Problems in Operations Research- Kindle Edition S.Chand- 2010.
2. Prem Kumar Gupta and D.S. Hira- Operations Research- S.Chand- 2016.
3. R.C.Mishra-Principles of Operations Research-New Age International -2011(1st Edition).
4. Kanti Swarup, P.K.Gupta and Man Mohan- Operations Research-Sultan Chand and Sons 2010(15th Edition).

HSS18R015 Total Quality Management	L	T	P	C
	3	0	0	3

Pre-requisite: Nil **Course Category:** Humanities Elective

Course Type : Theory

Course Objective(s):

This subject provides students with the knowledge to understand the philosophy and core values of Total Quality Management (TQM). It helps to determine the voice of the customer and the impact of quality on economic performance and long-term business success of an organization; apply and evaluate best practices for the attainment of total quality. Students who complete this course will be able to critically appraise management techniques, choose appropriate statistical techniques for improving processes and write reports to management describing processes and recommending ways to improve them.

Course Outcome(s):

The students will be able to

CO1: Understand the role and nature of quality in evolving international economic conditions

CO2: Apply the Principles of Quality Management for real time problems

CO3: Understand the quality encounter process, including supporting facilities and customer requirements/characteristics

CO4: Classify quality measurement methods and continuous improvement process

CO5: Frame Management strategy methods, including identification, development, implementation and feedback processes

Mapping of Course Outcome(s):

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	L	H			M							
CO2			M			L						
CO3	H	M		L								
CO4	M			H								
CO5		H		M								

UNIT 1: Introduction to Quality Management **9 Hours**

Definitions – TOM framework, benefits, awareness and obstacles - Quality – vision, mission and policy statements - Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.

UNIT 2: Principles and Philosophies of Quality Management **9 Hours**

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingeo and Walter Shewhart - Concepts of Quality circle, Japanese 5S principles and 8D methodology.

UNIT 3: Statistical Process Control and Process Capability **9 Hours**

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed - Process capability – meaning, significance and measurement – Six sigma concepts of process capability - Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve - Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

UNIT 4: Tools and Techniques for Quality Management **9 Hours**

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation.

UNIT 5: Taguchi Techniques **9 Hours**

Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio - Seven old (statistical) tools - Seven new management tools - Bench marking and POKA YOKE.

Text Book(s):

1. Poornima M. Charantimath- Total Quality Management- Pearson Education- 2011 (2nd Edition).
2. Dale H. Besterfield et al- Total Quality Management- Perarson Education- First Indian Reprints -2004(3rd edition).

Reference(s):

1. Shridhara Bhat K- Total Quality Management – Text and Cases- Himalaya Publishing House-2002(1st edition).
2. Jams R. Evans- Total Quality: Management, Organisation and strategy, South- Western College- 2004(4th edition).
3. Vincent K. Omachonu, Joel E.Ross- Principles of Total Quality- CRC Press-2004 (3rd edition).
4. S.Rajaram, M.Sivakumar- Total Quality Management-Wiley Publishers-2008(1st Edition).

HSS18R 016 – ADVANCED SOFT SKILLS

EFFECTIVE COMMUNICATION

Comprehending Ability, Business Vocabulary, Speed Reading, Non-Verbal Communication, Cross Cultural Communication, Meeting Management, Technology trend awareness

QUANTITATIVE ABILITY

Time & Work, Time-Speed-Distance, Permutation & Combination Probability, Geometry & Mensuration, Number Properties, Ratio & Proportion, Mixtures & Alligation, Percentages, Profit-Loss-Discount, Averages, Progression, Higher Mathematics

LOGICAL ABILITY

Non-Verbal Reasoning, Deductive & Inductive Reasoning, Binary Logic, Number Series, Clocks, Calendars

VERBAL ABILITY

Reading Comprehension, Parajumbles, Critical Reasoning, Subject-Verb Agreement, Synonyms & Antonyms, Grammar Reading Comprehension & Logic Miscellaneous Verbal questions

DATA INTERPRETATION

Line Charts, Bar Charts, Pie Charts, Venn diagrams, Caselets, Data tables