

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2020-2021)

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:

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- 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

2ndYear**3rdSEMESTER**

S. No.	Course code	Courses	Contact hrs per week			Total contact hours	Mid Term	End Term	Total Marks	Credits
			L	T	P					
1.	BS106	Physical Chemistry	3	-	-	45	35	40	75	3
2.	PCC-CS 102	Fluid Flow	3	1	-	60	50	50	100	4
3.	PCC-CS 103	Energy Technology	3	1	-	60	50	50	100	4
4.	ESC-GES 105	Strength of Materials	3	-	-	45	35	40	75	3
5.	OEC-OL 101	Open Elective I	3	-	-	45	35	40	75	3
6.	ESS-GES 157	Process Equipment Design	-	-	3	45	40	-	40	1.5
7.	BS156	Physical Chemistry Lab.	-	-	3	45	40	-	40	1.5
8.	PCC-CS 152	Fluid Flow Lab.	-	-	3	45	40	-	40	1.5
Total			15	2	9	390	325	220	545	21.5

Note:

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- 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

4thSEMESTER

S. No.	Course code	Courses	Contact hrs per week			Total contact hours	Mid Term	End Term	Total Marks	Credits
			L	T	P					
1.	PCC-CS 104	Heat Transfer	3	1	-	60	50	50	100	4
2.	PCC-CS 105	Chemical Engineering Thermodynamics	3	1	-	60	50	50	100	4
3.	PCC-CS 106	Mechanical Operations	3	1	-	60	50	50	100	4
4.	BS 107	Numerical Methods in Chemical Engineering	3	1	-	60	50	50	100	4
5.	ESC-GES 106	Engineering Materials	31	-	-	60	50	50	100	4
6.	PCC-CS 154	Heat Transfer Lab.	-	-	3	45	40	-	40	1.5
7.	PCC-CS 155	Mechanical Operation Lab.	-	-	3	45	40	-	40	1.5
Total			155	6		390	330	250	580	23

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

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	S.No.	List of Open Electives
1	Petroleum Processing Engineering	1.	Fuel Cell Technology
2	Industrial Safety and Hazards	2.	Nanotechnology
3	Plant Utilities	3.	Polymer Science and Engineering
4	Petrochemical Technology	4.	Operations Research
5	Biochemical Engineering	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.

Program Educational Objectives (PEOs)

1. The graduates of 4 year chemical engineering programme will work as process engineers, production engineers and design engineers in chemical process and allied industries.
2. The graduates will pursue higher studies in various institutions in India and abroad and also find opportunities in R & D organizations in areas of process design and development of chemical engineering products and thus strive for lifelong learning.
3. The graduates possess effective communication skills and abilities to work and lead in multi-disciplinary teams, possess professional attitude and ethics.

Programme Outcomes(POs)

1. The graduates have ability to apply knowledge of physical sciences, mathematics and chemical engineering.(**Engineering Knowledge**)
2. Identify, formulate and solve chemical engineering problems using fundamental (1st principles)and engineering sciences. (**Problem Analysis**).
3. Conduct experiments and design commercial equipments or processes with specific consideration of environmental, social, health and safety aspects in the area of chemical engineering and allied fields. (**Design & Development of Solutions**)
4. Use research methods, design of experiments and analysis techniques to analyze, interpret and present data and to solve complex engineering problems and provide valid conclusions. (**Investigation of Complex Problem**)
5. Use the IT techniques, modeling and simulation skills, and modern engineering tools necessary for chemical engineering practice. (**Modern Tools Usage**)
6. Analyze the local and global impact of engineering solutions and applications on individuals, organizations and impact on society as well as the impact of society on professional chemical engineers. (**Engineer and Society**).
7. Design a system, a component, or a process to solve the problems within realistic constraints such as economic, social, environmental, ethical, health and safety, manufacturability and sustainability. (**Environment & Sustainability**)
8. Understand the importance of professional ethics. (**Ethics**)
9. Function effectively individually or as a member of a team with the objective of performing and achieving goals. (**Individual & Team work**).
10. Communicate and present themselves effectively. (**Communication**)

11. Recognize the need for, and to engage in continuous professional development. **(Lifelong Learning)**
12. Understand the principles of engineering and management and apply these to the discipline as a member or leader in a team, to manage projects. **(Project management & Finance)**.

SYLLABUS OF B.E. CHEMICAL ENGINEERING 2020-2021
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
Course Objectives	To make the students <ol style="list-style-type: none"> 1. Understand the behavior 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. 			
Course Outcomes	CO1: To test the behavior of infinite series. Operate vectors and convert line integral to surface integral to volume integral. CO2: Analyze functions of several variables and their applications. CO3: Evaluate multiple integrals and apply them to practical problems. CO4: To study cylinders and cones and understand applying cylindrical and polar coordinates. Formulate and solve linear differential equations.			
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, 41 st Edition, Khanna Publishers, Delhi. 3. Differential Equations, Frank Ayers, TMH

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, ferroelectricity. (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 Kittel 8 th 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, Eastern Economy 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	
CO1: Understand Bragg's law and introduced to the principles of lasers, types of lasers and applications. CO2: Various terms related to properties of materials such as permeability, polarization etc. CO3: Basic knowledge of structural properties, crystal structure and X ray diffraction analysis. CO4: Basic knowledge of magnetic, superconducting, dielectric properties of materials. CO5: Knowledge of nanomaterials, nanotechnology and its application.	

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	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				
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 splitting 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				

<p>Chemical Bonding and structure Part II: Ligand Substitution 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</p> <p>Inorganic polymers: Types of inorganic polymers, polyphosphazenes, polysiloxanes –their structures and properties. 05hrs</p> <p>Bio-inorganic Chemistry of Iron and cobalt – Heme proteins, Non-Heme iron proteins, Iron Sulphur proteins and coenzyme B₁₂; 05 hrs</p> <p>Metal Toxicology : Toxic effects of heavy metals with special reference to Cd, Pb, Hg and As. 04hrs</p>	
<p>Recommended Books:</p> <ol style="list-style-type: none"> 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 Eastern Ltd., 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 Doull's 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. <i>Inorganic Chemistry: Principles Of Structure And Reactivity</i>, 4e By James E. Huheey, Ellen A. Keiter, Richard L. Keiter 	
Course Assessment Methods	<p>Assessment will consist of the following components</p> <ol style="list-style-type: none"> 1. Mid-Term <ol style="list-style-type: none"> 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	<p>CO1: Understanding the basics of wave mechanics and chemical bonding in inorganic chemistry.</p> <p>CO2: Understanding the relation between structure and reactions of various complex compounds.</p> <p>CO3: Understanding the mechanism of various reaction and the ways to control them.</p> <p>CO4: Identifying the elements hazardous to nature and means to control them.</p>

Title	COMMUNICATION SKILLS		Credits	1
Code	HSMC-HASS 101	Semester:- 1st	L T P	1 - -
Max. marks	End term- 15	Mid term- 10	Elective	N
Pre-requisites			Contact hours	15
Objectives	<ol style="list-style-type: none"> 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	The semester question paper of the subject will be of 50 marks having 8 questions of			

Examiner	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	<ol style="list-style-type: none"> 1. Ashraf, M. Rizvi, "Effective Technical Communication", McGraw Hill 2. Bovee, Courtland L. and John, V. Thill, "Business Communication Today", Pearson Education
Reference Books	<ol style="list-style-type: none"> 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 Technical Writing", 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 <p>Pease, A., "Body Language", Sheldon Press</p>
Course Assessment Methods	<p>Assessment will consist of the following components</p> <ol style="list-style-type: none"> 1. Mid-Term <ol style="list-style-type: none"> 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	<p>CO1: Gain proficiency in English language as medium for communication in both professional and personal life</p> <p>CO2: Increase in employment prospective of students by developing technical aspects of communication.</p> <p>CO3: Personality development of students by thorough knowledge of effective and enhanced communication skills</p>

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: <ol style="list-style-type: none"> To introduce the students to visual science in the form of technical graphics. 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. 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. 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:	<ol style="list-style-type: none"> P.S. Gill: Engineering Drawing R.K. Dhawan : A textbook of engineering Drawing, S. Chand & Co. Ltd. New Delhi 2nd edition. P.S.Gill: Machine Drawing Sham Tickoo : Understanding AutoCAD 2006, Wiley Publication James D. Bethune : AutoCAD, Pearson Publishers 			
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.			
Course Outcomes	CO1: Understand the use of different drawing tools, types of lines, dimensioning rotation of planes and types of projections. CO2: Projection of points, lines and planes. Visualization of solid objects through projection of solids and assembly drawing. CO3: Understand the importance of development of surfaces, isometric projection and computer graphics.			

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	<ul style="list-style-type: none"> 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, shaper, 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.	
Recommended 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	CO1: Identify basic prototypes in the carpentry trade such as Lap joint, Lap Tee joint, Dove tail joint, Bridle joint, and Mitre joint. CO2: Recognize and differentiate between the use of arc welding and gas welding in making different types of welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint. CO3: Describe the various fabrication processes in Machine shop, use of machine tools and materials, introduction to working of lathe, shaper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. CO4: Recognize the wiring techniques 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.

Title	PHYSICS LAB.		Credits	1
Code	BS152	Semester:- 1 st	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)				
<ol style="list-style-type: none"> To find the energy band gap of the given semiconductor by four probe method. To study the Hall Effect of a given semiconductor To determine the dielectric constant of the given materials. To study the B-H curve of the ferromagnetic materials. To determine the value of e/m for electron by long solenoid (helical) method. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph To determine the velocity of ultrasonics waves in a given liquid. To determine the frequency of A.C. mains using a sonometer and an electro-magnet. To find the capacitance of a capacitor using flashing and quenching of a neon lamp. To plot graph between current and frequency in a series LCR circuit and to find the resonant frequency. To find the wavelength of sodium light using Fresnel's biprism.(3) (i) To determine the wavelength of He-Ne laser using transmission grating. (ii) To determine the slit width using the diffraction pattern. To determine the wave length of sodium light by Newton's rings method. To determine the wave length of sodium light using a diffraction grating. To find the specific rotation of sugar solution using a Bi-quartz Polarimeter. 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	CO1: Proficiency in technical aspects of performing the experiments. CO2: State various laws which they have studied through experiments. CO3: Experimental data observations and analysis. CO4 Proficiency in designing scientific projects and reporting

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) KMnO ₄ (Estimation of C ₂ O ₄ -2) 02 b)K ₂ Cr ₂ O ₇ (Estimation of Fe+2/Fe+3) 02 c) Iodine [Iodometry&Iodimetry] (Standardisation with Sodium Thiosulphate,Estimation of Cu+2, AsO ₃ -3 and Sb+3) 04 (ii) Complexometric Titrations- Determination of Zn+2 by EDTA titration. 02 II Gravimetric Analysis a) Estimation of Ba+2/SO ₄ -2 as BaSO ₄ b) Estimation of Fe+2/Fe+3 as Fe ₂ O ₃ 04				
Text Book: Vogel's Qualitative Inorganic Analysis, 7th Ed. By G. Svehla, Pearson Education.				
Course Outcomes				
CO1: getting hands on training in handling various equipment.				
CO2: understanding practically all theoretical concepts				
CO3: working with discipline and as a team with co-operation.				

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	CO1: English Speaking skills of students will be enhanced. CO2: Students will become self confident in handling both professional and personal meetings/discussions. CO3: Students will be able to demonstrate improved technical writing skills. CO4: 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
Course Objectives	<p>The students shall</p> <ol style="list-style-type: none"> 6. Learn to expand various functions in terms of Fourier series. 7. Learn the methods to formulate and solve partial differential equations. 8. Be taught to apply the method of separation of variables to solve partial differential equations of engineering interest. 9. Learn to find Laplace transforms and inverse transforms and apply these to solve differential equations. 10. Understand the concept of Complex functions and their applications to various problems. 			
Course Outcomes	<p>CO1: Expand functions in terms of Fourier series and introduction of harmonic analysis. CO2: Formulate and solve various partial differential equations. Solve partial differential equations of engineering interest by the method of separation of variables. CO3: Find Laplace transforms, inverse transforms and apply these to solve various differential equations. CO4: Evaluate complex integrals and apply these to various problems.</p>			
Note for examiner	<p>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.</p>			
SECTION A				
Fourier Series				
Euler's Formulae, Dirichlet'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 Of Pde'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 Taylor's series and Laurent's series, Residues, Residue theorem and its simple applications.				
Text Books	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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					
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
<p>Course objectives</p> <ol style="list-style-type: none"> 1. Learn and understand the concept of structural conformations and stereochemistry of organic compounds 2. To introduce the basic knowledge regarding acidity, basicity and nucleophilicity of organic compounds 3. To explain the formation of different reaction intermediates like free radical, carbonium and carbanion ion in order to be able to understand the mechanism of various substitution reactions. 4. To create an awareness about the effect of different attached groups on the reactivity and rate of reaction in organic synthesis. 					
<p>Course outcomes</p> <p>CO1: Understand and explain the different nature and behaviour of organic compounds CO2: Understand the concept of stereochemistry CO3: Learn and identify organic reaction intermediate and explain the mechanism including the free radical substitution, electrophilic addition, electrophilic aromatic substitution and nucleophilic reactions. CO4: Identify important organic reactions and their application for syntheses.</p>					
SECTION A					
<p>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</p> <p>Delocalisation: Concept of aromaticity, stability of cycloalkanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating groups. 06hrs</p> <p>Stereochemistry : Enantiomers, Diastereomers, Meso- and Racemic compounds, Resolution of racemic mixture. Asymmetric synthesis, Walden Inversion, Configuration (D and L nomenclature), Absolute configuration (R, S, E and Z nomenclature) 08hrs</p>					
SECTION B					
<p>Organic Reagents and Reaction Intermediates : free radicals, carbonium and carbanions and the mechanism of important substitution, elimination as well as important rearrangement reactions-- : House synthesis, halogenation of alkanes, free radical mechanism, orientation, reactivity and selectivity; catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophilic 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 electrophilic substitution reactions, nucleophilic substitution Friedel-Crafts reactions, Anisole nucleophilic addition, Aldol condensation 18hrs</p> <p>Synthetic utility of diazonium salts, synthetic utility of Grignard reagents and alkyllithiumsk, basicity of amines, multistep synthesis. 05hrs</p>					
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	<ul style="list-style-type: none"> 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's Laws, 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				
Basic 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	<ol style="list-style-type: none"> Edward Hughes: Electrical and Electronic Technology, Pearson Education Publication, Asia, 2003. Nagsarkar, T.K. and Sukhija M.S.: Basic Electrical Engg., Oxford University Press, 2004. Bhargava: Basic electronics and Linear circuits, Tata McGraw Hill.
Reference Books	<ol style="list-style-type: none"> Nagrath, I.J. and Kothari, D.P.: Basic Electrical Engg., TMH, New Delhi. Malvino: Digital Principles and Applications, Tata McGraw Hill
Course Outcomes	<p>CO1: The student will understand how various loads are connected in circuits and difference between single and three phase system.</p> <p>CO2: The students will know the principles and working of different types of electrical machines used in industry</p> <p>CO3: The students will have the basic knowledge of digitalization and conversion of physical quantity to digital quantity.</p>

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
Course Outcomes	<p>CO1: To convert units and dimensions and modify equations from one system to another,</p> <p>CO2: To integrate the data and formulate the material and energy balance problems,</p> <p>CO3: To apply material and energy balance in different chemical processes (with and without reactions), including problems involving recycle, bypass and purge streams,</p> <p>CO4: To use steam tables and psychrometric charts.</p>			
Note for examiner	<p>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.</p>			
SECTION-A				
<p>Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.</p> <p>Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.</p>				
SECTION-B				
<p>Material Balances for Reacting systems including balances involving recycle and purge streams.</p> <p>Combustion Calculations.</p> <p>Energy balances on nonreactive and reactive systems.</p>				
Books Recommended:				
1.	Bhatt, V. I. & Vora, S. M.	:	Stoichiometry, 3 rd Edition, Tata McGraw Hill, 1984.	
2.	Himmelbleau, D. M.	:	Basic Principles and Calculations in Chemical Engineering, 6 th Edition, Prentice Hall, 1977.	
3.	Felder, R. M. & Rousseau R.W.	:	Elementary Principles of Chemical Processes, 3 rd 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, 2 nd 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	<ol style="list-style-type: none"> To develop logical skills so that students should be able to solve basic computing problems. 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:	<ol style="list-style-type: none"> Arora, Sumita "Computer Science with C++" Dhanpat Rai & Co. Balaguruswamy, "Object Oriented Programming in C++", Tata McGraw Hill. 			
Reference Books:	<ol style="list-style-type: none"> Kamthane, "Object Oriented Programming in ANSI and Turbo C++" Pearson Education India Lafore, Robert "Object Orients Programming in C++" 			
Course Assessment Methods	Assessment will consist of the following components <ol style="list-style-type: none"> Mid-Term <ol style="list-style-type: none"> One best of two minor tests (50% of Mid -term marks) 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	CO1: The student will demonstrate proficiency in C++ programming language. CO2: 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 <ul style="list-style-type: none"> • 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	CO1: Students will have hands on knowledge about the design, purpose and working of R-L-C series and parallel circuits CO2: Students will become confident in taking accurate readings of voltmeter, ammeter and wattmeter CO3: Students will have in depth knowledge about transformers, transistors, diodes and rectifiers and will be able to understand their applications in industry. CO4: Students will 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 objectives

1. : To familiarise with the laboratory equipments, various chemicals and set up a chemical reaction to ensure lab safety.
2. To Learn and apply basic technique used in the organic laboratory for preparation, purification of organic compounds.
3. To understand the synthesis of Benzamide & Aspirin and carry out the purification and percentage yield of compounds
4. To Identify important functional groups by the study of their properties and chemical reactions.

Course Outcomes

- CO1: Practise analytical skills and recognize various aspects of lab safety.
 CO2: Learn and apply basic technique used in the organic laboratory for preparation ,purification, and identification of organic compound.
 CO3: Outline the synthesis of Benzamide and Aspirin, and carry out the purification and percentage yield of compound.
 CO4: Identify important functional groups by a study of their properties and reaction.

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	CO1: The students will be able to demonstrate proficiency in C++ CO2: The student will become confident in solving any computation problem using his programming skills.

THIRD SEMESTER

Title	PHYSICAL CHEMISTRY			Credits	3
Code	BS 106	Semester:-3rd		L T P	3 --
Max.Marks	End term- 40	Mid term- 35	Practical -	Elective	N
Pre requisites				Contact Hours	45
Objectives The students shall <ul style="list-style-type: none"> • Learn to make and understand properties of ideal and non ideal solution • Learn to derive various rate laws and understanding the concept of different reaction rate theories • Learn to apply various adsorption models and basics of biochemical catalysis • Learn the basics and application of electrochemical processes in industry Outcome of course CO1: The students will be able to derive and apply laws related to ideal and non- ideal solutions, CO2: will develop basic understanding of slow and fast reactions CO3: will be able to apply different adsorption models on various adsorption processes and develop an understanding of enzyme catalysis CO4: will be able to solve numerical based on faradays laws and will develop a deep understanding of electrochemical processes.					
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					
UNIT- 1 Solutions and Colligative Properties: (8 Lectures) Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution UNIT-2: Chemical Kinetics (7 Lectures) Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism.					
SECTION B					
UNIT-3: Catalysis & Surface chemistry (7 Lectures) Introduction to Catalysis: Types of catalyst, specificity and selectivity. Enzyme catalysis, Michaelis-Menten mechanism, Surface chemistry: Physical adsorption, chemisorption, adsorption isotherms. Nature of adsorbed state, Adsorption of gases on solids, Freundlich isotherm, Langmuir adsorption isotherm and BET isotherms UNIT 4 : Electrochemistry (8 Lectures) Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.					

Chemical cells, reversible and irreversible cells with examples.
 Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and $\text{SbO/Sb}_2\text{O}_3$ electrodes.

Reference Books

Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press(2014).

Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).

Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).

Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).

Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).

Rogers, D. W. Concise Physical Chemistry Wiley (2010).

Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., JohnWiley & Sons, Inc. (2005).

Title	FLUID FLOW			Credits	4
Code	PCC-CS 102	Semester:-3 rd		L T P	3 1 -
Max.Marks	End term- 50	Mid term- 50	Practical -	Elective	N
Pre requisites				Contact Hours	60
THEORY				Time	3 Hours
Course Outcomes	CO1 Define types of fluids, describe boundary layer, define turbulence and apply Basic Equations of Fluid Flow. CO2 Describe fluid statics, pressure and Forces on Submerged bodies, Flow of Incompressible Fluids, pipes and fittings, economic pipe diameter. CO3 Employ Dimensional analysis, describe Compressible flow and examine flow through nozzles. CO4 Classify Flow Measurement equipments, Classification and Performance of Pumps, Turbines, Compressors, and Blowers, Selection and Specification, Net positive Suction Head.				
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					
<i>Fluid Statics:</i> Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability.					
<i>Fluid Properties:</i> 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.					
<i>Flow of Incompressible Fluids:</i> 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 $f=16/\text{Re}$ equations.					
SECTION- B					
<i>Dimensional analysis</i> 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. Chattopadhyaya, P. : Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, Delhi, 1997.

Title	ENERGY TECHNOLOGY			Credits	4
Code	PCC-CS 103	Semester:-3rd		L T P	3 1 -
Max.Marks	End term 50	Mid term 50	Practical	Elective	N
Pre requisites	-			Contact Hours	60

THEORY

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.
Course Objectives	<ul style="list-style-type: none"> ➤ To make students understand various conventional and non-conventional energy resources. ➤ To make students solve the problems of combustion. ➤ To make students understand the working of various types of furnaces.
Course Outcomes	CO1: Have knowledge of solid fuels, their analysis, cleaning methods, carbonization process and synthetic fuels from coal CO2: Have knowledge of liquid fuels and manufacturing processes of gaseous fuels CO3: Be able to describe various furnaces, draught and furnace atmosphere and solve combustion problems CO4: Have in-depth knowledge of various renewable sources of energy, their scope and technologies in use

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 & Refractories, 5th Edition, Khanna Publishers 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 Publishers Pvt. Ltd., 1989.
4. Sukhatme, S.P. : Solar Energy – Principles of Thermal Collection and Storage, 2nd Edition, Tata McGraw – Hill Publishing Company Ltd., 2006.
5. Sharma, S.P. and Mohan, C. : Fuels and Combustion, Tata Mc-Graw Hill Publishing Company Ltd. 1984.

Title	STRENGTH OF MATERIALS			Credits	3
Code	ESC-GES 105	Semester:-3 rd		L T P	3 - -
Max. Marks	End term-40	Mid term- 35	Practical- -	Elective	N
Pre requisites				Contact Hours	45
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.				
Course Objectives	<ol style="list-style-type: none"> 1. To make the students understand the basic concepts and principles of strength of materials. 2. To give ability to calculate stresses and deformations of objects under loading. 3. To make students able to apply the knowledge of strength of materials on engineering applications and design problems. 				
Course Outcomes	<p>CO1: Identify various types of Stressers and Strains, define Hooke's law, modulus of elasticity and modulus of rigidity, calculate stresses under impact loads and sudden applied loads under varying conditions.</p> <p>CO2: Apply the theory to solve numerical problems based on Shearing force, bending moment, types of load on beams, types of supports, Concentrated loads and uniformly distributed loads.</p> <p>CO3: Define different types of Struts and Columns, Explain Euler theory and its limitations, describe Rankine-Gordon formula and its applications to numerical problems.</p> <p>CO4: Describe Stresses and Strains in Thin Shells and in springs, Strain Energy and Theories of Elastic Failure and numerical problems.</p>				
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	1.5
Code	ESS-GES 157	Semester:-3 rd		L T P	- -3
Max. Marks	End term- -	Mid term- -	Practical- 40	Elective	N
Pre requisites				Contact Hours	45
To be familiar with the process and mechanical aspects of design of process equipments,					

Objectives	various design factors, design procedures, design codes and standards.
Course outcomes	CO1: Understand general design consideration, codes and specifications for pressure vessels. CO2: Design of thin-walled vessels under internal as well as external pressure. CO3: Design of foundation, supports and various joints.
PRACTICAL	
LIST OF PRACTICALS	
<ol style="list-style-type: none"> 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.

Paper Title : PHYSICAL CHEMISTRY LAB.

CO1: Getting hands on training in handling various equipment.

CO2: Understand practically all theoretical concepts.

CO3: Working with discipline and as a team with co-operation.

Paper Code BS 156**Max. Marks 40****Credits : 1.5**

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 $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$.
 - 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.

Paper Title: FLUID Flow Lab.

Course Objective	The course is focused to have hands-on experience by conducting lab experiments related to fluid flow using various equipment including flow measurement devices; pipe, valve and fittings; pumps etc.
Course Outcomes	CO1: Verify Bernoulli's theorem. CO2: Evaluate discharge coefficient for various flow measurement devices and understand their industrial applications. CO3: Identify various types of flow, valves and fittings and evaluate the frictional losses associated with them. CO4: Calibrate a given flow meter. CO5: Understand the characteristics of pumps. CO6: Verify $f=16/Re$ for laminar flow through a straight tube.

Paper Code PCC-CS 152**Max. Marks 40****Credits: 1.5**

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.

SECOND YEAR**4thSEMESTER**

Title	HEAT TRANSFER			Credits	4
Code	PCC-CS 104	Semester:-4th		L T P	3 1 -
Max. Marks	End term- 50	Mid term- 50	Practical- 1	Elective	N
Pre requisites				Contact Hours	60
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.				
Course Outcomes	CO1: To understand conduction, convection and radiation modes of heat transfer and to estimate heat transfer rates, CO2: To understand boiling and condensation phenomena CO3: To carryout thermal analysis of heat exchanger using LMTD and effectiveness method, CO4: To estimate steam economy, capacity of single and multiple-effect evaporators. CO5: To apply engineering judgment including an appreciation of cost and safety.				
SECTION- A					
<p><i>Conduction:</i> 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.</p> <p><i>Convection:</i> 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.</p> <p><i>Radiation Heat Transfer:</i> 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</p>					
SECTION- B					
<p><i>Condensation and Boiling:</i> 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.</p> <p><i>Evaporation:</i> 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.</p> <p><i>Heat Exchangers:</i> Various types of heat exchangers, overall heat transfer coefficients, heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units.</p>					

Books Recommended:

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|-------------------------------|--|
| 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.

Title	CHEMICAL ENGINEERING THERMODYNAMICS			Credits	4
Code	PCC-CS 105	Semester:-4th		L T P	3 1 -
Max. Marks	End term- 50	Mid term- 50	Practical-	Elective	N
Pre requisites				Contact Hours	60
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.				
Course Outcomes	CO1: Understand the First and Second Laws of Thermodynamics apply it to open and closed systems, steady and unsteady state processes, isothermal and adiabatic processes and solve related engineering problems. CO2: Estimate the thermodynamic properties of pure substances, especially fluids. Knowledge of various PVT equations of state including Principle of corresponding states and heat capacities to evaluate thermodynamic properties of fluids. CO3: Explain the underline principles of phase equilibrium and evaluate the thermodynamic properties in two-component and multi-component systems CO4: To develop and ability to envisage intermolecular potential and excess property behaviour of multi-component systems CO5: Impart ability to apply the concepts of phase equilibrium to vapour liquid equilibrium (VLE), separation processes and chemical reaction equilibrium				
SECTION- A					
<p>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, liquefaction 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.</p> <p>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.</p>					
SECTION- B					
<p><i>Phase Equilibria:</i> Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randell 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. <i>Chemical Equilibria:</i></p>					

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	MECHANICAL OPERATIONS			Credits	4	
Code	PCC-CS 106	Semester:-4th		L T P	3 1 -	
Max. Marks	End term- 50	Mid term- 50	Practical-	Elective	N	
Pre requisites				Contact Hours	60	
THEORY					Time	3 Hours
Note for the Examiner	The semester question paper of the subject will be of 60 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.					
CO1: Understand and determine various properties of solids, specific surface area, average particle sizes of particles in mixtures, sphericity and laws of crushing. Classification of SR equipments, power consumption of various machines, description and working of Size reduction equipments and their applications						
CO2: Understand various screening techniques and equipments, capacity and effectiveness of screens, standard screens						
CO3: Understand and apply knowledge of Filtration Processes , constant pressure and constant volume filtration and various filtration equipments, their types and applications						
CO4: Understanding and applying concepts of Flow around a single particle, drag force and drag coefficient, settling velocity of particles in a fluid, hindered and free settling of particles, thickening and gravity separation, types of settling devices.						
CO5: analyzing flow through a bed of particles, applications of fluidization & fluidized bed, conditions for fluidization, minimum fluidization velocity, types and applications of fluidization.						
CO6: Understand and applying concepts of Handling, Storage and Transportation of Solids , Agitation of liquids, axial flow impellers, radial flow impellers, design of agitators, velocity and power consumption of agitated vessels, blending & mixing.						
SECTION- A						
<i>Size Reduction:</i> Crushers and Grinders: jaw crusher, crushing rolls, Gyrotory Crusher Tumbling/revolving mills, hammer Mill and Fluid energy mill. Closed and open circuits grinding. Power requirements. Laws of crushing.						
<i>Mechanical Separation:</i> Screening: Stationery screens, Grizzlies, Trommel and Vibrating screens. International Standard Screens & Indian Standard Screens. Screening Analysis-differential and cumulative.						
<ul style="list-style-type: none"> ▪ 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
<i>Filtration:</i> Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.
<i>Centrifugation:</i> Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge.
<i>Fluidization:</i> Conditions for fluidization: Aggregate and particulate fluidization. Ergun's and Carman-Kozeny equations.
<i>Mixing and Agitation:</i> Basic ideas and characteristics of mixing equipment power consumptions scale-up.
<i>Conveying:</i> Mechanical and pneumatic conveying systems, storage & handling of materials.

Books Recommended:

1. Mc Cabe, Warren L., Smith, Juluain : Unit Operations of Chemical Engineering, 5th Edition, Mc C. and Harroit, Peter 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 Banchemo, 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.

Title	NUMERICAL METHODS IN CHEMICAL ENGINEERING			Credits	4
Code	BS 107	Semester:-4th		L T P	3 1 -
Max.Marks	End term 50	Mid term 50	Practical :	Elective	N
Pre requisites	-			Contact Hours	60

THEORY

Course Objectives	<ol style="list-style-type: none"> 1. To learn evaluate error in calculations and find numerical solution of algebraic and transcendental equations. 2. Understand the concept of Finite Differences and Learn to use Interpolation and Inverse Interpolation with equispaced and unequispaced data. Learn to use Least Square Curve Fitting Procedure. 3. Learn the methods to carry out numerical differentiation and numerical integration. 4. Learn to solve linear system of equations by Direct and Iterative methods. 5. Learn to solve ordinary differential equations of First and Higher order numerically using various methods. 6. Learn to use Finite Difference Approximation method to solve partial differential equations numerically.
Course	CO1: Learn evaluating error in calculations, use of numerical methods for solving

Outcomes	<p>algebraic and transcendental equations and using various methods to carry out numerical differentiation and numerical integration.</p> <p>CO2: Understanding the concept of Finite Differences and Learn to use this for Interpolation and Inverse Interpolation with equispaced and unequispaced data. Learn to use Least Square Curve Fitting Procedure.</p> <p>CO3: Solve numerically ordinary differential equations of First and Higher order/Simultaneous differential equations using different methods.</p> <p>CO4: To Find the solution of linear system of equations by Direct and Iterative methods. Learn to solve partial differential equations using Finite difference approximation method.</p>
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	
<p>Errors in Numerical Calculations, Solution of Algebraic and Transcendental Equations: The Bisection Method, The method of False Position, The Iteration Method, Newton-Raphson Method.</p> <p>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.</p> <p>Numerical Differentiation and Integration: Trapezoidal Rule, Simpson's 1/3 -Rule, Simpson's 3/8-Rule, Weddle's Rules and Romberg Integration.</p>	
SECTION- B	
<p>Solution of Linear Systems, Gaussian Elimination Method, Gauss-Jordan Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method.</p> <p>Numerical Solution of Ordinary Differential Equation: Taylor's Series Expansion Method, Picard's Method, Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, Simultaneous and Higher Order Equations.</p> <p>Numerical Solution of Partial Differential Equations: Finite-Difference Approximation to Laplace's Equation, Parabolic Equations and Hyperbolic Equations</p>	
Recommended Books	
<ol style="list-style-type: none"> 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	ENGINEERING MATERIALS			Credits	4
Code	ESC-GES 106	Semester:-4th		L T P	3 1 -
Max. Marks	End term- 50	Mid term- 50	Practical- -	Elective	N
Pre requisites				Contact Hours	60
THEORY				Time	3 Hours
Note for the Examiner	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.				
Course Objectives	<ul style="list-style-type: none"> ➤ To understand crystal structures and imperfections in atomic arrangement ➤ interpret binary phase diagram and phase transformations ➤ use of time-temperature-transformation diagrams 				

	➤ To understand properties of materials and application in engineering and corrosion
Course Outcomes	<p>CO1: Demonstrate an understanding of crystal structure, Space lattice, Miller Indices</p> <p>CO2: Describe and analyse imperfections in atomic arrangement, explain diffusion phenomenon in solids and perform simple diffusion problems</p> <p>CO3: Describe and analyse binary phase diagrams, TTT diagrams, demonstrate an understanding of phase transformations</p> <p>CO4: Classify types of materials, describe properties of materials and application in engineering and corrosion.</p>
SECTION-A	
<p><i>Atomic Structure:</i> Review of bonding in solids, Bonding forces and energies, Primary and Secondary bonds, structure – property – processing relationships</p> <p><i>Crystal Structure :</i>Space lattice, crystal systems, close packed morphology (Hexagonal and cubic close packing), interstitial spaces, Miller indices, linear and planar densities in crystals, single and polycrystalline structures, structure of ceramics (NaCl, Zinc blende, CsCl, silica and silicates, diamond crystal), effect of radius ratio on co-ordination</p> <p><i>Imperfections in atomic arrangement:</i> 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 (grain size reduction, solid-solution strengthening, strain hardening), Schmid's law.</p>	
SECTION-B	
<p><i>Phase diagrams and phase transformation:</i> binary phase diagrams – Fe-Fe₃C, Cu-Ni, Pb-Sn. microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes.</p> <p><i>Materials:</i>Standards and specifications, unified alloy numbering system, ferrous metals and alloys, nonferrous metals and alloys; overview of ceramic, polymeric and composite materials;</p> <p><i>Mechanical tests:</i> standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, impact, fatigue, creep etc.</p> <p><i>Corrosion:</i> Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, selection of materials of construction for handling different chemicals.</p>	

Books Recommended:

1. Askilland, Donald R. : The Science & Engineering of Materials, PWSKENT.
2. Shackelford, 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

Paper Title : HEAT TRANSFER Lab.

- CO1: Determination of heat transfer coefficient for different types of heat transfer equipment and Unsteady state heat transfer in jacketed vessels.
- CO2: Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface & heat losses for insulated pipes. Study of double pipe heat exchanger and 1, 2 - shell and tube heat exchanger.

CO3: Study and operation of long tube, forced circulation and multiple effect evaporators, Duhring plot for solutions involving nonvolatile solutes

Paper Code PCC-CS 154 Max. Marks 40 Credits : 1.5

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

Paper Title : MECHANICAL OPERATIONS Lab.

CO1: Understand the grinding operation and evaluate critical speed of a ball mill.

CO2: Analyze particle size distribution and evaluate screen effectiveness.

CO3: Understand pressure drop behavior for the flow of Newtonian fluid flowing through fixed and fluidized beds.

CO4: Understand the process of filtration and apply the basic equations of filtration.

CO5: Understand settling rate and behavior of particles falling in quiescent liquid.

Paper Code PCC-CS 155 Max. Marks 40 Credits: 1.5

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)

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					
Course Objectives	<ol style="list-style-type: none"> 7. To learn evaluate error in calculations and find numerical solution of algebraic and transcendental equations. 8. Understand the concept of Finite Differences and Learn to use Interpolation and Inverse Interpolation with equispaced and unequispaced data. Learn to use Least Square Curve Fitting Procedure. 9. Learn the methods to carry out numerical differentiation and numerical integration. 10. Learn to solve linear system of equations by Direct and Iterative methods. 11. Learn to solve ordinary differential equations of First and Higher order numerically using various methods. 12. Learn to use Finite Difference Approximation method to solve partial differential equations numerically. 				
Course Outcomes	<p>CO1: Learn evaluating error in calculations, use of numerical methods for solving algebraic and transcendental equations and using various methods to carry out numerical differentiation and numerical integration.</p> <p>CO2: Understanding the concept of Finite Differences and Learn to use this for Interpolation and Inverse Interpolation with equispaced and unequispaced data. Learn to use Least Square Curve Fitting Procedure.</p> <p>CO3: Solve numerically ordinary differential equations of First and Higher order/Simultaneous differential equations using different methods.</p> <p>CO4: To Find the solution of linear system of equations by Direct and Iterative methods. Learn to solve partial differential equations using Finite difference approximation method.</p>				
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					
<p>Errors in Numerical Calculations, Solution of Algebraic and Transcendental Equations: The Bisection Method, The method of False Position, The Iteration Method, Newton-Raphson Method.</p> <p>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.</p> <p>Numerical Differentiation and Integration: Trapezoidal Rule, Simpson's 1/3 -Rule, Simpson's 3/8-Rule, Weddle's Rules and Romberg Integration.</p>					
SECTION- B					
<p>Solution of Linear Systems, Gaussian Elimination Method, Gauss-Jordan Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method.</p> <p>Numerical Solution of Ordinary Differential Equation: Taylor's Series Expansion Method, Picard's</p>					

Method, Euler's Method, Runge-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
<ol style="list-style-type: none"> 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.
Course Objectives	<ul style="list-style-type: none"> ➤ To make students understand various conventional and non-conventional energy resources. ➤ To make students solve the problems of combustion. ➤ To make students understand the working of various types of furnaces.
Course Outcomes	CO1: Have knowledge of solid fuels, their analysis, cleaning methods, carbonization process and synthetic fuels from coal CO2: Have knowledge of liquid fuels and manufacturing processes of gaseous fuels CO3: Be able to describe various furnaces, draught and furnace atmosphere and solve combustion problems CO4: Have in-depth knowledge of various renewable sources of energy, their scope and technologies in use

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 & Refractories, 5th Edition, Khanna Publishers 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 Publishers Pvt. Ltd., 1989.
4. Sukhatme, S.P. : Solar Energy – Principles of Thermal Collection and Storage, 2nd Edition, Tata McGraw – Hill Publishing Company Ltd., 2006.
5. Sharma, S.P. and Mohan, C. : Fuels and Combustion, Tata Mc-Graw Hill Publishing Company Ltd. 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.
Course Objective	The course aims to understand the basic concepts of chemical kinetics for different types of reactions. Design of the reactors for homogeneous reactions such as batch, plug-flow and mixed-flow reactors. To understand the effect of temperature and pressure on reaction kinetics. The students learn about the real reactor on understanding the reasons of non-ideality in ideal reactors.
Course Outcomes	CO1: To understand the mechanism of chemical kinetics for different types of reactions. CO2: To design batch and flow reactors for single homogeneous reactions. CO3: To understand the factors affecting the conversion, yield and selectivity in multiple reactions. CO4: To understand the concepts of non-ideal reaction.

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.
CO1: Describe the kinetics of a batch and semi batch and adiabatic batch reactor CO2: To understand and demonstrate kinetics of CSTR and PFR CO3: Perform RTD studies in a CSTR
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, 3 rd Edition, John Wiley and Sons, 2004. 2. Smith, J.M. : Chemical Engineering, Kinetics, 3 rd Edition, McGraw Hill, 1980. 4. Dinbigh, K. and Turner, K.G. : Chemical Reactor Theory – An Introduction, Cambridge Univ. Press, 1978. 5. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4 th Edition, Prentice 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.
Course Outcomes	CO1: Classify mass transfer operations and laws of mass transfer. CO2: Evaluation of molecular diffusion in gases, liquids and solids. CO3: Discuss diffusion coefficient/Mass transfer coefficient, interphase mass transfer and estimation of number of stages. CO4: Evaluation of humidification operations, design of cooling tower and working of gas-liquid contacting equipments. CO5: Analysis of drying and discuss the working of different types of dryers.
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, 3 rd 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., 7 th Edition, McGraw-Hill, 2005.
5. Coulson & Richardson : Chemical Engineering, Vol.I (6 th Edition, 2009) and Vol. II. (5 th 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)
Course Outcomes					
CO1: Identify the application of basic chemistry concepts to process industries like Chlor-Alkali Industry, Manufacture of soda ash and caustic soda and Sulphuric Acid.					
CO2: Recognize current issues and trends in process industries with a Study of manufacture of Cement and Glass and identify the importance of safety, health, and the environment in process industries.					
CO3: Understanding the basic history and manufacture of industrial gases, and Manufacture of different types of paints and Course outcomes outline the guiding principles of quality in the process industries.					
CO4: Understanding the manufacture of various fertilizers and processes involved and recognize the safety aspects.					
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					
<i>Chlor-Alkali Industry:</i> Voltage efficiency, Current efficiency, Current density, Decomposition efficiency, Manufacture of soda ash by Solvay and Modified Solvay process, Manufacture of caustic soda.					
<i>Sulphuric Acid:</i> Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.					
<i>Cement & Glass:</i> Cement-Types of cement, Constituents of cement, Manufacture of Portland cement. Glass-Introduction, Types of glass, Raw materials, Manufacture of glass.					
<i>Ceramics:</i> Introduction, Properties of ceramics, Classification of refractories, Important steps involved in the manufacture of refractories					
SECTION- B					
<i>Industrial gases:</i> Manufacture and uses of carbon dioxide, oxygen and nitrogen, acetylene.					
<i>Paints:</i> Introduction, Classification of paints, Manufacture of paints, Requirement of a good Paint.					

<i>Fertilizers:</i> Nitrogenous 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 CO1: Experimental determination of NPK Values and micronutrients in different fertilizers. CO2: Estimation of Mg, Ca, Fe in cement and Loss of ignition, silica and insolubles. CO3: To determine the %age of chlorine in given sample of bleaching powder. 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, 5 th Edition, McGraw Hill, 1987.		
2.	Austine, G.T.	:	Shreeves Chemicals Process Industries, 5 th Edition, McGraw Hill, 1984.		
3.	Dryden, C.E., Rao M.G. & Silting, M.	:	Outlines of Chemical Technology, 3 rd 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
CO1: Design and specifications of pipes, pumps, fans and blowers. CO2: Design and specifications Dor thickeners, dust chambers, cyclone separators and centrifuges. CO3: Design of agitated vessels, impellers and Conveyor system for solids.					
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
CO1: Determination of solution of linear and non-linear algebraic and transcendental equations using computer programs or MATLAB.					

CO2: To carryout Numerical differentiation & integration using computer programs. CO3: To find solution of Ordinary and partial differential equations using computer programs. CO4: Carryout Interpolation and least squares approximation using computer programs.
Practical
Errors analysis, Solution of linear and non-linear algebraic 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.				
Course Objectives	<ol style="list-style-type: none"> 1. This course helps the students to learn the basic concepts, kinetics & mechanistic aspects of catalysis. 2. The course also aims at Designing of catalytic and non-catalytic heterogeneous systems. 3. To understand the effect of external and internal transportation reaction rates and kinetic regimes for fluid-fluid reactions. 4. To understand the effect of effect of external and internal transportation reaction rates and kinetic regimes for fluid-solid reactions . 				
Course Outcomes	CO1: Describe Heterogeneous catalyses, catalytic specificity. Preparation testing and characterisation of catalysts, catalyst poisoning and catalyst regeneration CO2: To understand and analyse the external and internal transport in catalytic reaction systems. CO3: Describe Fluid Solid catalytic reactions, reaction & diffusion within porous catalysts and effectiveness factors. CO4: Describe Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors. CO5: Analysis of rate data design outline and selection of fixed bed, fluid bed and slurry reactions				
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					
<ol style="list-style-type: none"> 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	Mid term	Practical : 25	Elective	N

	50	50		
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.			
Course Objective	The course objective is to study the concepts of mass transfer equilibria and operating lines for various systems like vapour-liquid, liquid-liquid, solid liquid and solid-gas systems, liquid - liquid extraction, leaching, adsorption and to apply the concepts to real problems.			
Course Outcomes	<p>CO1: To understand the concepts of mass transfer equilibria for vapour-liquid and to generate operating line for various mass transfer systems like absorption, distillation, liquid-liquid extraction. Leaching, adsorption and principles of crystallization.</p> <p>CO2: The students are able to comprehend the concepts of co current & counter current processes, cascades and concept of Ideal stage and stage efficiencies, continuous contact equipments, number of transfer units and height of a transfer unit (NTU & HTU) concepts, packed column for absorption, equipment for gas absorption</p> <p>CO3: The students will get acquaintance about McCabe–Thiele methods & Ponchon Savarit method to calculate the number of stages for distillation column and able to design the column.</p> <p>CO4: The students will be able to understand the working of different equipments used for various mass transfer operations such as leaching, crystallization, etc.</p>			
SECTION- A				
<p><i>Absorption:</i> 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.</p> <p><i>Distillation:</i> 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.</p>				
SECTION- B				
<p><i>Liquid-Liquid Extraction:</i> 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.</p> <p><i>Leaching:</i> 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.</p> <p><i>Adsorption:</i> 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.</p> <p><i>Crystallization:</i> Growth and properties of crystals saturation, nucleation, growth of crystals, effect of</p>				

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-Meiers 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

CO1: Application of different mass transfer equipments, Determination of mass transfer coefficients for naphthalene-air system. To determine drying rate curves for different wet solids in a batch drier.

CO2: Verification of Rayleigh's equation for differential distillation, Determination of flooding velocities in packed columns.

CO3: Determination of HETP for packed distillation columns, flooding velocities in packed columns.

CO4: Practice operation of a pilot sized distillation column under total reflux, Fractional approach to equilibrium for liquid-liquid extraction from single drop.

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.				
Course Objective	The objective of the course is focused to make the students understand the fundamental aspects of control systems employed in various chemical process industries along with the challenges and development of dynamic models of various processes through Laplace transformations.				
Course Outcomes					
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					
CO1: To plot the response curve for a given input to a U-tube manometer and to determine the transfer function from the response					
CO2: To study the dynamics of the given thermometer and compare the theoretical value of its time constant with the experimental value.					
CO3: Determine Experimentally characteristics of of control valves and liquid level measurement systems.					
CO4: Experimental studies on temperature and pressure control systems.					
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 behaviour 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:-6 th		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)
CO1: Identify the processes and the concepts involved in the Extraction and refining of oils & fats, hydrogenation of oils and Manufacture of soap and detergents. CO2: Understand the various water treatment processes for desalination as well as Water softening; using Lime soda, Ion exchange methods CO3: Recognized the different Manufacturing processes of pulp, paper and sugar. CO4: Understand the manufacture of activated carbon and carbon technology, synthesis of nano particle by plasma process.					
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	
<p><i>Oils & Fats:</i> Introduction, Extraction of oils from vegetable oils, refining of oils and fats, hydrogenation of oils.</p> <p><i>Soaps and Detergents:</i> Introduction, Raw materials, Manufacture of soap, Classification of deterdents, finishing of detergents.</p> <p><i>Water:</i> Sources and Constraints, Consumption patterns; Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.</p> <p><i>Desalination:</i> Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electro dialysis.</p>	
SECTION- B	
<p><i>Pulp & paper:</i> Introduction, Raw Materials, types of pulp, Manufacture of paper.</p> <p><i>Sugar:</i> Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.</p> <p><i>Carbon Technology:</i> 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.</p> <p><i>Nanotechnology:</i> Introduction and synthesis of nano particles by RF plasma process.</p>	
Practicals	
CO1	Ability to understand the significance of Acid Vaieu, Iodine Value and Saponification Value.
CO2	Ability to understand the concept of Reducing and Non Reducing sugars using (i) Pavys Method (ii) Fehlings Method and the difference between the two methods
CO3	To identify the nature of soap by determining the free and combined alkali, total fatty matter and moisture content
	<ol style="list-style-type: none"> <i>Oils & Fats:</i> Determination of Acid value, Iodine value, Saponification value. <i>Carbohydrates:</i> Reducing and non reducing sugars by (i) Fehlings method (ii) Pavy's method. <i>Soaps:</i> Determination of free and combined alkali, total fatty matter, moisture and insoluble.
Recommended Books	
1.	Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5 th Edition, McGraw Hill, 1987.
2.	Austine, G.T. : Shreeves Chemicals Process Industries, 5 th Edition, Mc Graw Hill, 1984.
3.	Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3 rd 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 : Active Carbon, Marcel Dekker Inc.
F	

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.
Objectives	<ul style="list-style-type: none"> ▪ Explain the physical properties of a fluid and their consequences on fluid flow and heat transfer, expressed in terms of the Reynolds number, Nusselt number, and other dimensionless quantities. ▪ Use conservation principles of mass, momentum, and energy to develop models of fluid flow and heat transfer systems that can be used to predict the behavior of real world systems.
Course outcomes	<p>CO1: Ability to understand the chemical and physical transport processes and their mechanism of heat, mass and momentum transfer analysis</p> <p>CO2: analyse any transport related problem mathematically and predict the physical behaviour of the process</p> <p>CO3: formulate problems along with appropriate boundary conditions and develop steady and time dependent solutions.</p>

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, 2001.
2. Weity, J.R. Wilson, R.E. and Wicks, C.E. : Fundamentals of Momentum Heat and Mass Transfer, 2nd 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	Mid	Practical: 25	Elective	N

	term 50	term 50			
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.				
Course Objectives	<ol style="list-style-type: none"> 1. This course aims at developing the students about environmental impacts of air, water and solid pollution. 2. The course aims at giving the students an insight into the environmental issues related to chemical process industries in terms of their impact on land, water and air and the possible mitigation techniques to reduce this effect for sustainably. 3. This course also aims to develop the basic knowledge about the biomedical, hazardous, and waste management. 				
Course Outcomes	<p>CO1: Describe principal air pollutants, their sources and effects. CO2: Discuss atmospheric dispersion of air pollutants and estimate concentration of air pollutants. CO3: Demonstrate the construction, working and theory of equipments used for the control of air pollution. CO4: Classify water pollutants, their sources and effects and calculation of water quality parameters. CO5: Application and design of physical/ chemical/ biological treatment methods for small communities/municipal sewage/industrial water/ waste water treatment. CO6: Classify solid wastes, their sources, effects and methods of disposal of solid wastes.</p>				
SECTION-A					
<p>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. <i>Air Pollution:</i></p> <ul style="list-style-type: none"> - 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					
<p><i>Water Pollution:</i></p> <ul style="list-style-type: none"> - 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. <p><i>Solid wastes:</i> Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.</p>					
Books Recommended:					
1.	Perkins, H.C.	:	Air Pollution,	McGraw Hill,	N.Y.
2.	Rao, C.S.	:	Environmental Pollution Control Engineering,	2 nd 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, 6 th Edition, Prentice-Hall of India, 2008.
7.	Mahajan, S.P.	:	Pollution Control of Process Industries, Tata McGraw Hill.
8.	Metcalf and Eddy	:	Waste-Water Engineering, 4 th Edition, Tata McGraw Hill, 2007.

Environment Engineering Laboratory (PRACTICALS)

CO1: Calculate BOD, COD, TSS & TDS of wastewater samples.

CO2: Determination of chromium separation, phenol content of water sample & To find the biodegradation constant (K) and the effect of timing on it

CO3: Practice and apply electro dialysis apparatus and reverse osmosis set up for waste water analysis.

CO4: To use stack monitoring kit to find: Efficiency of a cyclone & Dust sampling.

- To find BOD of water sample.
- To find COD of waste sample.
- To find the total dissolved solids (TDS) and its volatile and non-volatile components.
- To find the total suspended solids (TSS) and its volatile and non-volatile components.
- To do the chromium separation by different techniques from electroplating wastes.
- To find the phenol content of water sample and evolution of parameters.
- To operate the electro dialysis apparatus.
- To find the biodegradation constant (K) and the effect of timing on it.
- To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
- To use stack monitoring kit to find:
 - Efficiency of a cyclone.
 - 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)
Course Outcomes	CO1: Describe fundamentals of modelling and simulation, formulate mathematical models and perform degree of freedom analysis. CO2: Derive the mathematical models for chemical engineering systems and solve them using any one of the softwares Polymath/C/C++/Matlab. CO3: Apply simulation to get the output for the models of heat exchangers, distillation columns, reactor and process equipment.				
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)
CO1: Design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condenser and reboiler. CO2: Design of distillation column, calculation of number of plates, height and design of fractionator internals- sieve tray. CO3: Design aspects of fixed bed reactors and fluidized bed reactors.					
Practical					
<ol style="list-style-type: none"> 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. <p style="text-align: center;">Books Recommended:</p> <ol style="list-style-type: none"> 1. Coulson, Richardson & Sinnott, R.K. : Chemical Engineering, Volume 6 – An Introduction to Chemical Engineering Design, 4th Edition, Pergamon Press, 2007. 2. Ludwig, E.E. : Applied Process Design in Chemical and Petrochemical Plants, 2nd Edition, 1977. 3. Perry, J.H. : Chemical Engineers Handbook, 8th Edition, McGraw Hill, 2000. 4. Kern, D.Q. : Process Heat Transfer, McGraw Hill, 1965. 5. Shell and Tube Type Heat Exchangers, Indian Standards. 6. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 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.				
Course Objectives	<ul style="list-style-type: none"> ➤ To provide knowledge of pressure, temperature, level, humidity, viscosity, conductivity, humidity, pH, density and weight measurements. ➤ To provide knowledge of recording instruments, indicating and signalling instruments, control centre, transmission of instrument reading and instrumentation diagrams. 				
	➤				
	➤				
Course Outcomes	CO1: Classify elements and types of instruments, static and dynamic characteristics of instruments. CO2: Illustrate the different methods for the measurement of temperature and their useful applications. CO3: Elucidate the construction and working of various industrial devices used to measure pressure and vacuum. CO4: Explicate the construction and working of various industrial devices used to measure level. CO5: Discuss methods for measurement of viscosity, conductivity, humidity, density, weight and pH. CO6: Describe recording/indicating/signalling instruments and Control Centre. CO7: Construct Instrumentation diagrams.				
SECTION-A					
<p>General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system.</p> <p>Static and Dynamic Characteristics of Instruments:</p> <p>Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone.</p> <p>Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time.</p> <p>Temperature measurement:</p> <p>Thermal expansion methods – bimetallic thermometers, liquid-in-glass thermometer and filled-in-system thermometers.</p> <p>Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.</p> <p>Pressure measurement:</p> <p>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.</p>					
SECTION-B					
<p>Liquid level measurement:</p> <p>Direct measurement of liquid level –Float & tape liquid level gauge, float and shaft liquid level unit,</p>					

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 P 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, 1999.
4. Fribance, A.E. : Industrial Instrumentation Fundamentals, Tata McGraw – Hill Publishing Co. Ltd., 1962.
5. Patranabis, D. : Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw 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.				
Course Objectives	The objective of the course is to expose students to basic concepts in engineering economics, plant design, safety features and its importance to chemical engineering. The course isolates those problems that are commonly faced by engineers and develops the tools to properly grasp, analyse, and solve them. The tools introduced include present worth analysis, annual cash flow, rate of return, incremental analysis, future worth analysis, and payback period. The course also covers such topics as depreciation, after tax analysis, replacement analysis, inflation, and deflation.				
Course Outcomes	CO1: Formulate and apply interest factors to real life engineering problems CO2: Perform economic analysis for process to calculate equipment cost CO3: Develop and apply mathematical models describing real life cash flows and time value of money CO4: Evaluate engineering alternatives and profitability for process CO5: Perform breakeven analysis and optimum and plant design of a process.				
SECTION-A					
<i>Cost estimation:</i> 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

CO1: Apply the knowledge of chemical engineering and basic sciences to design or fabricate a system/unit/plant.

CO2: Apply knowledge of chemical engineering to solve energy and material balance and design efficient process.

CO3: Analyze the process components and perform the cost analysis and efficiency of the process.

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:-8 th		L T P	- - -
Max. Marks	End term--25	Mid term- -	Practical-	Elective	N
Pre requisites				Contact Hours	
CO1: Demonstrate technical knowledge of theory and practical subjects taught during whole degree course.					
CO2: Demonstration of professional aptitude, learning ability and communication skills, originality and capacity for application of this profession to service of mankind.					

CO3: Strive for lifelong learning, exhibiting professionalism and ethical behaviour and service of the nation, discipline and society.
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)
Course Objectives	<ul style="list-style-type: none"> ➤ To gain an understanding of the existing research relevant to a particular topic or area of study and define the problem statement ➤ Critical analysis of the published work and develop arguments to support the published work with evidence ➤ To present that knowledge in the form of a presentation and written report. 				
Course Outcomes	CO1: Survey of scientific, technical and commercial literature in engineering/technology and defining problem statement. CO2: Critical analysis and evaluation of literature CO3: Demonstrate effective public speaking and impromptu discussions CO4: Write technical report in a coherent and concise manner.				
Practical					
<p>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.</p> <p>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.</p> <p style="text-align: center;">Books Recommended:</p> <ol style="list-style-type: none"> 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 The Technical 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.

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.

FUEL CELL TECHNOLOGY (Theory)

To teach students

1. Fundamental knowledge required in the development of fuel cell technology.
2. Thermodynamics, chemical reaction engineering, transport processes and electrochemical engineering perspectives of fuel cell technology will be covered in the course.
3. Modelling and fuel cell characterization techniques will be covered in the course,
4. Knowledge of Hydrogen energy perspectives and hydrogen generation from renewal sources, storage and safety issues are covered

Course Outcomes

CO1: Knowledge and concept of fuel cell technology and various types.

CO2: Knowledge of thermodynamics, chemical reaction engineering, transport processes and electrochemical engineering perspectives.

CO3: Knowledge of fuel cell modeling and characterization techniques.

CO4: Knowledge of hydrogen energy, its generation and storage with safety issues

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
4. Bard,A. J. , L. R., Faulkner,Electrochemical Methods, Wiley, N.Y.(2004)

Books:

NANO TECHNOLOGY (Theory)

Course Objective	Students learn about nuances of Nanotechnology from basics to application such that they may be able to use this knowledge in their Professional Careers
Course Outcome	CO1: Understand the basis of nanotechnology in terms of bonding, types of nanomaterials.

	CO2 : Explain methods of synthesis and fabricating nanostructures (top down- bottom up).
	CO3: Relate the unique properties of nanomaterials to the reduced dimensionality of the material through characterisation.
	CO4 : Discuss applications of nanomaterials in various fields.

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, nanorobotic cells, molecular motors, nanomembranes, Organic molecular based computers, bionanodevices (sensors & actuators).]

Books Recommended

1. Nanoscale Materials in Chemistry by Kenneth J. Khabunde (ed.) Wiley Interscience.
2. Nanotechnology – An introduction to nanostructure of technique by Michel Kohler and Wolfgang Fritzsche 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)

CO1: Describe chemistry of polymers, classification of polymers, addition and condensation polymerisation, copolymerization, polymerization techniques.

CO2: Characterization of polymers, concept of average molecular weight and types, polymer crystallinity, analysis of polymers using IR, XRD, DSC, DMTA, TGA etc techniques.

CO3: Define Polymer compounding, different compounding ingredients for rubber and plastics, crosslinking and vulcanization.

CO4: Applications of Polymer processing techniques, injection molding, blow molding, calendaring, rotational molding, thermoforming, rubber processing etc.

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. & Billmeyer, 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)

CO1: Define and apply Linear Programming methods, describe problem formulation, graphical method, simplex method, duality sensitivity analysis and Transportation model based problems.

CO2: Describe Theory of Games, Algebraic, Graphical & Linear programming methods. Queuing Theory, elementary queuing system; single & multiple channel queuing model, , Poisson arrivals and Erlang service distribution; benefits and limitations of queuing theory.

Section-A

Linear Programming: problem formulation, graphical method, simplex method, duality sensitivity analysis.

Transportation model, Transshipment 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)

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, IPE 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)

Course Objectives	<ol style="list-style-type: none"> 1. To understand basic concepts in the area of entrepreneurship 2. To know the role and importance of entrepreneurship for economic development 3. To develop personal creativity and entrepreneurial initiative 4. To adopt of the key steps in the elaboration of business idea 5. To know the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures. 6. To enable the students to evolve a suitable framework for the preparation, appraisal, monitoring and control of industrial projects. 7. To make them understand the concepts of Project Management for planning to execution of projects. 8. To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
Course Outcomes	<p>CO1: To consider the legal and financial conditions for starting a business venture To evaluate the effectiveness of different entrepreneurial strategies</p> <p>CO2: To understand the nature of entrepreneurship and functions of the successful entrepreneur. To identify personal attributes that enable best use of entrepreneurial opportunities</p> <p>CO3: Explain the concept and attributes of projects, project management system, process and its principles, and various stages of a project. Perform technical feasibility, marketing feasibility and commercial viability using NPV, and further to understand tax and legal aspects of a project.</p> <p>CO4: Analyse project appraisal in public & private sector and estimate shadow prices and social discount rate. Examine project risk and performance assessment. Evaluate project management techniques using case studies.</p>

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. Manual 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.

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.

PETROLEUM PROCESSING ENGINEERING (Theory)

Course Objectives: The course aims at understanding the basic concepts of Petroleum Refining , refining operations and processes. Various aspects of refinery operations such as petroleum sources, technology and techniques, reaction mechanism, catalysts used and safety.

COURSE Outcomes

- CO1: Define Origin, exploration & drilling of petroleum crude, Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude.
- CO2: Describe Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel, lubricating oils and waxes.
- CO3: Illustrate separation processes, Describe Solvent extraction processes and solvent dewaxing.
- CO4: Describe Conversion Processes, cracking and refining, alkylation, polymerization, isomerisation and hydroprocessing, Safety and pollution considerations in refineries.

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	
CO1: Determine Flash point (Closed – cup) and smoke point for kerosene, ASTM distillation curve for gasoline, diesel oil.	
CO2: Determine Aniline point, Diesel Index, pour point and cloud point and cetane number for diesel oil.	
CO3: Determine viscosity at different temperatures using Ostwald viscometer for hydrocarbon solvents, viscosity index of lubricating oil by Redwood viscometer.	
CO4: Determine water content in petroleum products by Dean and Starks method.	
<ol style="list-style-type: none"> 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, 5 th Edition, McGraw Hill, 1985.
2.	Rao, B.K. : Modern Petroleum Refining Processes, 5 th Edition, Oxford & I Publishing Co., 2009.
3.	Guthrie, V.B. : Petroleum Products Handbook, McGraw Hill, 1960.
4.	Hobson, G.D., Pohl. : Modern Petroleum Technology, 5 th Edition, John Wiley, 1984.
	W.

INDUSTRIAL SAFETY & HAZARDS (Theory)

Course Objectives	<ol style="list-style-type: none"> 1. To know about industrial safety programs and toxicology, industrial laws, regulations and source models 2. To understand about fire and explosion, preventive methods, explosives and inflammable substances. 3. To determine about industrial hazards and its risk assessment. 4. To analyze the effects of workplace exposures, injuries and illnesses, and the methods to prevent incidents using effective control strategies.
Course Outcomes	<p>CO1: Identify the various types of hazards in work-place environment, protective and preventive measures in hazard control, Toxic Chemicals, maximum allowable concentrations and other standards. Biological threshold limit values.</p> <p>CO2: Recognize Mechanical and Electrical hazards, Explosives and inflammable substances, radioactive hazards</p> <p>CO3: Select appropriate Personal protective equipments and effective control strategies for Fire prevention. Good housekeeping in industrial environment.</p> <p>CO4: Understand 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, ISO9000.</p> <p>CO5: Describe Environmental impact assessment. Case studies of typical hazardous industries.</p> <p>CO6: Select proper control strategies for hazardous wastes.</p>

Section-A

Definition, identification, classification and assessment of various types of hazards in work-place environment, 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. Fire prevention. Good housekeeping in industrial environment.

Section-B

Standard safety procedures and disaster control. Indian Legislation on safety and prevention of hazards and safety code: ISO 14000. 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)

Course Objective	To teach the students about requirement and use of main utilities like compressed air, steam, water and refrigerants, which are required in process plants.
Course Outcome	CO1: Understand the selection of different utilities to run process plant. CO2: Analyze the use of compressed air through air compressore and vacuum pumps. CO3: Analyse of use of steam and or boiler. CO4: To analyse the power generation through IC engines and turbines. CO5: Understand the importance refrigeration and water resources.

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)

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, Allyl Alcohol, Glycerol, Phenol, Aniline.

Section-B

Nylon Monomers, Polyester Monomers, Styrene, Other Monomers - Bisphenol A, Epichlorohydrin, 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)

Course Objectives	<ol style="list-style-type: none"> 1. To describe the major metabolic pathways involved in the metabolism of nutrients in the human body. 2. To help the students understand the basic principles of various biochemical processes and realize the importance of different design parameters in bioreactor operation. 3. To recognize the industrial implication of biochemical engineering.
Course Outcomes	<p>CO1: Gaining knowledge about metabolic pathways and cell growth.</p> <p>CO2: Understanding the concept of enzyme kinetics and their applications.</p> <p>CO3: Designing and creating new processes and fermented products that are better economically and technologically.</p> <p>CO4: Understanding the basic calculations for heat and mass transfer and yield of product.</p>

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.