Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2019-2020)

First Year

1st SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Total contact hours	Mid Term	End Term	Total Marks	Credits
			L	T	P					
1.	BS101	Mathematics –I	3	1	-	60	50	50	100	4
2.	BS102	Physics	3	1	-	60	50	50	100	4
3.	BS103	Chemistry (Inorganic)	3	-	-	45	35	40	75	3
4.	HSMC-HASS 101	Communication Skills	1	-	-	15	10	15	25	1
5.	ESC-GES 151	Engineering Graphics	-	-	3	45	40	-	40	1.5
6.	ESC-GES 152	Engineering Workshop	-	-	3	45	40	-	40	1.5
7.	BS152	Physics Lab.	-	-	2	30	25	-	25	1
8.	BS153	Chemistry (Inorganic) Lab.	-	-	3	45	40	-	40	1.5
9.	HSMC-HASS 151	Communication Skills Lab.	-	-	2	30	25	-	25	1
		Total	**10**	**2**	**13**	**375**	**315**	**155**	**470**	**18.5**

Note:

- NSS/NCC/Sports proficiency/Community services/Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)

L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

1. Mid-Term
   a. One best of two minor tests (50% of Mid -term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)
2. End -Term

2nd SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Total contact hours	Mid Term	End Term	Total Marks	Credits
			L	T	P					
1.	BS104	Mathematics –II	3	1	-	60	50	50	100	**4**
2.	BS105	Chemistry (Organic)	3	-	-	45	35	40	75	3
3.	ESC-GES103	Electrical & Electronics Engineering	3	1	-	60	50	50	100	4
4.	PCC-CS101	Material & Energy Balance	3	1	-	60	50	50	100	4
5.	ESC-GES104	Computer Programming for problem solving	2	-	-	30	25	25	50	2
6.	ESC-GES153	Electrical & Electronics Engineering Lab.	-	-	3	45	40	-	40	1.5
7.	BS155	Chemistry (Organic) Lab.	-	-	3	45	40	-	40	1.5
8.	ESC-GES154	Computer Lab.	-	-	2	30	25	-	25	1
		Total	**14**	**3**	**8**	**375**	**315**	**215**	**530**	**21**

Note:

- NSS/NCC/Sports proficiency/Community services/Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)

L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

1. Mid-Term
   a. One best of two minor tests (50% of Mid -term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)
2. End -Term

SYLLABUS OF B.E. CHEMICAL ENGINEERING 2019-2020
FIRST YEAR

1st SEMESTER

Title	**MATHEMATICS-I**		**Credits**	04
Code	BS101	**Semester:-**1st	**L T P**	3 1 -
Max.Marks	**End term- 50**	**Mid term- 50**	**Elective**	N
Pre requisites			**Contact Hours**	60
Objectives	To make the students 1. Understand the behaviour of infinite series and their use. 2. Learn the concepts related to functions of several variables and their applications. 3. Understand the concept of Vectors and its applications. 4. Learn the methods of evaluating multiple integrals and their applications to various problems. 5. Learn the methods to formulate and solve linear differential equations and apply them to solve engineering problems.			
Note for the Examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section. The duration of End Term exam will be 3 hrs.			
SECTION- A				
Infinite Series: Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series.				
Multivariable Functions: Limit, Continuity and Partial Derivatives; Euler's Theorem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula.				
Vector Deferential Calculus and Integral Theorems: Gradient, Divergence, Curl, Statement of Green's, Gauss and Stoke's Theorem and their simple applications.				
SECTION- B				
Solid Geometry: Cylinders and Cones, Cylindrical and Spherical Polar Coordinates				
Integral Calculus: Area between plane curves; Volumes of solids of revolution; Lengths of plane curves; Areas of surfaces of revolution. Double integrals in rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical coordinates, Substitutions in Multiple Integrals.				
Ordinary Differential Equations: First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian.				
Text books:	1. G. B. Thomas, R. L. Finney: Calculus and Analytic Geometry, Ninth Edition, Pearson Education. 2. E. Kreyszig: Advanced Engineering Mathematics, Eighth Edition, John Wiley.			
Reference Books:	1. B. V. Ramana: Higher Engineering Mathematics, Tata McGraw Hill. 2. B. S. Grewal: Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi. 3. Differential Equations, Frank Ayers, TMH			

Course Outcomes	The students are able to 1. test the behaviour of infinite series. 2. analyze functions of several variables and their applications. 3. operate vectors and convert line integral to surface integral to volume integral. 4. evaluate multiple integrals and apply them to practical problems. 5. solve linear differential equations.

Title	**PHYSICS**			**Credits**	04
Code	BS102	**Semester:-** 1st		**L T P**	3 1 -
Max.Marks	**End term- 50**	**Mid term- 50**		**Elective**	N
Pre requisites				**Contact Hours**	60
Objectives	Basic concepts of optics and its applications, electromagnetism and magnetism properties, and Structural characterizations.				
Note for the Examiner					

SECTION A

1. Optics and Fibre Optics (12L + 4T)

- 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.

- Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.

- Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.

- Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.

2. Structural Characterization: (16 hours+5T)

Crystal Lattice, points groups, Bravais lattices, crystal systems, X ray diffraction Symmetry X-ray generation, Bragg Law, factors influencing intensity, Techniques, Indexing, precise lattice parameter determination, residual stress measurement

SECTION B

3. Electromagnetism and Magnetic Properties of Materials (17L + 6T)

Dielectric Materials: Review of basic formulas, dielectric constant and polarizability, sources of polarizability, classical treatment of dipolar, ionic and electronic polarizability, piezoelectricity, ferroelectrcity. (4)

Magnetic Materials: Review of basic formulas, magnetic susceptibility, classification of materials, Langevin diamagnetism, paramagnetism (only classical treatment), magnetism in metals, ferromagnetism in insulators, anti-ferromagnetism and ferrimagnetism, ferromagnetism in metals, ferromagnetic domains, hysteresis (8)

Superconductivity: Zero resistance, occurrence of superconductivity, Meissner effect, critical field, thermodynamics of superconducting transitions, electrodynamics of superconductors, qualitative idea of BCS theory. (3)

Nanotechnology: Nanomaterials and its applications, chemical and physical synthesis techniques of nano-powder and thin films. (2)

Text Books	1. Introduction to Solid State Physics: Charles Kittle 8th Ed.
Reference Books	a. Material science and Engineering – An Introduction by William D Callister, Jr, Sixth Edition, John Wiley and Sons. b. Material science and Engineering – A First Course by V.Raghvan Fourth Edition, EasternEconomy Edition c. Introduction to Solids (Tata McGraw Hill, Third Edition) - Leonid V Azaroff
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term

Course outcomes

Students will be familiar with

- Bragg's Law and introduced to the principles of lasers, types of lasers and applications
- Various terms related to properties of materials such as, permeability, polarization, etc.
- Some of the basic knowledge of structural properties, crystal structure as well as magnetic and dielectric properties of materials

Title	**CHEMISTRY (INORGANIC)**		**Credits**	03
Code	BS103	**Semester:-**1st	**L T P**	3 - -
Max.Marks	**End term- 40**	**Mid term- 35**	**Elective**	N
Pre requisites			**Contact Hours**	45
Objectives				
Note for the Examiner				

Section A

Introduction to quantum theory for chemical systems : Quantum theory and atomic structure: Introduction to wave mechanics, the Schrodinger equation, as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals from the Schroedinger equation . 06 hrs

Chemical Bonding and structure Part I : Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules. Bonding in Coordination Compounds: Theories of bonding i.e , Werner's theory, effective atomic number, valence bond theory, crystal field theory, crystal fields plitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Kinetic and Thermodynamic aspects of coordination compounds (crystal field stabilization energies of octahedral and tetrahedral complexes, spectrochemical series).Electronic spectra and magnetic properties of complexes.. 10 hrs

Homogeneous catalysis/mechanism of industrially important reactions :Organometallic Compounds: Nomenclature, types of ligands and bonding in organometallic compounds, The catalytic properties of the organometallic compounds and the mechanism of homogeneous catalysis for important industrial processes like hydrogenation, polymerisation and hydroformylation etc. 06 hrs

SECTION B

Chemical Bonding and structure Part II: LigandSubstitution reactions in complexes with coordination numbers 4 and 6 and their mechanism . Kinetic aspects of substitution in coordination

compounds; Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism and measurement of magnetic susceptibility of complexes by Guoy's method. 09 hrs

Inorganic polymers: Types of inorganic polymers, polyphosphazenes, polysiloxanes –their structures and properties. 05hrs

Bio-inorganic Chemistry of Iron and cobalt – Heme proteins, Non-Heme iron proteins, Iron Sulphur proteins and coenzyme B_{12} ; 05 hrs

Metal Toxicology : Toxic effects of heavy metals with special reference to Cd, Pb, Hg and As. 04hrs

Recommended Books:

1. Sharpe, A. G. : Inorganic Chemistry, 3rd Edition, Longman Publishers ELBS, 1992.
2. Lee, J. D. : Concise: Inorganic Chemistry, 5th Edition, Chapman and Hall Publishers, 1996.
3. Cotton, F. A. & Wilkinson, G. : Advanced Inorganic Chemistry, 3rd Edition,Wiley Eastern Ltd., 1982.
4. Cotton, F. A. & Wilkinson, G. : Basic Inorganic Chemistry, Wiley EasternLtd., 1987. 12
5. Mark, J., West, R. &Allcock,H. : Inorganic Polymer, Prentice Hall, New Jersey Publishers, 1982.
6. Basola, F. & Pearson, R. G. : Inorganic Reaction Mechanism, 2nd Edition, Wiley Eastern Publishers, 1984.
7. Amdur, Doull&Klaasen (Eds.) :Casarett and Doulls Toxicology, Pergamon Press, New York, 1991.
8. William &Burson (Eds.) : Industrial Toxicology: Safety and Health applications in the work place, Van Nostrand – Reinhold, New York, 1985.
9. *Inorganic Chemistry*: Principles Of Structure And Reactivity, 4e By James E. Huheey , Ellen A. Keiter , Richard L. Keiter

Title	**COMMUNICATION SKILLS**		**Credits**	1
Code	HSMC-HASS 101	**Semester:- 1st**	**L T P**	1 - -
Max. marks	**End term- 10**	**Mid term- 15**	**Elective**	N
Pre-requisites			**Contact hours**	15
Objectives	1. To inculcate effective communication skills in students for better performance in professional as well as personal life 2. To improve personality of students with advanced techniques in verbal, non verbal and para verbal communication.			
Note for the Examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section. The duration of End Term exam will be 3 hrs.			

SECTION A

Advanced Communication Skills

Scope, Significance, Process of Communication in an Organization, Types and Levels, Communication Networks, Technical Communication, Tools of Effective Communication, Barriers of Communication.

Speaking Skills

Interpersonal Communication, Presentation Skills, Voice Modulation, Persuasion, Negotiation and Linguistic Programming, Public Speaking, Group Discussions, Interviews and Case Studies, Conducting Meetings and Conferences

Personality Development

Body Language and importance of Non Verbal communication, Social and Professional etiquettes.

SECTION B

Communication and Media

Social and Political Context of Communication, Recent Developments in Media	
Advanced Techniques in Speaking Skills Importance of Listening/Responding to native and global accents, Telephonic Interviews and Video Conferencing	
Advanced Techniques in Technical Writing Job Application, CV Writing, Business Letters, Memos, Minutes, Reports and Report Writing Strategies, E-mail Etiquette, Blog Writing, Instruction Manuals and Technical Proposals	
Text Books	1. Ashraf, M. Rizvi, "Effective Technical Communication", McGraw Hill 2. Bovee, Courtland L. and John, V. Thill, "Business Communication Today", Pearson Education
Reference Books	1. Sharma, R.C. and Mohan, K., "Business Correspondence and Report Writing", Tata McGraw Hill 2. Raman, Minakshi and Sharma, S., "Technical Communication: Principles and Practice", Oxford University Press 3. Scott, Bill, "Communication for Professional Engineers", Thomas Teleford Ltd. 4. McMurrey, David A. and Joanne, Buckley, "Handbook for TechnicalWriting", Cengage Learning 5. Harve, L., Locke, W. and Morey, A., "Enhancing Employability and Recognizing Diversity", Universities UK and CSU 6. Lock, R., "Student Activities for taking charge of your Career Direction and Job Search", Cole Publishing Pease, A., "Body Language", Sheldon Press
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term
Course Outcomes	1. Gain proficiency in English language as medium for communication in both professional and personal life 2. Increase in employment prospective of students by developing technical aspects of communication. 3. Personality development of students by thorough knowledge of effective and enhanced communication skills

Title	**ENGINEERING GRAPHICS (PRACTICAL)**		**Credits**	1.5
Code	ESC-GES 151	**Semester:-**1st	**L T P**	- - 3
Max. Marks	**Practical-** 40		**Elective**	N
Pre requisites			**Contact Hours**	45
PRACTICAL				
Objectives	Objectives of the Engineering Drawing course are: 1. To introduce the students to visual science in the form of technical graphics. 2. To give general instructions related to Theory of Orthographic Projection of points, lines, planes and solids as per the BIS codes prevalent to drawing practices. 3. To upgrade the basic understanding and visualization of geometric objects and machine parts by introducing the students to section of solids, intersection and development of surfaces, isometric projection and orthographic projection of simple solids/blocks.			

	4. To introduce the students to Computer graphics to enhance understanding of the subject.
1. Introduction to engineering drawing, instruments, symbols and conventions in drawing practice.	
2. Types of lines and BIS codes for lines, dimensioning	
3. Introduction to methods of projections: Orthographic projection, Isometric projection	
4. Projection of points, lines, planes and solids on principal and auxiliary planes.	
5. Sectioning of solids, Intersection of solids	
6. Development of surfaces	
7. Drawing of threaded fasteners and assembly drawing	
8. Introduction to CAD software.	
Recommended Books:	1. P.S. Gill: Engineering Drawing 2. R.K. Dhawan : A textbook of engineering Drawing, S. Chand & Co. Ltd. New Delhi 2nd edition. 3. P.S.Gill: Machine Drawing 4. Sham Tickoo : Understanding AutoCAD 2006, Wiley Publication 5. James D. Bethune : AutoCAD, Pearson Publishers
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.
Course Outcomes	Student will be able to 1. understand the basics of engineering drawing. 2. visualize the different types of geometrical objects and the assembly drawing of machine parts.

Title	**ENGINEERING WORKSHOP (PRACTICAL)**		**Credits**	1.5
Code	ESC-GES 152	**Semester:- 1st**	**L T P**	- - 3
Max. marks	**Practical –** 40		**Elective**	N
Pre-requisites			**Contact hours**	45
PRACTICAL				
Objectives	• To make the students understand the need and importance of different manufacturing techniques. • To introduce the different tools and equipments used in mechanical workshops and develop the skill to use the same.			
Carpentry Shop: Description and use of carpenter's tools, Wood and timber, defects found in wood, seasoning of wood. Different types of timber in common use, making of lap joint, Bridle joint, dovetail joint and Mitre joint.				
Electric Tools: Exercise of wiring in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches, Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance, Relevant Indian Electricity Rules.				
Machine Shop:Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. Simple turning, threading, drilling board and knurling operations on a lathe.				
***Welding*:**Introduction to electric arc welding, gas welding and their use in making different types of joints e.g. lap joint, butt joint and T joint.				
Reccomended Books	1. Raghuwanshi, B.S. : A course in Workshop technology, Vol 1 & II, Dhanpat Rai & Sons , New Delhi. 2. Swarn Singh: Workshop Technology.			
Course Outcomes	Students will be able to 1. Understand the theory of different manufacturing techniques and tools . 2. Do practices by hand			

Title	PHYSICS LAB.		Credits	1
Code	BS152	Semester:- 1st	L T P	- - 2
Max. marks	Practical – 25		Elective	N
Pre-requisites			Contact hours	30

Objectives

Physics lab provides students the firsthand experience of verifying various theoretical concepts learnt in theory courses.

In a semester at least 10 experiments to illustrate the concepts learnt in Physics (Number of lab. Hrs. 2 per experiment)

1. To find the energy band gap of the given semiconductor by four probe method.
2. To study the Hall Effect of a given semiconductor
3. To determine the dielectric constant of the given materials.
4. To study the B-H curve of the ferromagnetic materials.
5. To determine the value of e/m for electron by long solenoid (helical) method.
6. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph
7. To determine the velocity of ultrasonics waves in a given liquid.
8. To determine the frequency of A.C. mains using a sonometer and an electro-magnet.
9. To find the capacitance of a capacitor using flashing and quenching of a neon lamp.
10. To plot graph between current and frequency in a series LCR circuit and to find the resonant frequency.
11. To find the wavelength of sodium light using Fresnel's biprism.(3)
12. (i) To determine the wavelength of He-Ne laser using transmission grating.
    (ii) To determine the slit width using the diffraction pattern.
13. To determine the wave length of sodium light by Newton's rings method.
14. To determine the wave length of sodium light using a diffraction grating.
15. To find the specific rotation of sugar solution using a Bi-quartz Polarimeter.
16. To design a hollow prism and used it find the refractive index of a given liquid
17. To synthesize the nanoparticles by chemical methods and structural characterization through X-ray diffraction.
18. To investigate the optical band gap of nanomaterial using UV-vis spectroscopy.
19. Fabrication of thin films by spray pyrolysis technique.
20. Fabrication of thin films using spin coater technique.

Text Books	1. Practical Physics by CL Arora, S Chand & Co. 2. Engineering physics by S.K. Srivastva
Reference Books	A text book of practical physics by William & Watson
Course Assessment Methods	One *project out of 6 carries 40% marks, 20% for respective viva and 20% for external exams and 10% for attendance.
Course outcomes	The student will gain • Proficiency in technical aspects of performing the experiments. • Proficiency in designing scientific projects

Title	CHEMISTRY (INORGANIC) LAB.		Credits	1.5
Code	BS153	Semester:- 1st	L T P	- - 3
Max. marks	Practical – 40		Elective	N
Pre-requisites			Contact hours	45

I. Volumetric Analysis :

(i) Redox Titrations :-Titrations involving

a) KMnO4 (Estimation of C2O4 -2) 02
b) $K_2Cr_2O_7$ (Estimation of Fe+2/Fe+3) 02
c) Iodine [Iodometry&Iodimetry] (Standardisation with Sodium Thiosulphate,Estimation of Cu+2, AsO3 -3 and Sb+3) 04

(ii) Complexometric Titrations- Determination of Zn+2 by EDTA titration. 02

II Gravimetric Analysis
a) Estimation of Ba+2/SO4 -2 as BaSO4
b) Estimation of Fe+2/Fe+3 as Fe2O3 04

Text Book: Vogel's Qualitative Inorganic Analysis, 7th Ed. By G. Svehla, Pearson Education.

Course Outcomes

The student will be able to

1. apply the concept of normality, molarity and oxidation and reduction and apply redox titrations involving potassium dichromate and Iodine
2. use Complexometric Titrations to determine metal ions by EDTA method.
3. use gravimetric procedures for estimation (Estimate Ba^{+2}/$SO4^{-2}$, and Fe^{+3})

Title	**COMMUNICATION SKILLS LAB.**		**Credits**	1
Code	**HSMC-HASS 151**	**Semester:- 1st**	**L T P**	- - 2
Max. marks	**Practical –** 25		**Elective**	N
Pre-requisites			**Contact hours**	30

Objectives	1.To develop better pronunciation and communication skills. 2.To be able to face interviews and participate in conferences or any personal or professionals discussions with confidence. 3.To develop technical writing skills. 4.To be able to articulate ones voice and overcome stage fright.

Organizational Communication

Verbal and Non-Verbal Communication at different levels of organization, Role Play, Interaction with Bosses and Co-employees

Speaking Techniques

Preparation of Interviews, Participation in Group Discussions and Case Studies, Making and Presenting Power Point Lectures.

Advanced Speaking Techniques

Conducting Meetings and Conferences, Exposure to different Accents, Listening and responding in the global scenario, Telephonic Interviews/Conversations, Video Conferencing

Technical Writing

Writing Letters, Memos, Minutes, Notes, CV, Job Applications, Reports and e-mails, Preparing Instruction Manuals and Technical Proposals

Course outcomes	1. English Speaking skills of students will be enhanced. 2. Students will become self confident in handling both professional and personal meetings/discussions. 3. Students will be able to demonstrate improved technical writing skills. **4.** Overall personality of students as well as their communication skills will be developed.

2nd SEMESTER

Title	**MATHEMATICS-II**		**Credits**	4
Code	BS104	**Semester:- 2nd**	**L T P**	3 1 -
Max marks	**End term- 50**	**Mid term- 50**	**Elective**	N
Pre-requisites			**Contact hours**	60
Objectives	The students shall • Learn to expand various functions in terms of Fourier series. • Learn the methods to formulate and solve partial differential equations. • Be taught to apply the method of separation of variables to solve partial differential equations of engineering interest. • Learn to find Laplace transforms and inverse transforms and apply these to solve differential equations. • Understand the concept of Complex functions and their applications to various problems.			
Note for examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section. The duration of End Term exam will be 3 hrs.			

SECTION A

Fourier Series
Euler's Formulae, Dirchielet's Conditions for Expansion, Change of interval, Odd and Even Functions, Expansion of Odd and Even Periodic Functions, Introduction to Harmonic Analysis.

Partial Differential Equations (Pde's)
Formation and classification of partial differential equations, first order linear equations, standard forms of non linear equations, Charpit's method, homogeneous linear equations with constant coefficients.

Engineering Applications OfPde's
Method of separation of variables , Solution of partial differential equations of engineering interest by the method of separation of variables.

SECTION B

Laplace Transforms
Definition, Transforms of Elementary functions, Properties of Transforms, Inverse Transforms, Transforms of Derivatives, Unit Step Function, Dirac's Delta Function & Unit Impulse function. Periodic Functions, Application of Transform to the solution of ordinary Differential equations

Calculus Of Complex Functions
Functions of complex variables, analytic functions, Cauchy-Riemann equations, Cauchy's theorem, Cauchy's integral formula, introduction to Tayler's series and Laurent's series, Residues, Residue theorem and its simple applications.

Text Books	1. G. B. Thomas, R. L. Finney: Calculus and Analytic Geometry, Ninth Edition, Pearson Education. 2. E. Kreyszig: Advanced Engineering Mathematics, Eighth Edition, John Wiley.
Reference Books	1. B. V. Ramana: Higher Engineering Mathematics, Tata McGraw Hill. 2. B. S. Grewal: Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi. 3. Differential Equations, Frank Ayers, TMH
Course Outcomes	The students are able to: 1. expand functions in terms of Fourier series. 2. formulate and solve partial differential equations. 3. solve partial differential equations of engineering interest. 4. find Lapalacetransforms, inverse transforms and apply these to solve various

	differential equations. 5. evaluate complex integrals and apply these to various problems.

Title	**CHEMISTRY (ORGANIC)**			**Credits**	3
Code	BS105	**Semester:- 1st**		**L T P**	3 - -
Max marks	**End term- 40**	**Mid term- 35**		**Elective**	N
Pre-requisites				**Contact hours**	45

SECTION A

Reactivity of organic molecules: Shapes and Molecular orbital structures of compounds containing C, N and O. Conformations of cyclic and acyclic systems, structures of dienes, pyridine, pyrrole, aromatic compounds. Factors affecting acidity,basicity and nucleophilicity of molecules (Kinetic as well as thermodynamic aspects) 08hrs

Delocalisation: Concept of aromaticity, stability of cycloalkanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating groups. 06hrs

Stereochemistry : Enantiomers, Diastereomers, Meso-and Racemic compounds, Resolution of racemic mixture. Asymmetric synthesis, Walden Inversion, Configuration (D and L nomenclature), Absolute con figuration (R , S, E and Z nomenclature) 08hrs

SECTION B

Organic Reagents and Reaction Intermediates : free radicals, carbonium and carbanions and the mechanism of important substitution,elimination as well as important rearrangenet reactions-- : House synthesis, halogenation of alkanes, free radical mechanism, orientation, reactivity and selectivity ;catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophillic addition reactions, peroxide effect, mechanism of allylic substitution, acidity of 1-alkynes, conjugated dienes, 1,2-and 1,4- additions, free radical and ionic mechanisms of addition polymerisation reactions, ringopening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkylbenzenes, aromatic electrophillic substitution reactions, nucleophilic substitution Friedel-Crafts reactions, Anisole nucleophilic addition, Aldol condensation 18hrs

Synthetic utility of diazonium salts, synthetic utility of Grignard reagents and alkyllithiumsk, basicity of amines, multistep synthesis. 05hrs

Books Recommended:

1. Bahl, B. S. &Bahl, Arun : Text-book of Organic Chemistry, 16th Edition, S. Chand and Company Ltd., New Delhi.
2. Solomons, T. W. G. : Fundamentals of Organic Chemistry, John Wiley and Sons, Inc., New York, 1994.
3. Morrison &Boyd : Organic Chemistry, Pearson education, 6th edition, 2007.
4. F.A.Carey: Organic Chemistry, Tata McGraw Hill, 7th edition, 2008.
5. Mukherji& Singh: Reaction mechanism in organic chemistry, Macmillan India Ltd.,

Title	**ELECTRICAL AND ELECTRONICS ENGINEERING**		**Credits**	4
Code	ESC-GES103	**Semester:- 2nd**	**L T P**	3 1 -
Max. marks	**End term- 50**	**Mid term- 50**	**Elective**	N
Pre-requisites			**Contact hours**	60
Objectives	• To provide students about basic knowledge of A.C and D.C circuits, theorems, laws. • Introduce to the students about difference between single phase and three phase system. • To teach the students basic principle of operation of transformers and other			

	electrical machines. • To make them aware of the difference between analog and digital system and study diodes, rectifiers, digital circuits.
Note for examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section. The duration of End Term exam will be 3 hrs.
SECTION A	
DC Circuits and Single Phase A.C. Fundamentals General introduction to Electrical Engineering, Kirchoff'sLaws ,Mesh and Node analysis, Superposition theorem , Thevenin Theorem, Norton Theorem, Maximum power transfer theorem. Generation of alternating voltages and currents, Equations for AC quantities, cycle, time period, frequency, amplitude, calculation of R.M.S values, Average values for different waveforms, solution and phasor diagram of single phase AC circuit with sinusoidal source of excitation, series and parallel combination of R-L-C circuits.	
Three Phase AC Fundamentals Disadvantages of single phase system, star and delta connection in three phase circuits, relation between line and phasor quantities, power in three phase system, solution of three phase balanced circuits, power and power factor measurement by two wattmeter method.	
Electrical Machines **B**asic principle and construction of transformers, E.M.F equation, approximate equivalent circuit, phasor diagram, losses, efficiency and condition for maximum efficiency, open circuit and short circuit test on single phase transformers. Operating principle and construction of three phase induction motors, Operating principle and construction of DC Machines, types of DC Machine & E.M.F equations	
SECTION B	
Semiconductor Diodes and Transistors General introduction to Electronics.Concept of stiff Voltage and Current Source. PN Junction, Depletion layer, Barrier Potential, Forward and Reverse Bias, Breakdown voltage, V-I characteristics, Half wave and full wave rectifiers, Zener diode. Introduction to junction transistors, Transistor amplifying action, CB, CE, CC-configuration characteristics.	
Digital Electronics Binary and Hexadecimal number system, conversion of numbers from one system to other, OR, Relations: Commutative, Associative and Distributive Laws. Concept of flip-flops, RS,JK flip flops, shift register.	
Text Books	1. Edward Hughes: Electrical and Electronic Technology, Pearson Education Publication, Asia, 2003. 2. Nagsarkar, T.K. and Sukhija M.S.: Basic Electrical Engg., Oxford University Press, 2004. 3. Bhargava: Basic electronics and Linear circuits, Tata McGraw Hill.
Reference Books	1. Nagrath, I.J. and Kothari, D.P.: Basic Electrical Engg., TMH, New Delhi. 2. Malvino: Digital Principles and Applications, Tata McGraw Hill
Course Outcomes	1. The student will understand how various loads are connected in circuits and difference between single and three phase system. 2. The students will know the principles and working of different types of electrical machines used in industry 3. The students will have the basic knowledge of digitalization and conversion of physical quantity to digital quantity.

Title	MATERIAL AND ENERGY BALANCE		Credits	04
Code	PCC-CS101	Semester:-2nd	L T P	3 1 -
Max.Marks	End term- 50	Mid term- 50	Elective	N
Pre requisites			Contact Hours	60
Note for examiner				

SECTION-A

Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.

Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.

SECTION-B

Material Balances for Reacting systems including balances involving recycle and purge streams.

Combustion Calculations.

Energy balances on nonreactive and reactive systems.

***Books Recommended*:**

1. Bhatt, V. I. & Vora, S. M. : Stiochiometry, 3rd Edition, Tata McGraw Hill, 1984.
2. Himmelbleau, D. M. : Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall, 1977.
3. Felder, R. M. & Rousseau R.W. : Elementary Principles of Chemical Processes, 3rd Edition, John Wiley and Sons, 1986.
4. Reklaithis, G. V. : Introduction of Material and Energy balances, John Wiley, 1983.
5. Lubyben, L.W. & Winzel, L. A. : Chemical Process Analysis, 2nd Edition, Prentice Hall, 1988.

Title	COMPUTER PROGRAMMING FOR PROBLEM SOLVING		Credits	2
Code	ESC-GES 104	Semester:-2nd	L T P	2 -
Max. Marks	End term- 25	Mid term- 25	Elective	N
Pre requisites			Contact Hours	30
Objectives	1. To develop logical skills so that students should be able to solve basic computing problems. 2. To learn the syntax and usage of C++ programming constructs.			
Note for the Examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section. The duration of End Term exam will be 3 hrs.			

SECTION- A	Hrs
Introduction To Programming: Basic introduction to computers, block diagram of computer.Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements for programming: System softwares like operating system, compiler, linker, loader. Application programs like editor. Overview of Algorithm and Flowcharts.	04
Programming In C++ : Data types in C++, Formatted input-output for printing integer, floating point numbers, characters and strings.	04

Operators And Expression: Expressions in C++ and their evaluation. Precedence and associativity rules. Operators: arithmetic operators, relational operators, logical operators,miscellaneous operators.	04
Statements: Decision making structures: if, if-else, nested if and if-else, switch-Case. Loop control structures: for, while, do-while. Role of statements like break, continue, go to.	03
SECTION- B	
Arrays: Concept and use of arrays, declaration and usage of 1-dimensional arrays and 2-dimensional arrays.	04
Functions: Advantage of modularizing C++ program into functions, function definition and function invocation. Methods of passing parameters to a function: call-by-value, call-by-reference; Passing arrays to functions, Recursion, Library functions.	04
Introduction To User-Defined Data Types: Structures- definition, declaration, use. Unions: definition, declaration, use, introduction to classes and Properties of object oriented programming **.**	04
Introduction to Numerical Methods And Spreadsheet Calculations: Developing programs to solve engineering computation problems and working with spreadsheets.	03

Text books:	1. Arora, Sumita"Computer Science with C++" Dhanpat Rai & Co. 2. Balaguruswamy, "Object Oriented Programming in C++", Tata McGraw Hill.
Reference Books:	1. Kamthane, "Object Oriented Programming in ANSI and Turbo C++" Pearson Education India 2. Lafore ,Robert "Object Orients Programming in C++"
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term
Course Outcomes	1. The student will demonstrate proficiency in C++ programming language. 2. The student will be able to solve basic engineering computation problems using C++

Title	**ELECTRICAL AND ELECTRONICS ENGINEERING LAB.**		**Credits**	1.5
Code	ESC-GES 153	**Semester:-**2nd	**L T P**	- - 3
Max. Marks	**Practical- 40**		**Elective**	N
Pre requisites			**Contact Hours**	45

Objectives	Students will be able • to design electric circuits. • To use voltmeter ,ammeter and wattmeter • Perform open circuit test and short circuit test on a single phase transformer and draw equivalent circuit • To identify diode characteristics and transistor characteristics and perform experiments related to rectifiers(half-wave and full-wave) • To verify various logical gates and networking theorems through

	experiments.
1. Overview of the equipments, instruments and procedure to be used, safety precautions and report writing.	
2. To study resonance in R-L-C series and parallel circuit.	
3. Measurement of power and power factor by three voltmeter method.	
4. Measurement of power and power factor by three ammeter method.	
5. To measure power and power factor using a single wattmeter in a single phase circuit.	
6. Measurement of power and power factor of three phase balanced load by two wattmeter method.	
7. To perform open circuit test and short circuit test on a single phase transformer and draw equivalent circuit.	
8. To obtain magnetization characteristics of DC Machine	
9. Study the forward and reverse biased diode characteristics.	
10. Study the CB, CE, CC transistor characteristics.	
11. To obtain the waveforms of half wave rectifier circuit on CRO.	
12. To obtain the waveforms of full wave rectifier circuit on CRO.	
13. Verification of basic and universal gates.	
14. To verify the thevenin theorem, nortan theorem, Maximum power transfer theorem	
Course Outcomes	Students will • have hands on knowledge about the design, purpose and working of R-L-C and parallel circuits • become confident in taking accurate readings of voltmeter, ammeter and wattmeter • have in depth knowledge about transformers, transistors , diodes and rectifiers and will be able to understand their applications in industry. • have knowledge about networking theorems and their utility in industry.

Title	**CHEMISTRY (ORGANIC) LAB.**		**Credits**	1.5
Code	BS155	**Semester:-**2nd	**L T P**	- - 3
Max. Marks	**Practical- 40**		**Elective**	N
Pre requisites			**Contact Hours**	45
1. Synthesis of organic compounds :Preparation of Benzamide& Aspirin-Purification, determination of melting point and percentage yield. 2. Identification of unknown organic compounds through group detection, physical constants and preparation of derivatives – Hydrocarbons, Phenols, Aldehydes, Ketones, Carboxylic acids, Amides and Amines.				
Course outcomes : List steps for identifying simple organic compounds Use different analytical procedures				

Title	**COMPUTER LAB.**		**Credits**	1
Code	**ESC-GES 154**	**Semester:-**2nd	**L T P**	- - 2
Max. Marks	**Practical- 25**		**Elective**	N
Pre requisites			**Contact Hours**	25
Objectives	1. To develop programs using C++ 2. To make the students design programs by using logic and become			

	confident in handling numerical problems .
1. Programs based on input & output in C++	
2. Programs using Decision Statements if-else, CASE	
3. Programs using while statements, do- while and for Loops	
4. Array based programs	
5. Developing user defined Functions with and without recursion	
6. How to create and access user defined data types	
7. Implementation of engineering computation programs using MATLAB and EXCEL spreadsheet.	
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce
Course Outcomes	1. The students will be able to demonstrate proficiency in C++ 2. The student will become confident in solving any computation problem using his programming skills.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering) [2019-2020]

Third Semester

S No.	Course code	Subject	L	T	P	Credits	Practical	Mid term	End term	Total marks	Category
1	CHE 201	Physical Chemistry	3	1	3	5	25	50	50	125	CHE
2	CHE 202	Fluid Flow	3	1	3	5	25	50	50	125	CHE
3	CHE 203	Process Plant Material & Energy Balance	3	1	-	4	-	50	50	100	CHE
4	CHE 204	Engineering Materials	3	1	-	4	-	50	50	100	CHE
5	ESC 201	Strength of Materials	3	1	-	4	-	50	50	100	ESC
6	ESC 202	Process Equipment Design	-	-	3	1	25	-	-	25	ESC
		Total	**15**	**5**	**9**	**23**	**75**	**250**	**250**	**575**	
		Total contact hours/week	**29**								

Note:

- **NSS/NCC/Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)**
- **Discipline (1st to 4th year, 1 credit to be earned in 8th semester)**

Fourth Semester

S No.	Course code	Subject	L	T	P	Credits	Practical	Mid term	End term	Total marks	Category
1	BSC 201	Mathematics – III	3	1	-	4	-	50	50	100	BSC
2	CHE 205	Heat Transfer	3	1	3	5	25	50	50	125	CHE
3	CHE 206	Chemical Engineering Thermodynamics	3	1	-	4	-	50	50	100	CHE
4	CHE 207	Organic Chemistry	3	1	3	5	25	50	50	125	CHE
5	CHE 208	Mechanical Operations	3	1	3	5	25	50	50	125	CHE
6	CHE 209	Comprehensive Viva	-	-	-	1	-	-	25	25	CHE
		Total	**15**	**5**	**9**	**24**	**75**	**250**	**275**	**600**	
		Total contact hours/week	**29**								

Note:

- **NSS/NCC/Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)**

- **Discipline (1st to 4th year, 1 credit to be earned in 8th semester)**

Fifth Semester

S No.	Course code	Subject	L	T	P	Credits	Practical	Mid term	End term	Total marks	Category
1	CHE 301	Numerical methods in Chemical Engineering	3	1	-	4	-	50	50	100	CHE
2	CHE 302	Energy Technology	3	1	-	4	-	50	50	100	CHE
3	CHE 303	Chemical Reaction Engineering-I	3	1	3	5	25	50	50	125	CHE
4	CHE 304	Mass Transfer-I	3	1	-	4	-	50	50	100	CHE
5	CHE 305	Chemical Technology (Inorganic)	3	1	3	5	25	50	50	125	CHE
6	CHE 306	Process Plant Design-I	-	-	3	1	25	-	-	25	CHE
7	CHE 307	Chemical Engineering Computation lab	-	-	3	1	25	-	-	25	CHE
		Total	**15**	**5**	**12**	**24**	**100**	**250**	**250**	**600**	
		Total contact hours/week	**32**								

Note:

- **Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)**
- **Discipline (1st to 4th year, 1 credit to be earned in 8th semester)**

Sixth Semester

S No.	Course code	Subject	L	T	P	Credits	Practical	Mid term	End term	Total marks	Category
1	CHE 308	Chemical Reaction Engineering-II	3	1	-	4	-	50	50	100	CHE
2	CHE 309	Mass Transfer-II	3	1	3	5	25	50	50	125	CHE
3	CHE 310	Process Dynamics & Control	3	1	3	5	25	50	50	125	CHE
4	CHE 311	Chemical Technology (Organic)	3	1	3	5	25	50	50	125	CHE
5	CHD 301	Departmental Elective-I	3	1	3	5	25	50	50	125	CHD
		Total	**15**	**5**	**12**	**24**	**100**	**250**	**250**	**600**	
		Total contact hours/week	**32**								

Note:

- **Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)**
- **Discipline (1st to 4th year, 1 credit to be earned in 8th semester)**

Seventh Semester

S No.	Course code	Subject	L	T	P	Credits	Practical	Mid term	End term	Total marks	Category
1	CHE 401	Transport Phenomena	3	-	-	3	-	35	40	75	CHE
2	CHE z402	Environmental Engineering	3	1	3	5	25	50	50	125	CHE
3	CHE 403	Process Modelling and Simulation	-	-	3	1	25	-	-	25	CHE
4	CHE 404	Industrial Training	-	-	-	1	-	25	-	25	CHE
5	CHE 405	Process Plant Design-II	-	-	3	1	25	-	-	25	CHE
6	CHE 406	Project work	-	-	2	-	-	-	-	-	CHE
7	CHO 401	Open Elective - I	3	-	-	3	-	35	40	75	CHO
8	CHD 401	Department Elective-II	3	1	-	4	-	50	50	100	CHD
		Total	12	2	11	18	75	195	180	450	
		Total contact hours/week	25								

Note:

- **Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)**
- **Discipline (1st to 4th year, 1 credit to be earned in 8th semester)**

Eighth Semester

S No.	Course code	Subject	L	T	P	Credits	Practical	Mid term	End term	Total marks	Category
1	CHE 407	Process Instrumentation	3	1	-	4	-	50	50	100	CHE
2	CHE 408	Process Engineering Economics	3	1	-	4	-	50	50	100	CHE
3	CHE 406	Project work	-	-	2	2	-	-	'S' or 'X'*	-	CHE
4	CHE 409	Comprehensive viva	-	-	-	1	-	-	25	25	CHE
5	CHE 410	Literature Survey, Report Writing and Seminar	-	-	3	NC	-	-	-	-	CHE
6	CHO 402	Open Elective-II	3	-	-	3	-	35	40	75	CHO
7	CHO 403	Open Elective-III	3	-	-	3	-	35	40	75	CHO
8	CHD 402	Department Elective-III	3	1	-	4	-	50	50	100	CHD
		Total	15	3	5	21	-	220	255	475	
		Total contact hours/week	23								

***'S' (Satisfactory) or 'X' (Repeat)**

Note:

- **Discipline (1st to 4th year, 1 credit to be earned in 8th semester)**

S. No.	List of Departmental Electives
1	Petroleum Processing Engineering
2	Industrial Safety and Hazards
3	Plant Utilities
4	Petrochemical Technology
5	Biochemical Engineering

S.No.	List of Open Electives
1.	Fuel Cell Technology
2.	Nanotechnology
3.	Polymer Science and Engineering
4.	Operations Research
5.	Supply Chain and Logistic Management
6.	Project Management and Entrepreneurship

Note:

1. Mid term evaluation shall be as per the format already approved by the competent authority (as indicated in the scheme already approved for the first year)
2. Departmental electives (I, II and III) shall be offered amongst the list indicated above depending on the available resources.
3. Open electives (I, II and III) shall be offered amongst the list indicated above depending on the available resources.
4. List of electives (open and departmental) is subject to change and as approval of the competent authority from time to time.

SYLLABUS OF B.E. CHEMICAL ENGINEERING 2019-2020

THIRD SEMESTER

Title	**PHYSICAL CHEMISTRY**			**Credits**	05
Code	CHE 201	**Semester:-**3rd		**L T P**	3 1 3
Max.Marks	**End term- 50**	**Mid term- 50**	**Practical -25**	**Elective**	N
Pre requisites				**Contact Hours**	42 14 (Practical Sessions)
THEORY				**Time**	3 Hours
Note for the Examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.				

SECTION- A

Solutions: Ideal and non-ideal solutions, Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids such as Phenol- water, triethylamine- water, and Nicotine- water systems. Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.

Chemical Kinetics: Rate equation of reactions of various orders, rate mechanism, kinetics of complex reactions. Concept of energy barrier and energy of activation. Theories of reaction rates, measurement of extent of reaction, zero order reactions. Rates of flow systems. Lindemann theory of unimolecular reactions.

Surface Phenomena: Adsorption of gases by solids. Types of adsorption, adsorption isotherms, Langmuir's adsorption equation, B.E.T. equation for determination of surface area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.

SECTION- B

Photochemistry: Laws of photochemistry, principles of photochemical excitation, quantum efficiency, Kinetics of photochemical reactions

Electrochemistry: Conductance of electrolytic solutions, transference number and its determination, Kohlrausch's law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionizaton of water, ionization constants of weak acids and weak bases, hydrolysis, pH, commonion effect, solubility product and salt effect.

Electrochemical Cells: Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half- cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity co-efficient from cell potential data, potentiometric titrations.

***Books recommended*:**

1. Maron, Samuel H. Prutton, Carl F. : Principles of Physical Chemistry, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Glasstone, Samuel : Textbook of Physical Chemistry, MacMillan and Co. Ltd. London
3. Barrow, M. Gorden : Physical Chemistry, McGraw Hill, N.Y.

4. Rose, J. : Dynamics of Physical Chemistry, Lond Pitman
5. Puri, B.R., Sharma, L.R. and Pathania, Madan, S. : Principles of Physical Chemistry, S. Nagin &Co Jalandhar.
6. Negi, A.S. and Anand, S.C. : A Text Book of Physical Chemistry, Wiley Eastern Ltd. New Delhi.
7. Laidler, Keith J. : Chemical Kinetics, Tata McGraw-Hill Co. Ltd., New Delhi.
8. Moore, W.J. : Basic Physical Chemistry, Prentice-Hall of India, New Delhi.
9. Atkin, P.W. : A Text Book of Physical Chemistry, Oxford University Press.

Paper Title : PHYSICAL CHEMISTRY LAB.(Practical)

Paper Code CHE 201 Max. Marks 25 Credits : 1

1. Surface tension of liquids using Stalagmometer and calculation of Parachor values.
2. Distribution of Iodine between water and carbon tetrachloride.
3. Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid.
4. Adsorption of acetic acid on activated charcoal.
5. Viscosity of liquids and composition of a binary solution.
6. Conductometry
   - Variation of equivalent conductance and specific conductance on dilution.
   - Dissociation constant of acetic acid.
   - Solubility of sparingly soluble salts.
   - Conductometric titrations of HCl vs NaOH and acetic acid vs. NaOH.
7. Potentiometric titration of HCl vs NaOH and acetic acid vs NaOH and determination of dissociation constant of acetic acid.
8. Colorimetry
   - Verification of Lambert-Beer Law.
   - Determination of concentration of solution of $KMnO_4/K_2Cr_2O_7$.
   - Determination of composition of Fe-Salicylic Acid Complex by Job's Method.

***Books Recommended*:**

1. Lavitt, B.P. : Findlay's Practical Physical Chemistry, Longman Group Ltd.

Title	**FLUID FLOW**			**Credits**	05
Code	CHE 202	**Semester:-**3rd		**L T P**	3 1 3
Max.Marks	**End term- 50**	**Mid term- 50**	**Practical -25**	**Elective**	N
Pre requisites				**Contact Hours**	42 14 (Practical Sessions)
THEORY				**Time**	3 Hours
Note for the Examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.				

SECTION- A

Fluid Statics: Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability.

Fluid Properties: Newtonian and non-Newtonian Fluids, Nature of Turbulence, Eddy Viscosity, Flow in Boundary Layers, Basic Equation of Fluid Flow, Bernoulli's Equation, Navier stokes equation.

Flow of Incompressible Fluids: Laminar and Turbulent flow in pipes, Velocity Distribution in Pipes, Frictional Losses in Pipes and Fittings, Fanning equation, Estimation of economic pipe diameter.

Derivation of HAGEN-POISEULLI and f=16/Re equations.
SECTION- B
Dimensional analysis and its Applications to Fluid Flow. *Flow of compressible fluids*: Compressible flow and flow through nozzles. *Flow Measurements*: Pilot tube, Orifice, Venturi, Rotameter and Notches, wet gas metre etc. *Fluid Machinery*: Classification and Performance of Pumps, Turbines, Compressors, and Blowers,Selection and Specification, Net positive Suction Head.

***Books Recommended*:**

1. Mc Cabe, W.L. and Smith, J.C. : Unit Operation of Chemical Engineering, McGraw Hill.
2. Fox, R.W. and McDonald, A.T. : Introduction of Fluid Mechanics (SI Version) 4th ed. John Wiley and Sons, 1996.
3. Coulson, J.M. and Richardson, J.F. : Chemical Engineering, Vol. I, Pergamon
4. Foust, A.S., Wensel, L.A., Clump, C.W., Maus, L. and Anderson, L. : Principles of Unit Operations, John Wiley.
5. Badger, W.L. and Banchero, J.T. : Introduction to Chemical Engineering, Tata McGraw Hill Pub. Co. Ltd., 1997.
6. Chattopadhya, P. : Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, Delhi, 1997.

Paper Title: FLUID Flow (Practical)

Paper Code CHE 202 **Max. Marks 25** **Credits: 2**

1. General study of pipe fittings, valves and other equipments in the unit operations laboratory.
2. Pressure drop for flow through pipelines, valves & fittings.
3. Characteristics of pumps.
4. Flow measurement by the use of orifice meter, venturimeter, rotameter & pitot tube.
5. Flow over weirs and notches.
6. Flow measurement of compressible fluids.

Title	**PROCESS PLANT MATERIAL AND ENERGY BALANCE**			**Credits**	04
Code	CHE 203	**Semester:-**3rd		**L T P**	3 1 -
Max.Marks	**End term- 50**	**Mid term- 50**	**Practical --**	**Elective**	N
Pre requisites				**Contact Hours**	42

THEORY	**Time**	3 Hours
	1.	
Note for the Examiner	The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.	
SECTION- A		
Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc. Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.		
SECTION- B		
Material Balances for Reacting systems including balances involving recycle and purge streams.		

Combustion Calculations. Energy balances on nonreactive and reactive systems

***Books Recommended*:**

1. Bhatt, V. I. & Vora, S. M. : Stiochiometry, 3rd Edition, Tata McGraw Hill, 1984.
2. Himmelbleau, D. M. : Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall, 1977.
3. Felder, R. M. & Rousseau R.W. : Elementary Principles of Chemical Processes, 3rd Edition, John Wiley and Sons, 1986.
4. Reklaithis, G. V. : Introduction of Material and Energy balances, John Wiley, 1983.
5. Lubyben, L.W. & Winzel, L. A. : Chemical Process Analysis, 2nd Edition, Prentice Hall, 1988.

Title	**ENGINEERING MATERIALS**			**Credits**	04
Code	CHE 204	**Semester:-** 3rd		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical- -**	**Elective**	N
Pre requisites				**Contact Hours**	42 (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The semester question paper of the subject will be of 40 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.		

SECTION- A

Atomic Structure: Review of bonding in solids, structure –property-processing Relationships

Crystal Structure : Space lattice,crystal systems, Miller indices, effect of radius ratio on co-ordination, structures of common metallic, polymeric, ceramic, amorphous and partly crystalline materials.

Imperfections in atomic arrangement: various defects in atomic arrangement, diffusion phenomenon in solids, Fick's first and second law of diffusion, solid solution, slip systems, various methods of strengthening materials, Schmid's law.

SECTION- B

Phase Diagrams and phase transformation: binary phase diagrams – Fe-Fe_3C, Cu-Ni, Pb-Sn. microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes.

Materials: Standards and specifications, unified alloy numbering system, ferrous metals and alloys, non-ferrous metals and alloys; overview of ceramic, polymeric and composite materials; Mechanical tests: standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, deformation, fatigue, creep etc.

Corrosion: Types and mechanism of corrosion, factors influencing corrosion, combating corrosion,selection of materials of construction for handling different chemicals

***Books Recommended*:**

1. Askelland, Donald R. : The Science & Engineering of Materials, PWSKENT.
2. Shackleford, J.F. : Introduction to Material Science for Engineers, Mc Millan.
3. Van-Vlack, L.H. : Elements of Material Science & Engineering, Addison Wesley
4. Raghavan, V. : Material Science & Engineering, Prentice Hall of India
5. Callister Jr. William D. : Materials Science and Engineering- An Introduction, Wiley

Title	**STRENGTH OF MATERIALS**			**Credits**	04
Code	ESC 201	**Semester:-**3rd		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical- -**	**Elective**	N
Pre requisites				**Contact Hours**	42 (Theory)
THEORY				**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.				

SECTION- A

Stresses and Strains: *Concept of simple stress and simple strain,* mechanical properties of solids, types of load, Tensile stress , compressive stress, shear stress, complementary shear stress, thermal stresses, tensile test , stress strain curve , Hooke's law, modulus of elasticity, modulus of rigidity, Principle of St. Venant strain, factor of safety, compound bars, , Compound Stresses and Compound Strains in two-dimensional stress system , Stresses on oblique plane due to pure shear, principle planes and principle stresses, maximum shear stress, Mohr's circle of stress, Poisson's ratio, volumetric strain, elastic constants and relations between them.

Shearing Force and Bending Moments in Beams: Shearing force, bending moment, types of beams, types of load on beams, types of supports, sign- conventions for shearing force and bending moment, point of inflection , relations between bending moment and shearing force shearing force and bending moment diagrams for beam under different loads. Concentrated loads, uniformly distributed loads, numerical problems.

Bending Stresses and Shearing Stresses in Beams: Pure bending, graphical determination of moments of inertia, bending stress, composite beams, reinforced concrete beams, General eccentric loading, combined direct and bending stresses, eccentric longitudinal loads , Shear stress distribution in rectangular section and circular section, numerical problems.

Deflection of Beam: Introduction, Macauly's integration method, simply supported beam with load at mid span and beam with eccentric load, moment area method, deflection due to shear, numerical problems.

SECTION-B

Torsion of Shafts: Torsion of thin circular shaft, composite shaft, combined bending and torsion. equivalent torque, equivalent bending moment, numerical problems.

Struts and Columns: Definition of strut and column, Euler's Column theory and assumptions made, Strut with both ends pinned, strut with one end fixed and one end free, strut with both ends free, Slenderness ratio, limitations of Euler theory, Rankine's Empirical formula, strut with eccentric loading, numerical problems.

Stresses and Strains in Thin Shells: Thin cylinder under internal pressure, thin spherical shell under internal pressure, volumetric strain, modifications for built-up shells, numerical problems.

Stresses and Strains in Springs: Types of Springs, stresses in Close coiled helical springs, open coiled helical springs, leaf springs, springs in parallel and in series, numerical problems.

Strain Energy and Theories of Elastic Failure: Strain energy and resilience, Strain energy in tension and compression due to suddenly applied load and impact loads, strain energy due to shear, strain energy due to bending, strain energy due to torsion, theories of elastic failure and their graphical representation, numerical problems.

Books Recommended:

1. Ryder, G. H. : Strength of Materials, 3rd Edition S.I. Units Macmillan, 1969.
2. Bedi, D. S. : Strength of Materials, 6th Edition Khana Book Publishing Co. (P)Ltd.
3. Timoshenko, S. : Strength of Materials Part-I, 3rd Edition, Cbs Publishers, 1986.
4. Singal & Sharma : Strength of Materials , Modern Publisher.

Title	**PROCESS EQUIPMENT DESIGN**			**Credits**	01
Code	ESC-202	**Semester:-**3rd		**L T P**	- - 3
Max. Marks	**End term- -**	**Mid term- -**	**Practical- 25**	**Elective**	N
Pre requisites				**Contact Hours**	14 (Practical Sessions)

PRACTICAL

LIST OF PRACTICALS

1. Study of factors influencing the design of vessels; classification of pressure vessels,applications, method of fabrications, fundamental principles and equations.
2. Study of pressure vessel codes specifications and standards; Review of code and its development, ASME codes, API-ASME code, Section VIII of ASME codes
3. General design considerations for pressure vessels; Design pressure, design temperature, materials, design stress (nominal design strength), corrosion allowance, design loads, minimum practical wall thickness.
4. Design of thin-walled vessels under internal pressure; Cylinders and spherical shells, heads and closures, design of flat ends, design of domes ends, conical sections and end closures.
5. Design of vessels subject to external pressure; Cylindrical shells, design of stiffening rings, vessels heads.
6. Design of vessels subject to combined loading: Weight loads, wind loads (tall vessels), torque.
7. Design of welded joints and Bolted flanged joints.
8. Design of Foundation and supports.

***Books Recommended*:**

1. Battacharyya, B.C. : Introduction to Chemical Equipment Design Mechanical aspects, Chemical Engineering Education Development Centre.
2. Brownell and Young : Process Equipment Design , Willey Publication
3. Joshi, M.V. : Process Equipment Design, Macmillan India.

FOURTH SEMESTER

Title	**MATHEMATICS-III**			**Credits**	4
Code	BSC 201			**L T P**	3 1 -
Max marks	**End term- 50**	**Mid term- 50**	**Practical --**		
Pre-requisites	Mathematics-I (101) & Mathematics-II (103)			**Contact hours**	42
Theory				**Time**	3 hours
Objectives	The students shall • Learn to find Rank of a matrix & find matrix inverse using Cayley-Hamilton theorem. • Learn to solve difference equations with constant coefficients. • Learn to find Z-transforms and inverse Z-transforms and apply these to solve difference equations. • Be taught to apply the series solution method to solve Bessel and Legendre differential equations. • Learn various Probability distributions, test of significance and goodness of fit.				
Note for examiner	**The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.**				

SECTION A	**Hrs**
Matrices: Rank of a matrix, Elementary transformations, Eigen-values, Eigen-vectors, Cayley-Hamilton Theorem and its application to find inverse of a matrix.	5
Difference equations: Solution of difference equations with constant coefficients, Complementary function and Particular solution.	5
Z-Transforms: Introduction, Some standard Z-transforms, Linearity property, Damping rule, Some standard results, Shifting rules, Initial and Final value theorems, Convolution theorem, Evaluation of inverse transforms, Applications in the solution of difference equations.	12
SECTION B	**Hrs**
Series solution of differential equations: Solution of differential equations in series with reference to Bessel and Legendre equations, elementary properties of Bessel and Legendre functions.	10
Statistics: Binomial distribution, Poisson distribution and Normal distribution, Test of significance for large samples, Comparison of large samples, Means of two large samples, Student's t-distribution, chi^2-test, Goodness of fit.	10

Text Books	1. G. B. Thomas, R. L. Finney: Calculus and Analytic Geometry, Ninth Edition, Pearson Education. 2. E. Kreyszig: Advanced Engineering Mathematics, Eighth Edition, John Wiley.
Reference Books	1. B. V. Ramana: Higher Engineering Mathematics, Tata McGraw Hill. 2. B. S. Grewal: Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi.
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term
Course	The students are able to:

Outcomes	• find Rank of a matrix & find matrix inverse using Cayley-Hamilton theorem. • solve difference equations with constant coefficients. • find Z-transforms and inverse Z-transforms and apply these to solve difference equations. • apply the series solution method to solve Bessel and Legendre differential equations. • apply various probability distributions, test of significance and goodness of fit.

Title	**HEAT TRANSFER**			**Credits**	05
Code	CHE 205	**Semester:-**4th		**L T P**	3 1 3
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical- 25**	**Elective**	N
Pre requisites				**Contact Hours**	42 (Theory) 14 (Practical Sessions)
THEORY				**Time**	3 Hours
Note for the Examiner	The semester question paper of the subject will be of 40 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.				

SECTION- A

Conduction: Steady state conduction in one dimensional system, general conduction equation, effect of variable thermal conductivity, steady state conduction involving internal heat generation, lagging on pipes, the critical thickness of insulation on pipes, extended surfaces of uniform thickness and fin effectiveness, fin efficiency.

Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.

Radiation Heat Transfer: Black Body radiation, and grey body radiation, physical mechanism, radiation properties and shape factor, heat exchange between non-black bodies, radiation shields pyrometry and effect of radiation on temperature measurement

SECTION- B

Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on vertical plates and cylinders as well as on horizontal cylinders. Effects of non-condensable gases and vapor velocity on condensation, pool boiling, forced convection boiling, working correlations for pool boiling.

Evaporation: Types of Evaporators, single and multiple effects, single and multiple effects calculations, evaporator capacity, economy, effect of liquid head and boiling point elevation, methods of feeding.

Heat Exchangers: Various types of heat exchangers, overall heat transfer coefficients, heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units.

***Books Recommended*:**

1. Mc Cabe, W.L., Smith, J.C. : Unit Operations of Chemical Engineering McGraw Hill.
2. Holman, J.P. : Heat Transfer, McGraw Hill Book Co.
3. Mc Adams, W.H. : Heat Transmission, McGraw Hill Book Co.
4. Chapmann, A.J. : Heat Transfer, Mc Millan Publishing Co.
5. Kern, D.Q. : Process heat Transfer, McGraw Hill Book Co.

6. Kreith, F. : Principles of Heat Transfer, Harper & Row Pub., London.
7. Geankoplis, C.J. : Transport Processes and Unit Operations, Prentice Hall of India Pvt. Ltd., 3rd Edition, 1999.

Paper Title : HEAT TRANSFER (Practical)

Paper Code CHE 204 Max. Marks 25 Credits : 1

1. Determination of heat transfer coefficient for different types of heat transfer equipment. Wilson plots.
2. Unsteady state heat transfer in jacketed vessels. (Open pan evaporator)
3. Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface.
4. Determination of heat losses for insulated pipes
5. Study of double pipe heat exchanger and to determine overall heat transfer coefficient
6. Study the performance characteristics of a 1,2 - shell and tube heat exchanger
7. Study and **operation** of long tube, forced circulation and multiple effect evaporators.
8. Duhring plot for solutions involving nonvolatile solutes

Title	**CHEMICAL ENGINEERING THERMODYNAMICS**			**Credits**	04
Code	CHE 205	**Semester:-**4th		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical-**	**Elective**	N
Pre requisites				**Contact Hours**	42 (Theory)
THEORY			**Time**		3 Hours
Note for the Examiner	The semester question paper of the subject will be of 40 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.				

SECTION- A

Brief review of the terms: state functions, types of systems, internal energy, heat and work and reversible and irreversible processes. First Law of Thermodynamics and its Engineering Applications i.e. constant volume processes, constant pressure processes, isothermal and adiabatic processes, pumps, turbines, compressors, nozzles, heat exchangers, pitot tube, venturimeter and orifice meter. Throttling Processes, Joule-Thomson Coefficient, liquefication of gases, thermochemistry includes a brief review of heat capacities and their measurement, standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, H-x diagrams, heat of solution, partial, molar enthalpies, enthalpy for phase change etc. Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor.

Review of Second law of thermodynamics, entropy concept, Entropy and lost work calculations. Microscopic interpretation of entropy. Third Law of thermodynamics and its applications. Free energy functions and their significance in phase and chemical equilibria, Clapeyron's equation and some important correlations for estimating vapor pressures. Estimation of thermodynamic properties by using graphs and tables.

SECTION- B

Phase Equilibria:

Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule).

Fugacity and its calculations. Dependence of fugacity of temperatures and pressure

Solution behaviour of real liquids and solids. Activity and activity coefficients. Variation of activity co-efficient with temperature and composition. Activity coefficients of electrolytes standard states. Properties of mixing. Excess Properties, Gibbs-Duhem equation and its application to vapour-liquid equilibria.

Chemical Equilibria:

Equilibrium constant in terms of measurable properties variations of equilibrium constant with temperature and pressure. Adiabatic reactions, Gibbs phase rule, equilibria in heterogeneous reactions.

***Books Recommended*:**

1. Smith, J.M., Van Ness, H.C. and Abbott, M.M. : Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw Hill Professional, 2005
2. Elliott, J.R and Lira, C.T. : Introductory Chemical Engineering Thermodynamic, Prentice Hall PTR., 1999.
3. Rao, Y.V.C. : Chemical Engg. Thermodynamics, Orient Blackswan, 1997.
4. Dodge, B.F. : Chemical Engg. Thermodynamics, McGraw Hill, 1944, Original from the University of Michigan, 2007.
5. Narayanan, K.V. : A Textbook of Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd., 2004.

Title	**ORGANIC CHEMISTRY**			**Credits**	05
Code	CHE 207	**Semester:-**4th		**L T P**	3 1 3
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical- 25**	**Elective**	N
Pre requisites				**Contact Hours**	42 (Theory) 14 (Practical Sessions)

THEORY		**Time**	3 Hours
	1.		
Note for the Examiner	The semester question paper of the subject will be of 40 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.		

SECTION- A

Classification of organic compounds: IUPAC nomenclature, Structural isomerism, Cis-trans isomerism. Shapes and Molecular orbital structures of compounds containing C, N and O. Conformations of alkanes. Organic reagents and reaction intermediates structures of dienes, pyridine, pyrrole, aromatic compounds. Optical isomerism, Chirality and optical activity; Enantiomers, Diastereomers, Meso-and Racemic compounds, Resolution of racemic mixture. Asymmetric synthesis, Walden Inversion, Configuration (D and L nomenclature), Absolute con figuration (R and S nomenclature)

Chemistry of hydrocarbons: House synthesis, halogenation of alkanes, free radical mechanism, orientation, reactivity and selectivity. Cracking effect of structure on physical properties of compounds. Alkenes, catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophillic addition reactions, peroxide effect, mechanism of allylic substitution, acidity of 1-alkynes, conjugated dienes, 1,2-and 1,4-additions, free radical and ionic mechanisms of addition polymerisation reactions, ring-opening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkylbenzenes, aromatic electrophillic substitution reactions, Friedel-Crafts reactions

SECTION- B

Delocalisation: Concept of aromaticity, stability of cycloalkanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating groups. Hydrogen-bonding.

Chemistry of functional groups: Alkyl and aryl halides, nucleophilic substitution, synthetic utility

of Grignard reagents and alkyllithiums, mechanism of Grignard reactions of alcohols, benzylalcohol, acidity of phenols epoxy compounds, Anisole nucleophilic addition, benzaldehyde, acetophene, benzophenone, aldol condensation, acidity of acids, alkyl and aryl amines. Synthetic utility of diazonium salts, basicity of amines, multistep synthesis.

Books Recommended:

1. Bahl, B. S. & Bahl, Arun : Text-book of Organic Chemistry, 16th Edition, S. Chand and Company Ltd., New Delhi.
2. Solomons, T. W. G. : Fundamentals of Organic Chemistry, John Wiley and Sons, Inc., New York, 1994.
3. Morrison & Boyd : Organic Chemistry, Pearson education, 6th edition, 2007.
4. F.A.Carey: Organic Chemistry, Tata McGraw Hill, 7th edition, 2008.
5. Mukherji & Singh: Reaction mechanism in organic chemistry, Macmillan India Ltd.,

Paper Title : ORGANIC CHEMISTRY (Practical)

Paper Code CHE 206 **Max. Marks 25** **Credits : 1**

1. Lab – Safety
2. Preparation of Benzamide & Aspirin-Purification, determination of melting point and percentage yield.
3. Identification of unknown organic compounds – Hydrocarbons, Phenols, Aldehydes, Ketones, Carboxylic acids, Amides and Amines.

Title	**MECHANICAL OPERATIONS**			**Credits**	05
Code	CHE 208	**Semester:-**4th		**L T P**	3 1 3
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical- 25**	**Elective**	N
Pre requisites				**Contact Hours**	42 (Theory) 14 (Practical Sessions)

THEORY		**Time**	3 Hours
Note for the Examiner	The semester question paper of the subject will be of 40 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.		

SECTION- A

Size Reduction: Crushers and Grinders: jaw crusher, crushing rolls, Gyratory Crusher Tumbling/revolving mills, hammer Mill and Fluid energy mill. Closed and open circuits grinding. Power requirements. Laws of crushing.

Mechanical Separation: Screening: Stationery screens, Grizzlies, Trommel and Vibrating screens. International Standard Screens & Indian Standard Screens. Screening Analysis-differential and cumulative.

- Motion of particle through a fluid: Stoke's Newton's law. Free and hindered setting.
- Setting tank and double cone classifiers
- Batch and continuous thickeners

Settling chamber, cyclone, filter bag and electrostatic precipitators.

SECTION- B

Filtration: Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.

Centrifugation: Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge.
Fluidization: Conditions for fluidization: Aggregate and particulate fluidization. Ergun's and Carman-Kozeny equations.
Mixing and Agitation: Basic ideas and characteristics of mixing equipment power consumptions scale-up.
Conveying: Mechanical and pneumatic conveying systems, storage & handling of materials.

***Books Recommended*:**

1. Mc Cabe, Warren L., Smith, Juluain C. and Harroit, Peter : Unit Operations of Chemical Engineering, 5th Edition, Mc Graw Hill Int. ed (Chemical Engineering Series) Mc Graw Hill Book Company, New York, 1993.
2. Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce : Principles of Unit Operations, Wiley International Edition, John Wiley & Sons Inc., New York.
3. Coulson, J.M. and Richardson, J.F. : Unit Operations (Volume 2 of Chemical Engineering) New York: Mc Graw – Hill Book Co;, Inc.
4. Gupta, Santosh K. : Momentum Transfer Operations, Tata McGraw-Hill, New Delhi.
5. Badger, Walter L. and Banchero, Julius T. : Introduction to Chemical Engineering, Mc Graw-Hill, Kogakusha Ltd., New Delhi.
6. Brown, C.G. : Unit Operations, John Wiley & Sons, Inc., New York.
7. Chattopadhyay, P. : Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, New Delhi.

Paper Title : MECHANICal OPERATIONS (Practical)
Paper Code CHE 207 Max. Marks 25 Credits: 01

1. Pressure drop and two phase flow characteristics in packed and fluidized beds.
2. Measurement of drag force.
3. Batch settling of slurries.
4. Constant pressure filtration.
5. Mixing, crushing, grinding, screening and particle size analysis (Anderson Pipette)

Title	**COMPREHENSIVE VIVA**			**Credits**	01
Code	CHE 209	**Semester:-**4th		**L T P**	- - -
Max. Marks	**End term--25**	**Mid term- -**	**Practical-**	**Elective**	N
Pre requisites				**Contact Hours**	
SECTION- A					
The viva-voce examinations will be comprehensive and covering all subjects taught during first to fourth semesters.					

Fifth Semester

Title	**NUMERICAL METHODS IN CHEMICAL ENGINEERING**			**Credits**	4
Code	CHE 301		**Semester:-**5th	**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical :**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Errors in Numerical Calculations, Solution of Algebratic and Transcendental Equations: The Bisection Method, The method of False Position, The Iteration Method, Newton-Raphson Method.

Interpolation: Finite Differences, Differences of a Polynomial, Newton's Formulae for Interpolation, Central Difference Interpolation Formulae, Interpolation with Unevenly Spaced Points, Divided Differences and their Properties, Inverse Interpolation, Curve Fitting, Least-Squares Curve Fitting Procedures, Weighted Least Squares Approximation.

Numerical Differentiation and Integration: Trapezoidal Rule, Simpson's 1/3 –Rule, Simpson's 3/8-Rule, Weddle's Rules and Romberg Integration.

SECTION- B

Solution of Linear Systems, Gaussian Elimination Method, Gauss-Jordan Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method.

Numerical Solution of Ordinary Differential Equation: Taylor's Series Expansion Method, Picard's Method, Euler's Method, Runga-Kutta Methods, Predictor-Corrector Methods, Simultaneous and Higher Order Equations.

Numerical Solution of Partial Differential Equations: Finite-Difference Approximation to Laplace's Equation, Parabolic Equations and Hyperbolic Equations

Recommended Books

1. Hildebrand, F.B. : Introduction to Numerical Analysis.
2. Scarborough, J.B. : Numerical Mathematical Analysis, Oxford and ISH Pub. Co.
3. Chopra, S.C., & Canale, R.P. : Numerical Methods for Engineers.
4. Sastry, S. S. : Introductory Methods of Numerical Analysis, 4th Edition, Prentice Hall.

Title	**ENERGY TECHNOLOGY**			**Credits**	4
Code	CHE 302	**Semester:-**5th		**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Fuels: Types of conventional fuels, their merits and demerits. Non-conventional/renewable energy sources, their importance for sustainable development and environmental protection.

Solid Fuels: Origin of coal, proximate and ultimate analysis of coal, coal preparation and washing methods, safe storage of coal. Low and High temperature carbonization, products of carbonization, By product coke ovens. Synthetics fuels from coal –Bergius process and Fischer Tropsch process.

Liquid fuels: Origin of petroleum, refining and distillation of crude oil, uses of petroleum products.

Gaseous fuels: Natural gas, manufacture of water gas and producer gas, gas cleaning methods.

SECTION- B

Principles of combustion: Combustion calculations, waste heat utilization.

Furnaces: Classification of furnaces, draught, furnace atmosphere, Portland cement continuous rotary kiln, blast furnace, glass melting furnace

Alternate sources of energy:

- Introduction to solar radiation and evaluation of radiation incident on a solar collector.
- Applications of solar thermal energy such as solar water heater, solar cooker, solar concentrators and solar thermal power generation.
- Types of solar photovoltaic systems and applications.
- Photosynthesis and biomass conversion systems.
- Wind Energy: Nature of wind and wind turbine performance.

Other renewable energy sources such as geothermal, tidal, ocean and wave.

Recommended Books

1. Gupta, O.P. : Elements of Fuels, Furnaces & Refractions, 5th Edition, Khanna Publishe 2007.
2. Rao, S. and Parulekar, B.B. : Energy Technology – Non-conventional, Renewable & Conventional, Edition, Khanna Publishers, 2007.
3. Dayal, M. : Renewable Energy – Environment and Development, Konark Publish Pvt. Ltd., 1989.
4. Sukhatme, S.P. : Solar Energy – Principles of Thermal Collection and Storage, 2nd Edition, T McGraw – Hill Publishing Company Ltd., 2006.
5. Sharma, S.P. and Mohan, C. : Fuels and Combustion, Tata Mc-Graw Hill Publishing Company Lt 1984.

Title	CHEMICAL REACTION ENGINEERING–I			Credits	5
Code	CHE 303		Semester:-5th	L T P	3 1 3
Max.Marks	End term 50	Mid term 50	Practical : 25	Elective	N
Pre requisites	-			Contact Hours	42 (Theory) 14 (Practical Sessions)

THEORY

Note for the Examiner	Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION- A

Introduction and a brief review of the kinetics of homogeneous reactions.
Interpretation of rate data from constant volume and constant pressure systems.
Single Ideal reactors.
Design for single reactions.

SECTION- B

Design for multiple reactions.
Thermal characteristics of reactors: temperature and pressure effects.
Non-ideality in reactors and its effects on chemical conversion. One parameter models to represent the behaviour of chemical reactors.

Practical

1. Kinetic studies in a batch reactor.
2. Kinetic studies in a plug flow reactor.
3. Kinetic studies in a CSTR.
4. Kinetic studies in a semi batch reactor.
5. RTD studies in CSTR.
6. Dispersion number for packed bed reactor.
7. Adiabatic batch reactor.

Recommended Books

1. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition, John Wiley and So 2004.
2. Smith, J.M. : Chemical Engineering, Kinetics, 3rd Edition, and McGraw Hill, 198
4. Dinbigh, K. and Turner, K.G. : Chemical Reactor Theory – An Introduction, CambridgeUniv. Pres
5. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prent Hall, 2007.

Title	MASS TRANSFER – I			Credits	4
Code	CHE 304		Semester:-5th	L T P	3 1 -
Max.Marks	End term 50	Mid term 50	Practical 0	Elective	N
Pre requisites	-			Contact Hours	42

THEORY

Note for the Examiner	Note for the Paper setter: The question paper should be divided into Section A

	and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION- A

Mass transfer operations, classification of mass transfer operations, choice of separation methods, methods of conducting mass transfer operations, design principles.

Introduction to mass transfer and diffusion, molecular diffusion in gases and liquids, diffusion coefficients for gases and liquids, diffusion in solids, types of solid diffusion.

Mass transfer coefficients, types of mass transfer coefficients, mass transfer coefficients in laminar flow, theories of mass transfer.

Interphase mass transfer, concept of overall mass transfer coefficient.

SECTION- B

Working principle, construction and industrial applications of various gas liquid contacting equipments like sparged vessels, mechanically agitated vessels, tray towers, packed towers, spray chambers, venturi scrubbers.

Humidification operations, psychometric chart, adiabatic saturation temperatures, wet bulb temperature, adiabatic operations, types of cooling towers.

Principle of drying, batch drying, drying curve, constructional details and working of different dryers

Recommended Books

1. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition. McGraw-Hill, 1981.
2. Sherwood, T.K., Pifford, Robert L. and Wilke, Charles R. : Mass Transfer, McGraw-Hill.
3. Sharma, K.R. : Principles of Mass Transfer, Prentice Hall of India Pvt. Ltd., 2007.
4. McCabe, Warren L., Smith Juliam C. and Harriott, Peter : Unit Operations of Chemical Engg., 7th Edition, McGraw-Hill, 2005.
5. Coulson & Richardson : Chemical Engineering, Vol.I (6th Edition, 2009) and Vol. II. (5th Edition, 2006).

Title	**CHEMICAL TECHNOLOGY (INORGANIC)**			**Credits**	5
Code	CHE 305		**Semester:-**5th	**L T P**	3 1 3
Max.Marks	**End term 50**	**Mid term 50**	**Practical-25**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42 (Theory) 14 (Practical Sessions)

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Chlor-Alkali Industry: Voltage efficiency, Current efficiency, Current density, Decomposition efficiency, Manufacture of soda ash by Solvay and Modified Solvay process, Manufacture of caustic soda.

Sulphuric Acid: Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.

Cement & Glass: Cement-Types of cement, Constituents of cement, Manufacture of Portland cement.

Glass-Introduction, Types of glass, Raw materials, Manufacture of glass.
Ceramics: Introduction, Properties of ceramics, Classification of refractories, Important steps involved in the manufacture of refractories

SECTION- B

Industrial gases: Manufacture and uses of carbon dioxide, oxygen and nitrogen, acetylene.
Paints: Introduction, Classification of paints, Manufacture of paints, Requirement of a good Paint.
Fertilizers: Nitrogeneous fertilizers- Manufacture of Ammonia, Nitric acid, Urea, CAN, Ammonium Sulphate. Phosphatic fertilizers- superphosphate and triple superphosphate. Potassic fertilizers- Potassium Chloride and Potassium Sulphate, Safety aspects.

Practical

1. Fertilizers (i) Determination of N-P-K Values
   (ii) Determination of micronutrients
2. Cement: Loss of ignition, silica, insolubles, estimation of Mg, Ca, Fe.
3. Water

Recommended Books

1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1987.
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, Mc Graw Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., N. Delhi, 2008.
4. Pandey, G.N. : Chemical Technology, Volume-I, Lion Press, Kanpur.

Title	**PROCESS PLANT DESIGN –I**			**Credits**	1
Code	CHE 306	**Semester:-5th**		**L T P**	- - 3
Max.Marks	**End term**	**Mid term**	**Practical:25**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	14 Practical Sessions

Practical

1. Design of piping & piping networks.
2. Selection, specification & power requirements of process pumps, fans and blowers.
3. Design of settling equipments like Dor thickeners, dust chambers, cyclone separators and centrifuges.
4. Design of agitated vessels using various types of impellers.
5. Design of Conveyor system for solids.

Recommended Books

1. Luding, E.E. : Applied Process Design in Chemical in Petrochemical Plants, Gulf Publishing Company.
2. Perry, J.H. : Chemical Engineers Handbook, McGraw Hill.
3. Joshi, M.V. : Process Equipment Design, Macmillan Indian.
4. Peters, M.S. and Timmerhaus, K.D. Plant Design and Economics for Chemical Engineers McGraw Hill.

Title	**CHEMICAL ENGINEERING COMPUTATION LAB. (Practical)**			**Credits**	1
Code	CHE 307	**Semester:-5th**		**L T P**	- - 3
Max.Marks	**End term**	**Mid term**	**Practical: 25**	**Elective**	N

Pre requisites	**-**	**Contact Hours**	14 Practical Sessions

Practical

Errors analysis, Solution of linear and non-linear algebric equations.
Numerical differential & integration.
Interpolation.
Least squares approximation.
Ordinary and partial differential equations.
Development of computer programs based on the above topics using Matlab and their applications in chemical process computations.

Recommended Books:

1. Grewal, B.S. : Numerical Methods in Engineering and Science, Khanna Publishers, N. Delhi, 2001.
2. Sastry, S.S. : Introductory Methods of Numerical Analysis, Prentice Hall of India.

Sixth semester

Title	**CHEMICAL REACTION ENGINEERING-II**			**Credits**	4
Code	CHE 308	**Semester:-**6th		**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Heterogeneous catalyses: A brief review of catalyses catalytic specificity. Preparation of catalysts, catalyst poisoning and catalyst regeneration.
Fluid Solid catalytic reaction: Kinetics; external transport processes, Reaction -and diffusion within porous spherical catalyst pellet. Effective diffusivity, thermal conductivity and effectiveness factors.

SECTION- B

Fluid - fluid reactions rate equations and their application to the design of reactors.
Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors.
Analysis of rate data design outline and selection of fixed bed, fluidised bed and slurry reactors for fluid solid catalytic reactions.

Recommended Books

1. Levenspiel, O : Chemical Reaction Engg., John Wiley
2. Fogler, H.S. : The elements of Chemical Kinetics, McGraw Hill.
3. Smith, J.M. : Chemical Engineering Kinetics, McGraw Hill.
4. Walas, S.M. : Reaction Kinetics for Chemical Engg., McGraw Hill.
5. Hills, C.J. : An Introduction to Chem. Engg., Kinetics and Reactor Design.

Title	**MASS TRANSFER-II (Theory)**			**Credits**	5
Code	CHE 309	**Semester:-**6th		**L T P**	3 1 3
Max.Marks	**End term 50**	**Mid term 50**	**Practical : 25**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42 (Theory) 14 (Practical Sessions)

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Absorption: Equilibria for absorption systems – use of Raoult's law, Henry's law for solubility predictions, Selection of absorbent, limiting liquid gas ratios, absorption factor use in design of plate absorbers. Kremser equation for ideal plates and translation of ideal plates to real plates using various efficiencies. Concept of transfer units for the design of packed absorbers.
Distillation: Limitations and applications, prediction of VLE using thermodynamic & experimental

techniques. Dew point & bubble point estimations for binary & multicomponent mixtures. Distillation methods – flash distillation, differential distillation for binary systems, steam distillation, optimum reflux ratio. Fractionation of binary mixtures using McCabe – Thiele method and enthalpy concentration method (Ponchon and Savarit method). Packed distillation columns. Azeotropic & extractive distillation preliminaries and molecular distillation.

SECTION- B

Liquid-Liquid Extraction: Ternary Equilibria and its representation on various plots. Selection criteria for solvent, Multistage extraction using partially miscible & immiscible solvents. Stagewise contact for countercurrent and crosscurrent extraction. Constructional details of equipment like mixer-settler, packed columns, pulsed extractor, sieve-tray extractor and centrifugal extractor.

Leaching: Preparation of solid, countercurrent and crosscurrent multistage contact Shank's system. Constructional details of equipment like Rotocel extractor, Hildebrandt extractor, Bollman extractor, Kennedy Extractor & Beet-Sugar Diffusion battery extractor.

Adsorption: Types of adsorption, nature of adsorbents, equilibria for adsorption systems. Brief manufacture and commercial applications and characteristics for common adsorbents. Stagewise & continuous contacting of fluid and solid phase. Description of contact filtration adsorption system. Hypersorber Ion-exchange system.

Crystallization: Growth and properties of crystals saturation, nucleation, growth of crystals, effect of impurities on crystal formation, effect of temperature on solubility, fractional crystallization, yield of crystals, crystal purity, yield calculation using phase diagram, energy requirements using enthalpy-concentration diagram. Methods of creating super saturation-Meirs supersolubility curve. Mechanism and methods for nucleation. Derivation for ideal growth of crystals and discussion of actual growth. Swanson-Walker and various vacuum crystallizers.

Practical

1. Determination of mass transfer coefficients for naphthalene-air system.
2. To determine drying rate curves for different wet solids in a batch drier under constant drying conditions
3. Fractional approach to equilibrium for liquid-liquid extraction from single drop.
4. Verification of Rayleigh's equation for differential distillation.
5. Determination of flooding velocities in packed columns.
6. Determination of HETP for packed distillation columns.
7. Study and operation of a pilot sized distillation column under total reflux.
8. Study of different mass transfer equipments.

Recommended Books

1. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.
2. Sherwood,T.K., Pigford, R.L & Wilke,C.R. : Mass Transfer, McGraw-Hill, Chemical Engineering Series, 1975.
3. Skelland, A.H.P. : Diffusion Mass Transfer, John Wiley &Sons., New York, 1974.
4. McCabe, Warren L., Smith Julian C. and Harriot, H.P. : Unit-Operations of Chemical Engg., 7th Edition, McGraw-Hill, 2005.
5. King, C.J. : Separation Processes, Tata McGraw Hill Publishing Co. Ltd., New Delhi , 1982.
6. Geankoplis, C.J. : Transport Process and Separation Processes, 4th Edition, Prentice Hall Inc., New Delhi, 2003.

Title	PROCESS DYNAMICS & CONTROL			Credits	5
Code	CHE 310		Semester:-6th	L T P	3 1 3
Max.Marks	End term 50	Mid term 50	Practical : 25	Elective	N
Pre requisites	-			Contact Hours	42 (Theory) 14 (Practical Sessions)

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Incentives for chemical process control, design aspects of a process control system. Difference between feedback and feed forward control configuration. Hardware elements of a control system, Block Diagrams.

Laplace transform and transfer functions. Difference between lumped and distributed parameter systems, Dynamic behaviour of first and higher order systems, interacting and non-interacting systems, dead time.

Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve.

SECTION- B

Closed-loop transfer functions, transient response of simple control systems, Routh stability criterion, Root Locus.

Introduction to frequency response: Bode diagrams, control system design by frequency response: Ziegler-Nichols controller settings, stability using frequency response, gain margin and phase margin.

Introduction to advanced control techniques such as cascade control, feed forward control, ratio control, inferential control.

Practical

1. U-Tube manometer
   (a) To plot the response curve for a given input to a U-tube manometer.
   (b) To determine the transfer function from the response curve obtained in part (a).
2. Time constant of a mercury thermometer
   To study the dynamics of the given thermometer and compare the theoretical value of its time constant with the experimental value.
3. Analysis of valve
   Develop a block diagram representing the dynamic bahavoiur of the given globe valve.
4. (a) Liquid level measurement
   With the given Bubbler System for Liquid Level Measurement, evaluate liquid height in the tank and compare it with actual values.
   (b) Calibration of Pressure Gauge
   Calibrate a pressure gauge in the range 0 psi to 60 psi.
5. Temperature control system

To maintain the temperature of the fluid at the set point value.

6. Time constant of liquid level tank
   To study the dynamics of liquid level in a tank and compare the analytical value of the time constant with the experimental value.
7. Liquid level control
   (a) To carry out the closed loop experiment on the given liquid level control system and record its response for step change in the inlet flow.
   (b) To plot the experimental response curve and comment on the response obtained.
8. Compurec
   Pressure control simulation with step input and sinusoidal input.

Recommended Books

1. Coughanowr, D.R. : Process Systems Analysis and Control, 2nd Edition. Mc Graw Hill, 1991.
2. Stephanopolous G. : Chemical Process Control -An Introduction to Theory and Practice, Prentice Hall of India, New Delhi, 2008.
3. Luyben W. L. and Luyben M.L.: Essentials of Process control, Mc Graw Hill International Editions, 1997.
4. Ogata K.: System Dynamics, 4th Edition, Pearson Education, 2004.
5. Harriott, P. : Process Control, TMH Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1972.

Title	**CHEMICAL TECHNOLOGY (ORGANIC)**			**Credits**	5
Code	CHE 311	**Semester:-**6th		**L T P**	3 1 3
Max.Marks	**End term 50**	**Mid term 50**	**Practical: 25**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42 (Theory) 14 (Practical Sessions)

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION- A

Oils & Fats: Introduction, Extraction of oils from vegetable oils, refining of oils and fats, hydrogenation of oils.

Soaps and Detergents: Introduction, Raw materials, Manufacture of soap, Classification of deterdents, finishing of detergents.

Water: Sources and Constraints, Consumption patterns; Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.

Desalination: Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electrodialysis.

SECTION- B

Pulp & paper: Introduction, Raw Materials, types of pulp, Manufacture of paper.

Sugar: Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.

Carbon Technology: Introduction, Classification of activated carbons, raw materials and manufacture

of activated carbons, precursors for carbon fibres, manufacture of carbon fibres from polyacrylonitrile, manufacture of carbon black by furnace black process, applications.

Nanotechnology: Introduction and synthesis of nano particles by RF plasma process.

Practicals

1. *Oils & Fats*: Determination of Acid value, Iodine value, Saponification value.
2. *Carbohydrates*: Reducing and non reducing sugars by (i) Fehlings method (ii) Pavy's method.
3. *Soaps*: Determination of free and combined alkali, total fatty matter, moisture and insoluble.

Recommended Books

1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1987.
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, Mc Graw Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., N. Delhi, 2008.
4. Pandey, G.N. : Chemical Technology, Volume-II, Lion Press, Kanpur.
5. Donnet J. B., Bansal R. C. : Carbon Fibres, Marcel Dekker Inc.
6. Donnet J. B., Bansal R. C., Wang M. J. : Carbon Black, Marcel Dekker Inc.
7. Bansal R. C., Donnet J. B., Stoeckli F : Active Carbon, Marcel Dekker Inc.

SEVENTH SEMESTER

Title	**Transport Phenomena**			**Credits**	3
Code	CHE 401	**Semester:-**7th		**L T P**	3 - -
Max.Marks	**End term 40**	**Mid term 35**	**Practical**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION-A

Transport of momentum, heat and mass by molecular motion-Newton's law of Viscosity, Fourier's law of heat conduction, Fick's law of diffusion.

Transport properties – Viscosity, thermal conductivity and mass diffusivity.

Emphasis on the analogy between momentum, heat and mass transfer with respect to transport mechanism and governing equations.

Development of mathematical models of transfer process through shell momentum balance, shell energy balance and shell mass balance for solving specific problems of transport of momentum, heat and mass in laminar flow or in solids in one dimension.

SECTION-B

Development of general differential equations of fluid flow, heat transfer and mass transfer and their applications in solving one-dimensional steady state and unsteady state problems of momentum, heat and mass transfer.

Interphase transport of momentum, heat and mass and dimensionless correlation for each one of them.

Momentum, heat and mass transfer analysis.

***Books Recommended*:**

1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N. : Transport Phenomena, 2nd Edition, John Wiley & Sons, 200
2. Weity, J.R. Wilson, R.E. and Wicks, C.E. : Fundamentals of Momentum Heat and Mass Transfe Edition, John Wiley & Sons, 2001.
3. Bennett.C.O. and Myres J.E. : Momentum, Heat and Mass Transfer, McGraw Hill.

Title	**Environmental Engineering**			**Credits**	5
Code	CHE 402	**Semester:-**7th		**L T P**	3 1 3
Max.Marks	**End term 50**	**Mid term 50**	**Practical: 25**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42 (Theory) 14 (Practical Sessions)

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION-A

Ambient air and water standards. Principal sources of pollution.

Inter-relationship between energy and environment pollution. Prevention of environmental pollution

through conservation, raw material substitutions, process and equipment modifications. A case study on the concept of zero discharge.

Air Pollution:

- Principal air pollutants and their usual sources.
- Effect of air pollutants on human health, animals, vegetation and materials.
- Atmospheric dispersion of air pollutants, temperature inversions, Estimation of pollutants by Gaussian plume model.
- Process and equipments used for the control of particulate pollutants.

SECTION-B

Water Pollution:

- Types of water pollutants, their sources and effects.
- BOD and COD
- Waste water treatment techniques and equipments, flocculation, skimming, floatation, etc.
- Primary Treatment-through settling.
- Secondary Treatment-Aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds.

Solid wastes: Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

***Books Recommended*:**

1. Perkins, H.C. : Air Pollution, McGraw Hill, N.Y.
2. Rao, C.S. : Environmental Pollution Control Engineering, 2nd Edition, New A International Pvt. Ltd., 2006.
3. Williamson, S.J. : Fundamental of Air Pollution, Addison Wesley Co. N.Y.
4. Numerow, N.L. : Liquid Wastes of Industry, Addison Wesley Co., N.Y.
5. Sincero, A.P. and Sincero, G.A. : Environmental Engineering, Prentice-Hall of India, 1999.
6. Hammer, M.J. and Jr. Hammer, M.J. : Water and Wastewater Technology, 6th Edition, Prentice-Hall India, 2008.
7. Mahajan, S.P. : Pollution Control of Process Industries, Tata McGraw Hill.
8. Metcalf and Eddy : Waste-Water Engineering, 4th Edition, Tata McGraw Hill, 2007.

Environment Engineering Laboratory (PRACTICALS)

1. To find BOD of water sample.
2. To find COD of waste sample.
3. To find the total dissolved solids (TDS) and its volatile and non-volatile components.
4. To find the total suspended solids (TSS) and its volatile and non-volatile components.
5. To do the chromium separation by different techniques from electroplating wastes.
6. To find the phenol content of water sample and evolution of parameters.
7. To operate the electrodialysis apparatus.
8. To find the biodegradation constant (K) and the effect of timing on it.
9. To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
10. To use stack monitoring kit to find:
    a. Efficiency of a cyclone.
    b. Dust sampling.

Note: Any six of the above mentioned experiments are to be conducted.

Title	Process Modelling & Simulation			Credits	1
Code	CHE 403	Semester:-7th		L T P	- - 3
Max.Marks	End term	Mid term	Practical:25	Elective	N
Pre requisites	-			Contact Hours	14 (Practical Sessions)

Practical

Functional design, property estimate as inputs for design. System concepts for computer aided design, computer aided flow sheet design. Process analysis. Process variables selection, equipment design through the selection of free parameters subject to constraints and other parameters, modular design. Simulation optimality. Dynamic design including control stability.

Typical equipments to be considered: heat exchangers, distillations columns, reactor and process equipments.

***Books Recommended*:**

1. Luyben, W.L. : Process Modeling, Simulation & Control, Mc Graw-Hill Book Co.
2. Franks, R.G. E. : Modeling and Simulation in Chemical Engineering, Wiley Interscience.
3. Mischke, C. : Computer Aided Design, Prentice Hall.

Title	Process Plant Design-II			Credits	1
Code	CHE 405	Semester:-7th		L T P	- - 3
Max.Marks	End term	Mid term	Practical:25	Elective	N
Pre requisites	-			Contact Hours	14 (Practical Sessions)

Practical

1. Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condenser and reboiler.
2. Design of distillation column, calculation of number of plates, height and design of fractionator internals- sieve tray.
3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculations. HTU and NTU.
4. Design aspects of fixed bed reactors and fluidized bed reactors.

***Books Recommended*:**

1. Coulson, Richardson & Sinnott, R.K. : Chemical Engineering, Volume 6 – An Introduction to Che Engineering Design, 4th Edition, Pergamon Press, 2007.
2. Ludwig, E.E. : Applied Process Design in Chemical and Petrochemical P 2nd Edition, 1977.
3. Perry, J.H. : Chemical Engineers Handbook, 8th Edition, McGraw Hill, 20
4. Kern, D.Q. : Process Heat Transfer, McGraw Hill, 1965.
5. Shell and Tube Type Heat Exchangers, Indian Standards. : Instt., IS: 43-197.
6. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw- 1981.

7.	Levenspiel, O.	:	Chemical Reaction Engineering, 3rd Edition, John Wiley and Sons, 2004.
8.	Walas, S.M.	:	Reaction Kinetics for Chemical Engg., McGraw Hill.
9.	Scott Fogler, H.	:	Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007.

EIGHT SEMESTER

Title	**Process Instrumentation**			**Credits**	4
Code	CHE 407	**Semester:-**8th		**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION-A

General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system.

Static and Dynamic Characteristics of Instruments:

Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone.

Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time.

Temperature measurement:

Thermal expansion methods – bimetallic thermometers, liquid-in-glass thermometer and filled-in-system thermometers.

Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.

Pressure measurement:

Use of manometers, Bourdon gauge, bellows type gauge. Vacuum measurement–Mcleod gauge, thermoionic type ionization gauge, pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system.

SECTION-B

Liquid level measurement:

Direct measurement of liquid level –Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission of liquid level.

Level measurement in open vessels: Bubbler system, diaphragm box system, air trap system. Level measurement in pressure vessels – Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge. (6 Hrs.)

Measurement of viscosity, conductivity, humidity and pH.

Density measurement – liquid level method, displacement meter and hydrometer.

Measurement of weight – spring scale, pneumatic force meter and hydrostatic force meter.

Process Instrumentation–Recording instruments, indicating and signaling instruments, control centre, transmission of instrument reading, instrumentation diagrams.

***Books Recommended*:**

1. Eckman, Donald P. : Industrial Instrumentation, CBS Publisher and Distributors, Indian F 2004.
2. Singh, S.K. : Industrial Instrumentation and Control, 2nd Edition, Tata McGraw – Hill, 2007.
3. Considine, D.N. : Process Instruments and Controls Handbook 2nd Edition, McGraw Hill,
4. Fribance, A.E. : Industrial Instrumentation Fundamentals, Tata McGraw – Hill Publishi

Ltd., 1962.
5. Patranabis, D. : Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw Hill Publishing Co. Ltd., 1999.

Title	**Process Engineering Economics**			**Credits**	4
Code	CHE 408	**Semester:-**8th		**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	42

THEORY

Note for the Examiner	**Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.**

SECTION-A

Cost estimation: Factors affecting investment and production costs. Capital investments, fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimating capital investment. Estimation of total product cost. Different costs involved in the total product costs. Different cost involved in the total product for a typical chemical process plant.

Interest and Investment Costs: Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary annuity. Perpetuities and capitalized costs.

Taxes and Insurance: Types of taxes and tax returns, types of insurance and legal responsibility.

Depreciation: Types of depreciation. service life salvage value, present value and methods of determining depreciation, single unit and group depreciation.

SECTION-B

Profitability, Alternative Investments and Replacements: Mathematical methods of profitability evaluation. Cash flow diagrams. Determination of acceptable investments. Alternatives when 'an investment must be made and analysis with small increment investment, replacement. Breakeven analysis. Balance sheet and income statement.

Optimum Design: Procedure with one variable, optimum reflux ratio in distillation and other examples.

Preliminary Steps in Plant Design: Plant design factors. project organization, plant location, preliminary data collection, process engineering

***Books Recommended*:**

1. Peters, M.S. & Timmerhaus, K.D. : Plant Design and Economics of Chemical Engineers, Mc Graw Hill New York, 4th Edition, 1991.
2. Ulrich, G.D. : A Guide to Chemical Engineering Process Design & Economics, John Wiley, 1984.
3. Guthrie, K.M. : Process Plant Estimating, Evaluation & Control, Craftsman Solano Beach, Calif, 1947.
4. Jelen, F.C. : Cost and Optimisation Engineering, McGraw Hill, New York, 1970.
5. Holland, F.A. & Wastson, F.A. : Introduction to Process Economics, 2nd Edition, Wiley, 1983.
6. Bassel, W.D. Preliminary Chemical Engineering Plant Design, Elsevier, New York 1976.

Paper Title : PROJECT WORK
Paper Code CHE 406

Each student is required to submit a project report on the design of a chemical plant, selecting the best process with optimum equipment size and operating conditions. The object is to test the ability of the student to apply his entire knowledge of Chemical Engineering principles to conceptualize, analyze and solve the problems. To judge his knowledge and originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course.

Title	**COMPREHENSIVE VIVA**			**Credits**	01
Code	CHE 409	**Semester:-**8th		**L T P**	- - -
Max. Marks	**End term--25**	**Mid term- -**	**Practical-**	**Elective**	N
Pre requisites				**Contact Hours**	
The viva-voce examinations will be comprehensive and covering mainly chemical engineering and technology subjects covered during all the semester including the Eight Semester.					

Title	**Literature Survey, Report Writing & Seminar**			**Credits**	**No Credit**
Code	CHE 410	**Semester:-**8th		**L T P**	- - 3
Max.Marks	**End term**	**Mid term**	**Practical: s or x**	**Elective**	N
Pre requisites	**-**			**Contact Hours**	14 (Practical Sessions)

Practical

Forms of technical reports: aims and forms according to type of readership and extent of circulation. Abstracts, extended abstracts, tables, graphs. Visual representation of data: slides, microfilms, others techniques including those of audio-visual representation. Correct use of audio equipment.

Research papers and their presentation and publication. Information retrieve direct and through abstracts.

Practical training in writing and presentation of technical reports through audio-visual means. Technique of effective public speaking organized and imprompt discussions.

Preparation of technical report on an assigned topic after survey of scientific, technical and commercial literature, using card indexes, microfilms and other information retrieval methods.

Use of Computer softwares for report writing.

***Books Recommended*:**

1. Mikdran, A.M. : Use of Engineering Literature, Butter Worths.
2. Sottle, R.T. : The Use of Chemical Literature, Butter Worths.
3. Hoover, H. : Essentials For TheTechnical Writer, John Wiley.
4. Robertson, W.S. & Siddle, W.D. : Technical Writing and Presentation, Pergamon.

Paper Title: Open Elective (Theory)

Course Duration: 42 Lectures of one hour each.

FUEL CELL TECHNOLOGY (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.	

Section-A

Overview of fuel cells: Low and high temperature fuel cells;
Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency.
Fuel cell reaction kinetics - electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents,
Electrocatalyses - design, activation kinetics,
Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

Section-B

Fuel cell characterization: - in-situ and ex-situ characterization techniques, i-V curve, frequency response analyses; Fuel cell modeling and system integration: - 1D model - analytical solution and CFD models. Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

Books Recommended

Text books:
1. O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).
2. Basu,S.(Ed) Fuel Cell Science and Technology,Springer, N.Y.(2007).
3. Liu, H.,Principles of fuel cells, Taylor & Francis, N.Y. (2006)

Reference Books:
1. Bard,A. J. , L. R., Faulkner,Electrochemical Methods, Wiley, N.Y.(2004)

NANO TECHNOLOGY (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.	

Section-A

Introduction: Plenty of room at the bottom-Feynman's concept, evolution of ultra-fine materials, the missing link between conventional laws in physics and chemistry and new theories.
Building Blocks of Nanotechnology: covalent architecture, coordinated architecture and weakly bound aggregates, Interactions and topology

Chemical Properties: The effect of nanoscale metals on chemical reactivity, effect of nanostructure on mass transport, metal nanocrystallites support on oxides, supported nanoscale catalysts.

General principles for synthesis of monodispersed nanoparticles, metals and intermetallics, Ceramics, composites, nanoparticles, colloids/Micelles/vesicles/Polymers/glasses, Crystalline, and zeolite hosts.
Review of fundamental behaviour of 0-D(nanoclusters), 1-D(nanowires), 2-D(thin film multilayers), and 3-D(bulk nanostructures) materials. Introduction to size dependent phenomenon in nanostructure for various applications, specific production techniques like chemical vapor deposition, arc ignition etc. Formation of clusters and nanoparticles from supersaturated vapor and selected properties, sputtering and thermal evaporation and laser methods. Synthesis of nanoparticles by chemical routes.

Section-B

Approches to production: Top down and bottom up, Mechanical attrition, high energy ball milling, and mechanical attrition, nanocomposites by mechano-chemistry, mechanism of grain size reduction, property of microstructure relationships.
Characterization techniques : Tools in nanotechnology: Scanning electron microscopy(SEM), Transmission electron microscopy and high resolution(TEM), energy dispersive spectroscopy (EDX), Atomic force microscopy(AFM), Magnetic force microscopy(MFM), Chemical Force Microscopy(CFM), Focused ion beam, nanolithography, powder x-ray diffractometry, UV visible.

Nanomaterials: CNTs, Polymer Nanocomposites nanoceramics, nanometals, nanopolymers, structures-properties-applications, Quantum dots. Concepts Bio-Nanotechnology.
Applications: Nanotherapeutics, Molecular diagnostics, tissue engineering, nanopumps, nanorobtoics cells, molecular motors, nanomembranes, Organic molecular based computers, bionanodevices (sensors & actuators).]

Books Recommended

1. Nanoscale Materials in Chemistry by Kenneth J. Khabhunde (ed.) Wiley Interscience.
2. Nanotechnology – An introduction to nanostructure of technique by Michel Kohler and Wolfgang Frittsche 2004- Wiley VCH
3. Springer Handbook of Nanotechnology by Bharat Bhushan
4. Encyclopedia of Nanotechnology- Hari Singh Nalwa.
5. Nanostructures and Nanomaterials by G. Cao, Imperial College Press, 2004
6. Introduction to Nanotechnology by Owen and Poole, Wiley
7. Nano-materials by A. K. Bandopadhyay, New Age International

POLYMER SCIENCE AND ENGINEERING (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.		

Section-A

Chemistry of polymers:
Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness,
Polymerization methods: addition and condensation; their kinetics, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic

copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

Polymer Characterization:
Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

Section-B

Polymer Technology:
Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization

Polymer processing:
Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

Books Recommended:

1. Williams, D.J. : Polymer Science and Engineering, Prentice Hall Inc.
2. Rodriguez, F. : Principles of Polymer Systems, Tata McGraw Hill Pub.
3. Odian,G. : Principles of Polymerization, McGraw Hill.
4. Collins, E.A., Bares, J. & Billmeryer, F.W., Experiments in Polymer Science, Wiley Inter Science.
5. Kumar, A. & Gupta, S.K. : Fundamental of Polymer Science and Engineering, Tata McGraw Hill Pub.
6. Middleman, S. : Fundamentals of Polymer Processing, McGraw Hill, New York.
7. Moore, G.R. and Kline, D.E., "Properties and Processing of Polymers for Engineers", Society of Plastics Engineers, Prentice–Hall, Englewood Cliffs, NJ, 1984
8. Tadmor, Z. and Gogos, C.G.: Principles of Polymer Processing, John Wiley & Sons, 1979.

OPERATIONS RESEARCH (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.		

Section-A

Linear Programming: problem formulation, graphical method, simplex method, duality sensitivity analysis.
Transportation model, Transhipment problem, traveling salesman problem, Assignment models, Sequencing model, Replacement model.

Section-B

Theory of Games: Pure strategy games, principle of dominance; mixed strategy games (Algebraic, Graphical & Linear programming method), 2-person, non-zero- sum games.

Queuing Theory: Introduction, elementary queuing system; single channel queuing model, queuing cost behaviour, multiple channel queuing model, Poisson arrivals and Erlang service distribution; benefits and limitations of queuing theory.

Books Recommended:

1. Vohra, N.D. : Quantitative Techniques in Management; 2nd Edition, Tata McGraw Hill.
2. Gupta, P.K. and Hira, D.S. : Operation Research, S. Chand, New Delhi.
3. Swarup Kanti, Gupta, P.K. and Man Mohan : Operation Research, 12th revised Edition, Sultan Chand & Sons, New Delhi;

SUPPLY CHAIN & LOGISTIC MANAGEMENT (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.	

Section-A

Introduction to Supply Chain Management: Definition; Scope & Importance of Supply Chain Management; Key drivers Of the SCM; Features of Supply Chain Management; Supply Chain Network – 1st Tier , 2nd Tier; Network decisions in SCM; Suppliers and Customers; Customer Service Dimension (Seven "R" Principles, Service after sale, Customer delight)

Role of Logistics in Supply Chains: Definition of Logistics Management; Scope and role of Transportation, Traffic & transportation; Relationship between transportation and other business functions, Transport Economics: Distance – volume-density, Freight Cost, Handling, Liability, market factors; Third party logistics (3 PL) & fourth party logistics service provider (4 PL), Logistics equipment; Reverse Logistics, Government rule & regulations related to Logistics; Purchase Cycle, Make or Buy, Price analysis, Negotiations.

Section-B

Inventory Management: Inventory Control, Planning & Managing Inventories; Warehouse Management (Receipt, issue, storage and preservation, stock verification, In bound and out bound distribution operations); Order Management; Competitive advantage through logistics and supply chain management; Responsive Supply Chain; Supply chain process integration, performance measurement; Value Chain, Value System and Supply Chain.

Planning demand and supply: Planning & Sourcing in Supply Chain, Demand forecasting, Type and Time horizon of forecast and category of forecasting, aggregate planning; Financial issues in Supply Chain - Macro and micro view, Asset management, Du Pont Model, Supply Chain Costing; Decision environment in SCM; Global supply chain perspectives - New business models, role of IT in SCM.

Books Recommended:

1. Harald Dyckhoff et al, Ed.: Supply Chain Management and Reverse Logistics, Springer (India).

2. Jayashree Dubey and M.L. Saikumar Ed.: Supply Chain Management, IIPE Hyderabad and New Century Publication.
3. Sarika Kulkarni, Ashok Sharma: Supply Chain Management-Creating Linkages for Faster Business Turnaround, McGraw Hill.
4. RP Mohanty: Supply Chain Management-Theories and Practice, Biztantra.
5. Robert B. Handfield, Ernest L. Nicholas, Jr.: Introduction to Supply Chain Management,Pearson Education.
6. Ronald H. Ballou, Samir K. Srivastava: Business Logistics/Supply Chain Management, Pearson Education.
7. John Mentzer: Supply Chain Management, Response Books.
8. Janat Shah: Supply Chain Management, Pearson Publications.
9. N. Chandrasekaran: Supply Chain Management - Process, System and Practice, Oxford Press.

PROJECT MANAGEMENT AND ENTREPRENEURSHIP (Theory)

THEORY		Time	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.		

Section-A

Introduction to Projects: Meaning & Definition of Project, Attributes of a Project, Difference among Projects, Routine Activities and Programs; Project Life Cycle

Project Planning: Work Breakdown Structure, Types of Work Breakdown Structure, Planning Framework and Its Importance

Project Feasibility: Marketing, Technical & Financial Feasibility

Social Cost Benefit Analysis: Rationale, UNIDO and Little Mirrlees Approaches

Project Schedule Planning; Network Analysis Techniques; Project Implementation; Project Monitoring & Control

Section-B

Entrepreneur- Meaning & Definition of Entrepreneur, Characteristics of Entrepreneur, Nature and importance of Entrepreneur, Functions, Entrepreneur V/s Manager, Women Entrepreneurs.

Entrepreneurship: Concept, Policies Governing Entrepreneurs, Entrepreneurial Development Programmes, Contribution of Entrepreneurship to Economic Development

Institutions for Entrepreneurial Development; Role of Various Commercial Banks and Development financial Institutions.

Books Recommended:

1. UNIDO: Guidelines for Project Evaluation, United Nations, reprinted,1993..
2. Mannual for the preparation of Industrial Feasibility Studies, United Nations 1995.
3. Manual for Evaluation of Industrial Projects, United Nations, reprinted on 1993..
4. IMD little and J.A. Mirrlees: Project Apraisal and Planning in Developing Countries, 1975.
5. Prasanna Chandra: Projects: Preparation, Appraisal Budgeting and Control, 7th edition, TMH.
6. Vasanta Desai: Dynamics of entrepreneurial development and management, 11th edition, Himalaya pub.
7. Vasanta Desai: Entrepreneurial development, and Management, 13th edition, Himalaya pub., Harper Collins, edition- Paperback.
8. Peter F. Drucker: Innovation and development.

Paper Title: Departmental Elective (Theory)

Course Duration: 45 Lectures of one hour each.

PETROLEUM PROCESSING ENGINEERING (Theory)

THEORY		Time	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.		

Section-A

Introduction to petroleum industry, world petroleum resources, petroleum industry in India. Origin, exploration & drilling of petroleum crude. Transportation of crude and products.

Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline,naphtha, kerosene, diesel, lubricating oils and waxes.

Section-B

Separation Processes: Design and operation of topping and vacuum distillation units and tube still furnaces. Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.

Conversion Processes: Thermal cracking: visbreaking and coking processes, catalytic cracking, thermal reforming and catalytic reforming, alkylation, polymerization, isomerisation and hydroprocessing.

Safety and pollution considerations in refineries.

Practicals

1. To plot ASTM distillation curve for gasoline, diesel oil.
2. To determine Flash point (Closed – cup) and smoke point for kerosene.
3. To determine Aniline point, Diesel Index and cetane number for diesel oil.
4. To determine pour point and cloud point for furnace oil and diesel oil.
5. To determine viscosity at different temperatures using Ostwald viscometer for hydrocarbon solvents.
6. To determine softening point and penetration number for asphalt and grease samples.
7. To determine viscosity index of lubricating oil by Redwood viscometer.
8. To determine water content in petroleum products by Dean and Starks method.

Books Recommended:

1. Nelson, W.L. : Petroleum Refinery Engineering, 5th Edition, McGraw Hill, 1985.
2. Rao, B.K. : Modern Petroleum Refining Processes, 5th Edition, Oxford & I Publishing Co., 2009.
3. Guthrie, V.B. : Petroleum Products Handbook, McGraw Hill, 1960.
4. Hobson, G.D., Pohl. W. : Modern Petroleum Technology, 5th Edition, John Wiley, 1984.

INDUSTRIAL SAFETY & HAZARDS (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.	

Section-A

Definition, Hazards identification, Hazards and operability studies (HAZOP), Failure mode and effect analysis (FMEA), classification and assessment of various types of hazards in work-place environment and Industrial Hygiene, protective and preventive measures in hazard control.

Toxic Chemicals: maximum allowable concentrations and other standards. Biological threshold limit values.

Mechanical and electrical hazards. Personal protective equipments. Explosives and inflammable substances. Radioactive hazards. Good housekeeping in industrial environment.

Section-B

Fire prevention, design to prevent fire and explosion (inverting static electricity, sprinkler system), boiling liquid expending vapour explosion (BLEVE). Fire triangle, Dow's Fire and explosion index, dilution and ventilation.

Standard safety procedures and disaster control; OSHAS, OHSMS and OSHA. Current amendments in Indian Legislation on safety and prevention of hazards and safety code: ISO 14000, ISO 9000. Environmental impact assessment. Control strategies for hazardous wastes.
Case Studies of typical hazardous industries.

***Books Recommended*:**

1. Wills, G.L. : Safety in Process Plant Design.
2. Less, F.P. : Loss Prevention in Process Industries.
3. Chanleft, E.T. : Environmental Protection.
4. Berhowex, P.M. & Rudd, D.F : Strategy of Pollution Control.
5. Safety for Chemical Engineers : A.I.Ch.E. Publications, 1976-77.

PLANT UTILITIES (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.	

Section-A

Importance of Process utilities in Chemical Plant.
Compressed air and Vacuum: Reciprocating air compressors, vacuum pumps, air receivers, piping systems.
Steam: Boiler, steam handling and distribution steam nozzles.

Section-B

Refrigeration: Air refrigeration cycle, vapour compression cycle, liquification processes.
Power Generation: Internal Combustion engines. Gas turbines, steam power plants.
Water: Water Resources, storage & distribution of water reuse & conservation of water.

***Books Recommended*:**

1. Jouganson, R. : Fan Engineering, Buffalo Rorge Co., 1970.
2. Wangham, D.A. : Theory and Practice of Heat Engines, ELBS Cambridge University Press, 1960.
3. Lyle, O. : Efficient Use of Steam, HMSO, 1963.
4. Stoccker, W.F. : Refrigeration and Air Conditioning, Mc-Graw Hill, 1950.
5. Kurl, W.F. J.H.M. : Reuse of Water in Industry, Butterworth, London.

PETROCHEMICAL TECHNOLOGY (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.	

Section-A

General Introduction: Definition, history and economic perspective of petrochemical

industry, raw materials for petrochemical industry-petroleum, natural gas, coal, bio-mass, agro-residues, etc.
First Generation Petrochemicals: Petrochemicals based on aliphatic, olefinic, acetylene,aromatics, etc. Hydrocarbons-processing and applications.
Second Generation Petrochemicals: Products based on Synthesis Gas, Method, Ethanol,Ethylene Oxide, Vinyl Chloride, Propylene Oxide, Isopropyl Alcohol, Acetone, AllylAlcohol, Glycerol, Phenol, Aniline.

Section-B

Nylon Monomers, Polyester Monomers, Styrene, Other Monomers - Bisphenol A, Epichlorophydrin, diisocyanates, Pentaerythritol, etc. - properties,process technologies and applications. .
Third Generation Petrochemicals: Important Polymers such as Polyethylene, Polypropylene and their Copolymers and other Derivatives Rubbers, Diene Polymers, Styrene Polymers,Vinyl Polymers and Condensation Polymers - properties, process technologies and applications.

***Books Recommended*:**

1. Steiner, H.: Introduction to Petroleum Chemicals, Pergamon Press.
2. Waddane, A.L. : Chemicals from Petroleum, John Murry.
3. Topchiev, A.V. : Synthetic Materials from Petroleum, Pergamon Press.
4. Astle, M.J. : The Chemistry of Petrochemicals, Reinhold.
5. Maiti, S.: Introduction to Petrochemicals, Oxford and IBH Pub. Co. Ltd., New Delhi, 1992.
6. Frank, H.G. & Stadelhofer, J.W.: Industrial Aromatic Chemistry, Springer Verlag Berlin, 1987.

BIOCHEMICAL ENGINEERING (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.		

Section-A

Isolation and Utilization of Enzymes: Purification, immobilization, application of enzyme technology.
Kinetics of Enzyme-Catalyzed Reactions: The substrate, enzyme kinetics, factors affecting enzymatic activity and enzymatic reactions in heterogeneous reactions.
Metabolic Pathways and Energetics of the Cell: The concept of energy coupling, aerobic and anaerobic metabolism, photosynthesis and biosynthesis, transport across cell membranes.
Cellular Genetics and Control: Growth and reproduction of a single cell, alteration of cellular DNA, commercial applications.

Section-B

Kinetics of Substrate Utilization. Product Yield and Biomass Production: Growth cycle for batch cultivation and its mathematical modeling, products synthesis kinetics, thermal death kinetics of cells and spores.
Transport Phenomena in Microbial Systems: Gas-liquid mass transfer, determination of oxygen transfer rates, mass transfer, surface-area correlations for mechanically agitated vessels, scaling of mass transfer equipment, particulate mass transfer, heat transfer.
Design and Analysis of Biological Reactors: The ideal continuous-flow stirred-tank reactor (CSTR), residence time distribution, different types of reactors, relationship between batch and continuous biological reactors. Fermentation technology, product manufacture by fermentation, reactors for biomass production.

Books Recommended:

1. Balley & Ollis : Biochemical Engineering Fundamentals, McGraw Hill Book Co., 1986.
2. Aiba Humphrey & Millis : Biochemical Engineering, Academic Press, 1973.
3. Whitaker Stanbury & Whitaker, Hall : Principles of Fermentation Technology, Adita Books, New Delhi, 1997.