REGULATION 2020

COURSE STRUCTURE

SYLLABUS

GIET UNIVERSITY, GUNUPUR, ODISHA

CHEMICAL ENGINEERING DEPARTMENT

SCHOOL OF ENGINEERING AND TECHNOLOGY

Incorporated by Act 23 of Govt. of Odisha and under approval of UGC & AICTE

Accredited by NAAC with a CGPA of 3.28/4 at *A Grade*

Five UG Programs CSE, ME, CHE, AEIE & EEE Accredited by NBA

Gunupur - 765022 , Dist.- Rayagada, Odisha, INDIA

www.giet.edu

4 Year B.Tech Degree Programme

Regulation 2020

Choice Based Credit System

Outcome Based Assessment

Chemical Engineering

Programme Educational Objectives

Programme educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. Programme educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Chemical Engineering UG Programme at GIET, Gunupur is framed and designed such that within first few years after graduation, the graduates will be able to:

PEO 1: Acquire the fundamental principles of science and chemical engineering with modern experimental and computational skills.

PEO 2: Face current technical challenges in the society by maintaining a professional and ethical attitude towards the society and also considering impacts on safety, health and environment.

PEO 3: Excel their career as Chemical Engineers or researchers in both traditional and emerging fields of Chemical Engineering such as environmental, material, food, pharmaceutical and energy applications.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To correlate theoretical concepts with real time experimental and field data through application of process simulation and analytical techniques.

PSO2: To develop cutting edge chemical processes, equipment and products for the benefit of the human kind using innovative research and development skills and continuous learning efforts.

PROGRAMME OUTCOMES (POs)

1**. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Structure of Undergraduate Engineering Program

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER								TOTAL CREDITS
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management Courses	3	3	2	2	-	-	2	-	**12**
2	Basic Science Courses	8	8	4	-	-	-	-	-	**20**
3	Engineering Science Courses including workshop, drawing, basics of electrical mechanical/computer etc.	10	10	4	4	-	-	-	-	**28**
4	Professional Core Courses	-	-	11	15	15	11	-	-	**52**
5	Professional Elective Courses relevant to chosen specialization / branch	-	-	-	-	3	6	6	3	**18**
6	Open subjects - Electives from other technical and/or emerging Subjects	-	-	-	-	3	3	3	6	**15**
7	Project work, Seminar and Internship in industry or elsewhere	-	-	2	1	2	1	5	8	**19**
8	Mandatory Courses [Environmental Sciences, Induction Training, Indian Constitution, Essence of Indian Traditional Knowledge]	0	0	0	0	-	-	-	-	**0**
	TOTAL	**21**	**21**	**23**	**22**	**23**	**21**	**16**	**17**	**164**

SEMESTER WISE COURSE STRUCTURE

I Semester [First Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Mathematics-I	3	1	0	4
2	Basic Science Courses		Physics / Chemistry	3	0	2	4
3	Engineering Science Courses		Engineering Mechanics	3	1	0	`4
4	Engineering Science Courses		Programming for Problem Solving	2	0	4	4
5	Humanities and Social Sciences including Management Courses		Communicative English -I	2	0	2	3
6	Engineering Science Courses		Engineering Graphics & Design / Workshop/Manufacturing Practices	1	0	2	2
7	Mandatory Courses		Induction Program	-	-	-	0
			Total Credits:	**14**	**2**	**10**	**21**

II Semester [First Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Mathematics-II	3	1	0	4
2	Basic Science Courses		Physics / Chemistry	3	0	2	4
3	Engineering Science Courses		Basic Electrical & Electronics Engineering	3	0	2	`4
4	Engineering Science Courses		Data Structure & Algorithms	2	0	4	4
5	Humanities and Social Sciences including Management Courses		Communicative English -II	2	0	2	3
6	Engineering Science Courses		Engineering Graphics & Design / Workshop/Manufacturing Practices	1	0	2	2
7	Mandatory Courses		NCC/NSS/Yoga	-	-	-	0
			Total Credits:	**14**	**1**	**12**	**21**

III Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Mathematics-III	3	1	0	4
2	Engineering Science Courses		Object Oriented Programming	3	0	2	4
3	Professional Core Courses		Heat Transfer	3	0	2	4
4	Professional Core Courses		Fluid Mechanics	3	0	2	4
5	Professional Core Courses		Chemical Process Calculation	3	0	0	3
6	Humanities and Social Sciences including Management Courses		Organizational Behavior / Optimization In Engineering	2	0	0	2
7	Internship		Summer Industry Internship	-	-	2	1
8	Project		Project	-	-	2	1
9	Mandatory Courses		Constitution of India / Essence of Indian Traditional Knowledge	-	-	-	0
			Total Credits:	**17**	**1**	**10**	**23**

IV Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Engineering Science Courses		Material Science	3	0	2	4
2	Professional Core Courses		Numerical Methods in Chemical Engineering	3	0	0	3
3	Professional Core Courses		Mass Transfer-I	3	0	2	4
4	Professional Core Courses		Mechanical Operations	3	0	2	4
5	Professional Core Courses		Chemical Engineering Thermodynamics	3	0	2	4
6	Humanities and Social Sciences including Management Courses		Engineering Economics and Costing Optimization In Engineering	2	0	0	2
7	Mandatory Courses		Environmental Sciences	-	-	-	0
8	Project		Project	-	-	2	1
			Total Credits:	**17**	**0**	**10**	**22**

V Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Chemical Process Technology	3	0	2	4
2	Professional Core Courses		Chemical Reaction Engineering- I	3	0	2	4
3	Professional Core Courses		Transport Phenomenon	3	0	0	3
4	Professional Core Courses		Mass Transfer-II	3	0	2	4
5	Professional Elective Courses		Computational Fluid Dynamics Process utility and Industrial Safety Biotechnology Biochemical Engineering	3	0	0	3
6	Open Elective Courses		Open Elective - 1	3	0	0	3
7	Internship		Summer Industry Internship	-	-	2	1
8	Project		Project	-	-	2	1
			Total Credits:	**18**	**0**	**10**	**23**

VI Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Process Equipment Design	3	0	2	4
2	Professional Core Courses		Process Control	3	0	2	4
3	Professional Core Courses		Chemical Reaction Engineering- II	3	0	0	3
4	Professional Elective Courses		Process Modeling and Simulation Fuel and Energy Technology Fertilizer Technology Polymer Technology	3	0	0	3
5	Professional Elective Courses		Fluidization Engineering Petroleum Refinery Engineering Mineral Process Engineering Multicomponent Distillation	3	0	0	3
6	Open Elective Courses		Open Elective - 2	3	0	0	3
7	Project		Project	-	-	2	1
			Total Credits:	**18**	**0**	**6**	**21**

VII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses		Treatment of Industrial effluent Interfacial Engineering Modern Separation Technique Process Instrumentation	3	0	0	3
2	Professional Elective Courses		Green Technology Plant Safety and Risk Analysis Sustainability Engineering Integrated Solid Waste Management	3	0	0	3
3	Open Elective Courses		Open Elective - 3	3	0	0	3
4	Humanities and Social Sciences including Management Courses		Marketing Management Engineering Economics and Costing Entrepreneurship Development Human Resource Management	2	0	0	2
5	Project		Summer Industry Internship	-	-	2	1
6	Project		Project Work-I	0	0	8	4
			Total Credits:	**11**	**0**	**10**	**16**

VIII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses		Safety in Chemical Industries Nanotechnology Physical and Analytical Chemistry Water Conservation and Management	3	0	0	3
2	Open Elective Courses		Open Elective - 4	3	0	0	3
3	Open Elective Courses		Open Elective - 5	3	0	0	3
4	Project		Project Work-II & Dissertation	0	0	12	6
5	Project		Seminar and Comprehensive Viva-Voce	0	0	4	2
			Total Credits:	**9**	**0**	**16**	**17**

UG IN CHEMICAL ENGINEERING

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits	QP
THEORY								
1	BS	BBSBS1010	Engineering Mathematics-I	3	1	0	4	A
2	BS	BBSBS1021	Engineering Physics	3	0	0	3	A
		BBSBS1022	Engineering Chemistry					A
3	ES	BBSES1031	Basics of Mechanics	3	0	0	3	A
		BBSES1032	Basics of Thermodynamics					A
4	ES	BBSES1041	Basics of Electronics	3	0	0	3	A
		BBSES1042	Basics of Electrical Engineering					A
5	ES	BBSES1050	Programming for Problem Solving	3	0	0	3	A
6	HS	BBSHS1060	Communicative English and Soft skills	2	0	0	2	A
PRACTICAL / SESSIONAL								
7	BS	BBSBS1121	Engineering Physics Laboratory	0	0	2	1	
		BBSBS1122	Engineering Chemistry Laboratory					
8	ES	BBSES1141	Basics of Electronics Laboratory	0	0	2	1	
		BBSES1142	Basics of Electrical Engineering Laboratory					
9	ES	BBSES1150	Programming for Problem Solving Laboratory	0	0	2	1	
10	HS	BBSHS1160	Communicative English and Soft skills Laboratory	0	0	2	1	
11	ES	BBSES1171	Engineering Drawing	0	0	2	1	
		BBSES1172	Engineering Workshop					
12	MC	BBSHS1180	NSS	-	-	-	0	
TOTAL				**17**	**1**	**10**	**23**	

I SEMESTER

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSBS 1010	ENGINEERING MATHEMATICS-I	3	1	0	4	A

Pre –Requisite: Fundamental of calculus

Course Educational Objectives

CEO1	To find critical points, and use them to locate maxima and minima.
CEO2	To provide the standard methods for solving differential equations.
CEO3	To study Fourier series and to express a function in Fourier series.
CEO4	To use matrices, determinants and techniques for solving systems of linear equations in the different areas of Linear Algebra.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Implement the engineering problems using the concept of Partial differentiation and series and to understand its application.
CO2	Solve the initial value and boundary value problem of ODE related to Electrical circuit.
CO3	Execute the technique of Fourier series for applying in Engineering applications.
CO4	Find the Eigen value and vector of a matrix by using properties of linear algebra

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2												
CO2	2	3												
CO3	1	3												
CO4	2	3												
Avg.	1.5	2.75												

SYLLABUS

UNIT-I MULTI-VARIABLE CALCULUS (13 Hours)

Partial differentiation, Euler's theorem, Total derivative, Taylor's theorem for function of two variable (without proof), Maxima and Minima for function of two variables, Differentiation under integral sign (Leibnitz rule).

UNIT- II (12 Hours)

DIFFERENTIAL EQUATIONS-I

Ordinary differential Equations: First order and first degree differential equations and their method of solving, Application to Electrical circuits and heat conduction.

DIFFERENTIAL EQUATIONS-II

Linear differential equations of higher order and their different methods of solutions (operator methods). Second order linear differential equations and their solutions: Euler Cauchy equation, solution by undermined coefficient method and variation of parameters. Simple application to electrical circuits.

UNIT -III (10 Hours)

Fourier series, Fourier expansion of functions of arbitrary period, Even and odd functions, Half Range Expansion.

UNIT -IV LINEAR ALGEBRA: (15 Hours)

Matrices, Types of matrices, Rank of matrix, Eigen values and Eigen vectors, Clayey – Hamilton theorem (without proof), system of linear equations, Orthogonal matrices, Complex matrices, Hermitical and skew-Hermitical matrices, Unitary matrices, similarity of matrices. Quadratic forms and Canonical forms.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books

1. Advanced Engineering Mathematics by E. Kreyszig, Tenth Edition, Willey
2. Differential Calculus by Santi Narayan and Mittal, S.Chand Publications

Reference Books:

1. Higher Engineering Mathematics by BS Grewal : Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by B.V.Ramana, McGraw Hills Education
3. Advanced Engineer methods by N. P. Bali & Manish Goyal.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSBS1021	ENGINEERING PHYSICS	3	0	0	3	A

Pre –Requisite: Knowledge in +2 Physics and Mathematics

Course Educational Objectives

CEO1	Providing fundamental knowledge about the oscillations and waves
CEO2	To familiar with structure and properties of materials.
CEO3	Providing knowledge of mathematical concepts to solve electromagnetic problems and fundamental information about Quantum mechanics with applications.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand and analyze the concept of oscillation and wave mechanics.
CO2	Describe the principle of lasing and optoelectronics devices in communication system.
CO3	Explain the ideas of crystal structure, crystal diffraction and classification of materials.
CO4	Interpret the fundamentals of electromagnetism and deduce the electromagnetic wave equations.
CO5	Express the basics of quantum mechanics and illustrate the quantum mechanical problems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		3	2											
CO2					3		1							
CO3		3			1									
CO4	3		2											
Avg.	0.75	1.5	1		1		0.25							

SYLLABUS

UNIT:01 **(12 Hours)**

Interaction of Wave and Matter

Simple Harmonic Oscillator, Damped harmonic oscillator and Forced harmonic oscillator, and coupled oscillator, Waves and its Characteristics, Superposition of Waves, Interference by division of wave front (Bi-prism experiment) and division of amplitude (Newton's Ring experiment). Introduction to Diffraction, types of diffraction.

LASER, spontaneous & stimulated emission, Einstein's relation, Ruby Laser and He-Ne Laser, Semiconductor laser, application of Laser. Optical fiber, Acceptance angle, Numerical aperture, Skip distance, Step index and Graded index fibers, Attenuations in optical fibers, applications of optical fiber in communication systems.

UNIT:02 **(12 Hours)**

Physics of Materials Introductions to materials, Crystallography, Crystal structure, crystal direction and plane, Miller indices, Inter planar spacings, Reciprocal Lattice and its characteristics, Reciprocal Lattice of SC, FCC and BCC, Brillouin Zone, Bragg's law. Energy bands in solids (conduction band, valence band and Fermi level), Classification of materials on the basis of band theory. Magnetic properties of Materials & their applications. Nano materials and applications (particulates, thin films, nano structures, etc.)

UNIT:03 **(10 Hour)**

Electromagnetic theory and wave Review of grad, divergence and curl, Gauss divergence theorem and Stoke's theorem (no derivations), fundamental laws of electrostatics, magneto-statics and electromagnetism, displacement current and conduction current, Maxwell's equations. Electromagnetic wave and its characteristics, electromagnetic wave equation for free space and in charge free conducting medium, electromagnetic energy, Poynting vector and Poynting theorem.

UNIT:04 **(12 Hours)**

Quantum Mechanics Introduction to dual nature: Black body radiation, photoelectric effect, Compton effect (qualitative idea only), de-Broglie's hypothesis, Heisenberg's uncertainty principle and its application to non-existence of electron inside the nucleus and ground state energy of one dimensional harmonic oscillator, Basic postulates of Quantum Mechanics, Wave function and its characteristics, probability density , normalization, eigen values, eigen functions and expectation values, Schrödinger's equation (time dependent and time independent). Application of Schrödinger equation to one dimensional potential well, potential step and potential barrier (qualitative ideas).

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Engineering Physics by D. K. Bhattacharya and Poonam Tanden, Oxford University Press.
2. Engineering Physics, H K Malik and A K Singh, Tata McGraw Hill, MGH.

Reference Books:
1. Materials Science & Engg., V. Raghvan, Prentice Hall of India.
2. Concepts of Modern Physics, A. Beiser, S. Mahajan, S.R. Choudhary, Tata McGraw Hill.
3. Lasers & Optical engineering, P Dass, Narosa Publishers, Springer Publisher.
4. Engineering Physics by B. B. Swain and P. K. Jena, Kitab Mahal,Cuttack
5. Quantum Mechanics by SatyaPrakash, Kitab Mohal, etc. Kedar Nath Ram Nath Publisher

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSBS1022	ENGINEERING CHEMISTRY	3	0	0	3	A

Pre –Requisite: Chemistry

Course Educational Objectives

CEO1	To impart the knowledge of application of chemical sciences in the field of engineering
CEO2	To focus on microscopic chemistry in terms of atomic and molecular levels.
CEO3	The course aims at elucidating principles of applied chemistry in water treatment.
CEO4	To give detailed account about the reactivity of metals w.r.t prevention of corrosion.
CEO5	To enlighten the students with the applications of polymers.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Analyze microscopic chemistry in terms of atomic and molecular orbital and Explain the ranges of the electromagnetic spectrum by electronic transition
CO2	Identify water treatment techniques for domestic and industrial purposes
CO3	Compare types of corrosion, and it's control measures.
CO4	Understand various types of polymers, their preparation along with applications

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2		2	3							
CO2	3	3	1	2		2	3							
CO3	3	3	2	1		2	3							
CO4	3	3	2	1		2	3							
Avg.	3	2.75	1.75	1.5		2	3							

SYLLABUS

UNIT-1ATOMICANDMOLECULARSTRUCTURE (13 Hours)

Schrodinger's wave equation(no derivation), Significance of wave functions, Particle in a box, Application for conjugated molecule, Molecular Orbital theory and Energy level diagram for Diatomic molecules, Spectroscopic techniques and applications: Electronics spectroscopy, Vibrational and rotational spectroscopy of diatomic molecules.

UNIT-2 WATER CHEMISTRY (13 Hours)

Types of Hardness, Determination of Hardness by EDTA method, Treatment of water for Domestic use, Water softening processes Lime-soda process, Ion Exchange method, Boiler feed water, Scale and Sludge, Caustic embrittlement, Carbonate and phosphate conditioning, Colloidal conditioning, Calgon conditioning.

UNIT-3 CORROSION (10Hours)

Thermodynamic functions: Entropy, Free energy, Relation between E.M.F and free energy, The Nernst's equation and application, Definition of corrosion, Types of corrosion: Dry corrosion and wet corrosion, Galvanic corrosion, Concentration cell corrosion, Factors influencing corrosion, Corrosion control: Cathodic protection (Sacrificial anodic protection and Impressed current cathodic protection), Inhibitors, Protective coatings: Galvanization and Tinning.

UNIT -4 POLYMER CHEMISTRY (12 Hours)

Introduction, polymer, Classification of polymers, Plastics: Thermosetting and thermo plastic, PVC, PE, PS, PMMA, PTFE, Bakelite,Nylon-6,6,Nylon-6, Fiber reinforced plastic.

*ADD-ON COURSES: Conducting Polymer (Polyaniline, Polyacetylene), Bio-Degradable and Non-Bio Degradable polymer, Nano composite.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books: 1.Engineering chemistry by Jain & Jain, Dhanpat Rai publishing company (p) Ltd

Reference Books:

1. A Text Book of Engineering Chemistry by S.S.Dara, S Chand Publishers.
2. A Text Book of Engineering Chemistry by SashiChawla, Dhanpat Rai Publishing house.
3. Text Book of Engineering Chemistry, 2nd edition, by R.Gopalan, D.Venkapaya & Sulochana Nagarajan, Vikas Publishing

House Pvt. Ltd.
4. B. Tech Chemistry- I and II by P. K. Kar, S. Dash, B. Mishra kalyani publishers.
5. Physical Chemistry By P.W Atkins
6. Engineering Chemistry(NPTEL Web Book) by B . L Tembe, Kamaluddin and M.S. Krishna
7. Fundamentals of Molecular spectroscopy By C . N Banwell
8. University chemistry by B.H. Mahan

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1031	BASICS OF MECHANICS	3	0	0	3	A

Pre –Requisite: Physics, Mathematics

Course Educational Objectives

CEO1	To apply the established engineering method to complex engineering problem.
CEO2	To understand the vectorial and scalar representation of forces and moments.
CEO3	To evaluate the different forces exhibit in truss member.
CEO4	To obtain the knowledge on kinematics and kinetics of particle to analyze simple and practical problems

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Determine the resultant force and moment for given force system.
CO2	Evaluate the forces in members of trusses, frames and problems related to friction.
CO3	Analyze the properties of surface in relation to centroid and moment of inertia
CO4	Adapt the laws of motion, kinematics of motion and their interrelationship

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	2	3												
CO3	3	3												
CO4	2	3												
Avg.	2.5	2.75												

SYLLABUS

UNIT:1 **[16 Hours]**

STATICS OF PARTICLES

Fundamental concepts and principles of engineering mechanics. Resolution of forces Resultant of several concurrent forces Free body diagram. Principles of transmissibility. Moment of a force Varignon's theorem Equivalent system of forces Types of supports and corresponding reactions.

UNIT:2 **[12 Hours]**

ANALYSIS OF TRUSSES AND FRICTION

Introduction to Truss Analysis of Trusses Method of joints, Method of sections.
Laws of Friction Angle of Friction Angle of Repose Ladder and Wedge Friction

UNIT:3 **[12 Hours]**

PROPERTIES OF SURFACES

Determination of first moment area of plane figures by integration – Determination of centroid of composite figures by using standard formula.
Determination of second moment area of plane figures by integration Parallel and perpendicular axis theorems
Determination of area moment of inertia of composite figures by using standard formula Polar moment of inertia Radius of gyration.

UNIT:4 **[10 Hours]**

DYNAMICS OF PARTICLES

Rectilinear motion: uniform velocity and uniformly accelerated motion Newton second law D'Alembert's principle and its applications work and energy equation Impulse and Momentum Impact of elastic bodies.

Teaching Methods: Chalk& Board/ PPT/ Guest Lecture

Text Books:

1. Timoshenko, and Young, "Engineering Mechanics", Tata Mc Graw Hill Book
2. S. S. Bhavikatti, "Engineering Mechanics", New Age International

Ref. Books:

1. Dr. Bansal.R.K, & Sanjay Bansal, "A Text book of Engineering Mechanics", Lakshmi publications.
2. A.K.Tayal, "Engineering Mechanics Statics And Dynamics", Umesh Publications
3. Rajasekaran.S, & Sankarasubramanian.G, "Engineering Mechanics", Vikas Publishing House Pvt Ltd, 2011

4. Engineering Mechanics, (3ed edition) by Statics and Dynamics K.Vijaya Kumar Reddy and J Suresh Kumar, BS Publications.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1032	BASICS OF THERMODYNAMICS	3	0	0	3	A

Pre –Requisite: Physics, Chemistry and Mathematics

Course Educational Objectives

CEO1	Learn to classify the fundamentals of thermodynamics like pressure, temperature etc.
CEO2	Apply principle and law of thermodynamics to analysis of different systems
CEO3	Become aware of relevance of environmental and social issues on the analysis process of systems.
CEO4	To understand the basics of properties of pure substance like steam and its conditions and Application of Thermodynamics in engineering practices

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Explain the basic concepts of system, control volume, thermodynamic properties, thermodynamic equilibrium, temperature, work and heat energy.
CO2	Apply the laws of thermodynamics to refrigerators, heat engines, heat pumps compressors and nozzles etc.
CO3	Interpret and apply the concept of entropy to thermodynamic systems
CO4	Evaluate properties of pure substances, gases and their mixtures and to derive and apply to thermodynamic problems.

CO-PO & PSO Mapping

Cos	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	2	3												
CO3	2	3												
CO4	3	3												
Avg.	2.5	2.75												

SYLLABUS

UNIT 1 **(15ours)**

Basic concepts & definition, scope of thermodynamics. Macroscopic & microscopic approach. Definition of fixed mass (closed) system & control volume (open) system, isolated system. Thermodynamic properties (extensive & intensive), state & its representation on a property diagram, process and its representation, cyclic process Characteristics of properties (point & path function), reversible & irreversible process, Quasistatic Process. Thermodynamic equilibrium. Pressure, Types of pressure, Zeroth law of thermodynamics & temperature scales, calibration of thermometers. Ideal gasses & their P V T relation. Energy transfer; Work transfer(definition & calculation), different modes of work Displacement work for various process, Free expansion work, Heat transfer; modes of heat transfer, basic laws in conduction, convection & radiation.

UNIT 2 **(13 Hours)**

First law of thermodynamics, formal statement (using cyclic process) first law for processes of fixed masses (closed system) Introduction of internal energy, enthalpy as thermodynamic properties Definition of sp.heats (C_p & C_v) and their use in calculation of internal energy & enthalpy with emphasis on ideal gas. Application of first law to control volume (Steady Flow); nozzle, diffuser, compressor, turbine, throttling device.

UNIT 3 **(12 Hours)**

Second law of thermodynamics, Kelvin Planck & Clausius statements, Carnot cycle. Reversible & irreversible engines and their efficiency (Thermal and maximum Efficiency)
Entropy concepts, Clausius inequality, Entropy Principle.

UNIT 4 **(10 Hours)**

Properties of pure substance, P v, T s, h s diagram for steam , Steam properties, Introduction to steam table with respect to specific volume, pressure, temperature, enthalpy & entropy, Mollier Diagram. Application of thermodynamics: Steam power plant, Refrigerators and Heat Pump, I C Engines (working principle with schematic diagrams only)

Teaching Methods: Chalk& Board/ PPT

Text Books:

1 Engineering Thermodynamics by P.K.Nag, Publisher: TMH
2 Basic Engineering Thermodynamics by D S Kumar, Publisher: S K Kataria & Sons New Delhi.

Ref. Books:
1. Fundamental of Engineering Thermodynamics by E. Rathakrishnan, publisher. PHI
2. Thermodynamics: An Engineering Approach by Yunus A. Cengel, Michael A. Boles Publisher: Mcgraw Hill Education
3. Thermal engineering by R.K.Rajput, Laxmi Publications Pvt. Ltd.
4. Steam Tables in SI Units by K. Ramalingam, Scitech Publications (P) Ltd.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1041	BASICS OF ELECTRONICS	3	0	0	3	A

Pre-requisites (if any):

Course Educational Objectives

CEO1	Identify the basic tools and test equipment used to construct, troubleshoot, and maintain standard electronic circuits and systems.
CEO2	Explain the construction and application of standard circuit configurations and identify the component types and connections used to build functioning electronic circuits.
CEO3	Design simple combinational and sequential logic circuits
CEO4	Identify functions of digital multimeter, cathode ray oscilloscope and transducers in the measurement of physical variables

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Recognize different components such as transistors, resistors, capacitors and diodes which fit on a small chip with each leg of the chip connecting to a point within the circuit.
CO2	Apply modern modelling software for drafting different electronic circuits.
CO3	Analyze modern electronic circuits and systems.
CO4	Formulate mathematical descriptions and procedures in designing new electronic systems and technically present

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1													
CO2			2											
CO3			2											
CO4	2		2											
Avg.	0.75		1.5											

SYLLABUS

UNIT-1 **(12Hours)**

Semiconductor Devices:- Classification of material, Energy band diagram, properties of semiconductors, Types of semiconductors, Semiconductor diode (no bias, forward, reverse),temperature effects, diode equivalent circuit, zener diode, LED , Half wave rectifier, full wave rectifier, clippers ,clampers.

UNIT-2 **(10Hours)**

Bipolar Junction Transistors (BJTs):- Introduction, transistor operation, Simplified structure and physical operation of n-p-n and p-n-p transistors in the active region, Common–Base configuration, Common–emitter configuration, Common-collector configuration Current-voltage characteristics of BJT, BJT as an amplifier and as a switch.

Field Effect Transistors (FETs):- Introduction, construction and characteristics of JFETs, transfer characteristics, D-MOSFET, E –MOSFET.

UNIT-3 **(9Hours)**

Communication Systems: -Analog and digital signals, block diagram of basic communication system, need for modulation, methods of modulation,AM/FM transmitters & receivers (Block diagram description only)

Electronic Instruments:- Basic principle of Oscilloscope, Function of the sweep generator, Block diagrams of oscilloscope, Measurement of frequency and phase by Lissajous method, Application of oscilloscope for measurement of voltage, period and frequency, Block diagram of standard signal generator, AF sine and square wave generator, and Function generator.

UNIT-4 **(11Hours)**

Digital Systems and Binary Numbers:-Digital systems, Binary numbers, number system conversion, octal &hexa decimal number, 1's& 2's compliments, signed binary numbers, binary codes, binary logic.

Logic Gates and Boolean Algebra:- The inverter, The AND, OR, NAND NOR, Exclusive-OR and Exclusive-NOR gate, Boolean operations and expressions, Laws and Rules of Boolean algebra, DeMorgan's theorem, Boolean analysis of logic circuits, Standard forms of Boolean expressions, Boolean expression and truth table Combinational Logic and Their Functions: Basic combinational logic circuits, Implementation of combinational logic, The universal properties of NAND and NOR gates, Basic adders

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Electronic Devices (Seventh Edition), Thomas L. Floyd, Pearson Education, 482 FIE, Patparganj, Delhi – 110 092 (Selected Portions).
2. Digital Fundamentals (Eighth Edition), Thomas L. Floyd and R.P. Jain, Pearson Education, 482 FIE, Patparganj, Delhi – 110 092.
3. Electronic Instrumentation, H.S. Kalsi, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Reference Books:

1. Microelectronic Circuits (Fifth Edition), Adel S. Sedra and Kenneth C. Smith, Oxford University Press, YMCA Library Building Jai Singh Road, New Delhi – 110 001.
2. Electronic Devices and Circuit Theory (Ninth Edition), Robert L. Boylestad and Louis Nashelsky, Pearson Education, 482 FIE, Patparganj, Delhi – 110 092.
3. Electronics Principles (7th Edition), Albert Malvono and David J. Bates, Tata McGraw-Hill Publishing Company Limited, New Delhi.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1042	BASICS OF ELECTRICAL ENGINEERING	3	0	0	3	A

Pre -Requisite: Physics and Mathematics

Course Educational Objectives

CEO1	Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
CEO2	This course provides comprehensive idea about DC & AC circuit analysis, magnetic circuit analysis, working principles of machines and common measuring instruments.
CEO3	Emphasize the effects of electric shock and precautionary measures. Improve the ability to function on multi-disciplinary teams.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the basic concepts of magnetic, AC & DC circuits.
CO2	Explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
CO3	Gain knowledge about the fundamentals concepts of power generation, domestic wiring, electric shock and preventive measures
CO4	Understand Electrical power generation and transimission process in India and function on multi-disciplinary teams.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2												
CO2	1	2												
CO3	2	2												
CO4	1	1												
Avg.	1.5	1.75												

SYLLABUS

UNIT-1 **(15 Hours)**

DC Circuits:

Introduction to electrical terminology, Ohm's Law, Equivalent Resistance, series-parallel circuits, star-delta transformation, types of elements, ideal and practical voltage & current sources; Kirchhoff's Law, Mesh and Nodal Analysis.

Network theorems:

Superposition Theorem, Thevenin theorem, Maximum power transfer theorem excited by independent sources, Transients in RL & RC series circuits.

UNIT-2 **(13 Hours)**

Single phase & Three phase Ac circuits:

AC Fundamentals: RMS & Average value, form and peak factors, Complex algebra, concepts of reactance, impedance and their representation, AC through pure R, L, C, series RL, series RC, series RLC circuit, Concept of power & power factor; expression of power in complex notation.

Three-phase AC circuits:

Comparison between 1-ph & 3-ph AC circuit, Star & Delta connection, relation between line and phase quantities, Measurement of 3-phase power using 2-wattmeter method.

Magnetic circuits:

Magnetic flux, Magnetic flux density, Magnetic fields intensity, Relation between B & H, B-H curve, Analogy between Electric and Magnetic circuit, Leakage flux.

UNIT-3 **(12 Hours)**

DC Machines:

Introduction, working principle of DC Generator, Construction, Types, EMF equation, working principle of DC Motor Back e.m.f, Application of DC machines.

AC Machines:

Introduction, Principle of operation of AC machines, Transformers, Construction, EMF equation, Turn ratio, Ideal transformer on no load with phasor diagram, 3-phase Induction motor principle of operation, Rotating magnetic field, Types of rotors, Synchronous speed and slip, Introduction to 1-phase Induction motor, 1-phase motors types, appli cations of 3-phase and 1-phase motors, AC generator and motors, Principle of operation, types of rotors, Synchronous motor operating principle.

UNIT-4 **(10 Hours)**

Measuring Instruments:

Introduction, Classification of instruments, construction and working principles of PMMC and moving iron type Instruments.

Introduction to Power System &Domestic Wiring:General layout of electrical power system and functions of its elements, Generation of electricity (Hydro, Thermal and Nuclear power plant), standard transmission and distribution voltages, Service main, Meter board, Fuse, MCB, Earthing (pipe & plate earthing), House wiring, Electric shock & precautions.

Teaching Methods: Chalk& Board/ PPT

Text Books:

1. V. Del Toro, "Principles of Electrical Engineering" Prentice Hall International.
2. P.V. Prasad, S.Sivanagaraju, R.PrasadBasic Electrical and Electronics Engineering; CENGAGE Learning.
3. I.J. Nagarath, " Basic Electrical Engineering" Tata McGraw Hill
4. D.E. Fitzgerald & A. Grabel Higginbotham, " Basic Electrical Engineering Mc- Graw Hill.

Reference Books:

1. Edward Hughes, " Electrical Technology" Longman
2. T.K. Nagsarkar & M.S. Sukhija, "Basic Electrical Engineering" Oxford University Press.
3. H. Cotton, " Advanced Electrical Technology" Wheeler Publishing
4. W.H. Hayt & J.E. Kennely, "Engineering Circuit Analysis" Mc Graw Hill.
5. Theory and Problems of Basic Electrical Engineering by D.P.Kothari & I.J. Nagrath PHI.
6. Fundamentals of Electrical Engineering and Electronics by B. L. Theraja, S. Chand & Company Ltd, Reprint Edition 2013.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1050	PROGRAMMING FOR PROBLEM SOLVING	3	0	0	3	A

Pre –Requisite:

Course Educational Objectives

CEO1	To formulate algorithm, translate into program and then execute the programs for verifying its correctness.
CEO2	To analyze a problem for knowing its efficiency and decompose it into functions using divide and conquer approach.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	To formulate simple algorithms for arithmetic and logical problems and translate into programs.
CO2	To develop programs, understand and analyze its complexity.
CO3	To understand and develop programs using functions and recursions
CO4	To develop programs using pointers and structures and understand their functionality.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1											
CO2	3	3	2											
CO3	3	3	2											
CO4	3	3	2											
Avg.	3	2.75	1.75											

SYLLABUS

UNIT- I **(11 Hours)**

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)Idea of Algorithm: Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo-code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code Arithmetic expressions and precedence. Conditional Branching. Writing and evaluation of conditionals and consequent branching.

UNIT- II **(11 Hours)**

Loops: writing programs and evaluation of loops
while, do-while and for loop, break, continue, nested loop
Arrays: Arrays (1-D, 2-D)
Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

UNIT- III **(11 Hours)**

Character arrays and Strings: String handling operations, programs on strings, string handling functions.
Functions: Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.
Recursion: Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series

UNIT- IV **(11 Hours)**

Pointers: Idea of pointers, Defining pointers, dynamic memory allocation, Use of Pointers in self-referential structures, notion of linked list (no implementation)
Structure: Structures, Defining structures and Array of Structures.

Teaching Methods: Chalk& Board/ PPT

Text Books:

1. *Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill*
2. *E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill*

References:

1. *Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice*

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSHS 1060	**COMMUNICATIVE ENGLISH AND SOFT SKILLS**	**2**	**0**	**0**	**2**	**A**

Pre -Requisite: fundamentals of grammar, vocabulary, usage of internet

Course Educational Objectives

CEO1	To promote communication skills and soft skills.
CEO2	To enhance the employability and entrepreneurial skills
CEO3	To motivate the students to participate in group discussions without stage fear

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the importance of effective communication for professional development
CO2	Application of vocabulary and grammar for effective communication.
CO3	Application of Information and Communication Technology(ICT) for career development
CO4	Nurture and motivate positive attitude towards placements.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								1		3				
CO2										1		2		
CO3								2			3			
CO4									3			1		
Avg.								0.75	0.75	1	0.75	0.75		

SYLLABUS

UNIT -1 Importance of English for Communication in the 21st Century **(9 Hours)**

1.1 Role of English in enhancing employability and entrepreneurial skills
1.2 The Nature and Scope of Communication
1. 3 Objectives of Communication: Information, advice, suggestion, order, motivation, persuasion, warning, negotiation, decision-making, etc. through English Language skills, i.e., LSRW skills
1.4 The process of communication and factors that influence communication: Sender, receiver, channel, code, topic, message, context, feedback, noise, filters and barriers (steps such as Ideation, Encoding, Transmission, Decoding, etc. need to be dealt with); Audience and purpose
1.5 Types of Communication: General and Professional Communication; Formal and Informal Communication; Verbal and Non-verbal communication; Intrapersonal and Interpersonal communication; Written communication and Spoken communication.

UNIT -2. English Vocabulary, Grammar & Usage **(8 Hours)**

2.1 Synonyms and Antonyms
2.2 Words often confused
2.3 Technical terms and one word substitutes
2.4 Idioms and Phrasal Verbs
2.5 Identify common errors in English.
2.6 Communicative use of the Passive Voice
2.7 Difference between American, British and Indian English (Vocabulary based) 1

UNIT- 3. Introduction to Corporate Communication **(10 Hours)**

3.1 Seven C's communication
3.2. Ten C's of Non-communication.
3.3 Corporate Communication – Direction of Communication: Downward Communication, Upward Communication, Horizontal/Lateral Communication, Diagonal Communication
3.4 Communication challenges in today's work place: Advances in technology; culturally diverse workforce; Team-based

organizational Settings; how to overcome these challenges
3.5 Information and Communication Technology (ICT) and the corporate world, Power point presentation using multimedia; Internet and Intranet; Fax; Teleconferencing; Videoconferencing;
3.6 Corporate/Business etiquette: Good listening skills, proper dressing and grooming; proper handshake, mobile etiquette, table manners

UNIT- 4 Soft skills Development. **(9 Hours)**

4. 1 Importance of soft skills in personal and professional life
4.2 Are we hardwired for success?
4.3 Importance of developing a positive attitude
4.4 Leadership skills.
4.5 Teamsmanship.
4.6. Lateral thinking
4.7 Emotional Intelligence.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *An Introduction to Professional English and Soft Skills* by B. K. Das et al., Cambridge University Press.
2. *Communicative English for Engineers and Professionals* by Nitin Bhatnagar and Mamta Bhatnagar. Published by DK/Pearson.
3. Practical English Usage. Michael Swan, OUP,1995.

Reference Books:

1. Technical Communication , Principle and Practice by Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2. Business Communication Today by Bovee, Courtland L., Thill, John V. Prentice Hall.
3. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success by Gopalaswamy Ramesh and Mahadevan Ramesh. Pearson.
4. Oxford Guide to English Grammar by John Easthood. Oxford University Press.
5. 365 Ways to Change Your World by Norman Vincent Peale by Orient Paperbacks.

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSBS1121	ENGINEERING PHYSICS LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	Students will understand the basic principles of physics and their mathematical description.
CEO2	Students will be able to use the laws of physics and calculus to solve problems
CEO3	Students will be able to work together in collaborative groups to perform experiments, gather data and reach conclusions.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the uses of various Basic Instruments for different Physical measurements.
CO2	Apply the Physical Laws and verify those using standard Experiments.
CO3	Organize experiments to determine different Physical quantities and anlyze those for different application to Physical Systems.
CO4	Evaluate the magnitudes of Physical quantities systematically through experiments and design new experiments with the theoretical knowledge

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		3	2											
CO2					3		1							
CO3		3			1									
CO4	3		2											
Avg.	0.75	1.5	1		1		0.25							

SYLLABUS

List of Experiments:

1. Study of frequency of an electric tuning fork by meld's experiment.
2. Study of the acceleration due to gravity by using Bar/Kater's pendulum.
3. Study of the law of transverse vibration by using sonometer.
4. Study of wavelength of light by Newton's Rings apparatus.
5. Study of wavelength of light by Fresenel's bi-prism/Michelson inter ferometer.
6. Study of grating element of a plane diffraction grating.
7. Study of double slit interface due to He-Ne laser.
8. Study of monochromaticity and divergence of the given laser beam
9. Study of reflection and total internal reflection by optical fibers
10. Study of Hall-coefficient of a semiconductor
11. Study of dielectric constant of given solid by Leacher wire method.
12. Study of the resistivity of a semiconductor with temperature by four- probe method.
13. Study of band gap energy of PN junction (Ge/Si) diode.
14. Study of plank's constant using photo-voltaic cell.
15. Study of B-H curve of ferromagnetic substance.

16. Study of magnetic susceptibility of solods.

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSBS1122	ENGINEERING CHEMISTRY LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To train the students about the applications of chemical sciences in the field of engineering and technology

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the basic methods of chemical analysis and instrumentations involved
CO2	Standardize of Chemicals
CO3	Estimate the hardness, ions in salts and compositions in ores.
CO4	Synthesizes the drugs and know about their applications

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		2		2			2		2		3			
CO2							3		3		2			
CO3		2		2			2		2		2			
CO4		2		2			2		2		2			
Avg.		1.5		1.5			2.25		2.25		2.25			

SYLLABUS

List of Experiments:

1. Determination of total hardness of water by using EDTA.
2. Determination of amount of NaOH and Na_2CO_3 present in mixture of two.
3. Standardization of $KMnO_4$ using sodium oxalate.
4. Determination of ferrous ion in Mohr's salt by standardized $KMnO_4$.
5. Determination of % of dissolved oxygen in given water sample.
6. Estimation of available chlorine in bleaching powder solution.
7. Determination of rate constant of acid catalyst Hydrolysis reaction.
8. Preparation of aspirin
9. Estimation of calcium in limestone.
10. Estimation of Zinc in brass.
11. To determine the strength of HCl and acetic acid from the mixture of acid by strong alkali (NaOH) by Conductrometry
12. Preparation of nanoparticle.
13. Determination of partition coefficient of iodine in benzene and water.
14. Preparation and determination of pH of buffer solution.

15. To determine the molecular weight of polymer by viscosity measurement.

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSES1141	BASICS OF ELECTRONICS LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To provide students engineering skills by way of breadboard circuit design with electronic devices and components.
CEO2	To design and analyze various Electronic circuits such as multivibrators, applications of operational amplifiers, RC coupled amplifiers, oscillators, digital circuits etc. so that students are able to understand the practical aspects of basic electronics theory.
CEO3	To enable the students to simulate and test the Analog, Digital and mixed Electronics circuits .

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Generate sine, square and triangular waveforms with required frequency & amplitude using function generator.
CO2	Demonstrate introductory knowledge of software for schematic capture, circuit simulation, and circuit board layout.
CO3	Analyze the characteristics of different electronic devices and circuits such as diodes, transistors, rectifiers, amplifiers etc.,
CO4	Plan new electronic systems and technically present them

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1	1											
CO2		2	2											
CO3		1	1											
CO4		2	2											
Avg.		1.5	1.5											

SYLLABUS

List of Experiments:

EXPERIMENTS: 1 Familiarization of electronic components and devices (Testing of semiconductor diodes and transistors using digital multi meter)

EXPERIMENTS: 2 Study and use of Oscilloscope, signal generator to view waveforms and measure amplitude and frequency of a given waveform.

EXPERIMENTS: 3 V-I characteristics of semiconductor diode

EXPERIMENTS: 4 Studies on half-wave and full-wave rectifier circuits without and with capacitor filter; recording of the waveforms and measurement of average and rms values of the rectifier output.

EXPERIMENTS: 5 Studies on clipper circuit.

EXPERIMENTS: 6 Studies on clamper circuit.

EXPERIMENTS: 7 V-I characteristic of an n-p-n or p-n-p transistor, DC biasing the transistor in common-emitter configuration and determination of its operating point (i.e., various voltages and currents).

EXPERIMENTS: 8 MOSFET I-V characteristics

EXPERIMENTS: 9 Studies on Logic gates (Truth table verification of various gates).

EXPERIMENTS: 10 Studies and experiments using ADDER CIRCUITS ICs

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSES1142	BASIC ELECTRICAL ENGINEERING LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To know the basic concepts on different types of circuits.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Illustrate the transformers and single phase motors constructional features
CO2	Analyse various electrical quantities with combination of loads
CO3	Examine the characteristics of AC and DC machines
CO4	Distinguish the methods of speed control of DC motors

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1	2											
CO2		2	2											
CO3		1	2											
CO4		2	2											
Avg.		1.5	2											

SYLLABUS

List of Experiments:

1. Study of different electrical equipment's(transformer, single phase motors)
2. Power factor improvement using capacitor for fluorescent lamp.
3. Verification of Superposition and Thevenin's theorem
4. Measurement of reactive power by using single watt-meter method
5. 3phase Power measurement by using two wattmeter methods.
6. Calculation of current, voltage and power in series R-L-C circuit excited by single-phase AC supply and calculation of power factor.
7. Determination of open circuit characteristics (OCC) of DC shunt generator
8. Starting and speed control of a dc shunt motor by (a) field flux control method, and (b) armature voltage control method.
9. V-I characteristics of incandescent lamps and time-fusing current characteristics of a fuse.
10. Connection and testing of a single-phase energy meter.

SUBJECT CODE	NAME OF THE SUBJECT	L	T	P	C	QP
BBSES1150	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	3	0	0	3	A

Pre –Requisite:

Course Educational Objectives

CEO1	To develop programs for problems on different applications of array, functions, pointers and structure.
CEO2	To analyze different problems by comparing and implementing in programming.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	To understand operating system and its simple commands, writing programs, compilation, debug and execution process.
CO2	To develop programs using loop controls, arrays and understand the complexity using different programs.
CO3	To develop programs using functions and recursive function by decomposing a problem and analyze them.
CO4	To understand numerical problems, develop programs using pointers , structures and understand their functionality.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2											
CO2	3	3	3	1										
CO3	3	3	3											
CO4	3	3	3	1										
Avg.	3	2.75	2.75	0.5										

SYLLABUS

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
1) Introduction to OS: Before starting experiments explain the facilities and operations of OS.
2) Introduction to the C compiler, Compilation and Execution Process & writing simple programs.
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
1) WAP to input radius of a circle and Find the area, perimeter of it.
2) WAP to input two numbers and swap them without using intermediate variable.
3) Write a program to accept Fahrenheit and calculate its equivalent Celsius.
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
1) Write a program to input principle amount, no. of terms and rate of interest. Find simple interest.
2) WAP to input three unequal numbers and find the greatest using conditional operator.
3) Write a program to input a float value and display its integer part & fractional part separately.
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
1) Write a program to find the real roots of a quadratic equation when three co-efficient values are given.
2) Write a program to input a lower case alphabet and test whether it is vowel or consonant.
3) Write a program to find the greatest among three numbers.
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
1) Write a program to generate Fibonacci series of N numbers.
2) Write a program to find the greatest common divider of two positive numbers given.
3) Write a program to accept a positive integer and test it for palindrome or not.
4) Write a program to calculate the following sum:
Sum = 1-(x^2)/2! +(x^4)/4! – (x^6)/6! + (x^8)/8! – (x^10)/10!
5) Write a program to generate the following pyramid.

```
        1
      1 2 3
    1 2 3 4 5
  1 2 3 4 5 6 7
```

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
1) Write a program to accept 10 integers in to an array and find largest and smallest integers present in them.
2) Write a program to apply binary search on an array having elements in sorted order.
3) Write a program to accept 10 numbers in to an array and sort it using insertion sort in ascending order.

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
1) Write a program to input elements 4x4 matrix. Find the principal diagonal of them.
2) Write a program to input values into two matrices A(3x4), B(4x3). Perform matrix multiplication and display the resultant matrix.
3) Write a program to accept a string and test whether it is palindrome or not using string handling functions.
Tutorial 7: Functions, call by value:
Lab 7: Simple functions
1) Write a C program which contains three UDF's namely add(), subtract() and multiply(). Each function accepts two integers as their arguments and calculate and return the results
2) Write a program to create an UDF and test a number is prime or not.
3) Write a program to find the factorial of a given number using UDF.
Tutorial 8: Recursion, structure of recursive calls
Lab 8: Recursive functions
1) Write a program to find greatest common divisor of two integers using recursive functions.
2) Write a program to accept 10 elements into an integer array. Find the largest element present using recursive function.
3) Write a program to generate Fibonacci series using a recursive function.
Tutorial 9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 9: Programming for solving Numerical methods problems
1) Write a program to implement Newton-Raphson Method.
2) Write a program to implement Euler's method.

Tutorial 10: Pointers, structures and dynamic memory allocation
Lab 10: Pointers and structures
1) Write a program to create user defined function called swap having two integer pointers as its arguments and it has no return value. Call this function using call-by-address.
2) Write a program to store 'n integers using dynamic memory allocation. Find the average value of the integers using a user defined function.
3) Write a program to input 11 cricket players' details using a structure array having member's player name, team name, batting average. Create a function which will display the player name whose batting average is >=30.
4) Write a program to create a structure for product having members like product code, price and quantity. Store N product details using dynamic memory and display them.

SUBJECT CODE	NAME OF THE LAB	L	T	P	C	QP
BBSHS 1160	COMMUNICATIVE ENGLISH AND SOFT SKILLS LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To develop the vocabulary and usage skills of students by practice
CEO2	To develop the communication skills of the students, especially Listening and Speaking skills.
CEO3	To enable students to participate in group discussions through proper listening and speaking.
CEO4	To enable students eliminate grammatical mistakes in speech and writing.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Memorize and explain a good range of vocabulary and usage .
CO2	Use grammar for effective speaking in GD and other formats of speaking
CO3	Able and defend in conversational and public speaking competencies.
CO4	Develop active listening and speaking skill in different real life situation

CO-PO & PSO Mapping

	PROGRAMME OUTCOMES												PSOs	
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1										2	1			
CO2									2	2				
CO3									2	2				
CO4										2		1		
Avg.									1	2	0.25	0.25		

SYLLABUS

Phonetics & Listening Skills 16 hours = 8 classes [2 listening tests x 10 marks = 20 marks]
Vowels, diphthongs, consonants, consonant clusters; The International Phonetic Alphabet (IPA); phonemic transcription; Problem sounds; Syllable division and word stress; Sentence rhythm and weak forms; Contrastive stress in sentences to highlight different words; Intonation: falling, rising, and falling-rising tunes; Listening to Newspaper reading/Video, etc. Listening with a focus on pronunciation (ear-training): segmental sounds, stress, weak forms, intonation & Listening for comprehension. Reading of English daily newspapers and self-development books be integrated listening and speaking activities.

Speaking skills 16 hours = 8 classes [4 speaking tests x 10 = 40 marks]

- Topics for 1 minute, 2 minutes, and 5 minutes speaking
- Pictures, Quotations, Attitude-testing Questions may be used.
- Summarizing/responding to handouts, articles, books, magazines and newspapers.

Individual/Group presentations/discussion on given topics

Soft skills development 14 hours = 7 classes [4 assignments x 10 = 40 marks]
Positive thinking (Teachers to engage game/activity-oriented classes)

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text/Reference Books:

1. Business and Corporate Soft skills developed by Rai Tech. University (PDF available)
2. Spoken English (with CD). Sasikumar V and P V Dhamija. New Delhi: Tata McGraw-Hill Education Pvt. Ltd. (2nd Ed.)

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1171	ENGINEERING DRAWING	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions
CEO2	To enable students to acquire requisite knowledge, techniques and attitude required for advanced study of engineering drawing

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Demonstrate the views of different solid object.
CO2	Construct projection of plane surface and solids.
CO3	Develop Sections of various Solids surface.
CO4	Identify the projection in isometric scale.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2			2										
CO2	1			3										
CO3	2			3										
CO4	1			2										
Avg.	1.5			2.5										

Unit 1

1. Introduction: Introduction to Standards for Engineering Drawing practice, Line work and Dimensioning. [1 – Sheets]
2. Co ordinate system and reference planes: Definitions of HP, VP, RPP & LPP. Selection of drawing size and scale. Representation of point and line. [1 – Sheets]

Unit 2

3. Orthographic Projections : Introduction, Definitions Planes of projection, reference line, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only),True and apparent lengths, True and apparent inclinations to reference planes. [1 – Sheets]
4. Orthographic Projections of Plane Surfaces (First Angle Projection Only): Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, hexagon and circle. [1 – Sheets]
5. Projections of Solids (First Angle Projection Only) : Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, cylinders and cones in different positions. [1 sheet]

Unit 3

6. Sections and Development of Lateral Surfaces of Solids : Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. [2 – Sheets]

Unit 4

7. Isometric Projection (Using Isometric Scale Only) : Introduction, Isometric scale, Isometric projection of tetrahedron, cones and spheres. [1 – Sheets]

Teaching Methods: Chalk& Board

TEXT BOOKS

1. Engineering Drawing N.D. Bhatt & V.M. Panchal, Charotar Publishing House, Gujarat.
2. Computer Aided Engineering Drawing S. Trymbaka Murthy, I.K. International Publishing House Pvt. Ltd., New Delhi
1. 3. Engineering Drawing by N. S. Parthasarathy and Vela Murali Oxford University Press.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1172	ENGINEERING WORKSHOP	0	0	2	1	

Pre Requisite:

Course Educational Objectives

CEO1	To enable students to work on different trades like Fitting, Carpentry, Black smithy etc… which makes the students to learn how various joints are made using wood and other metal pieces
CEO2	To familiarize with the basic manufacturing processes and to study the various tools and equipment used, hands on training is given in different sections

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Explain various safety precaution and use of various hand tools
CO2	Demonstrate the process configuration and basic mechanism of different machines like Lathe, Shaper and Milling machine.
CO3	Identify and apply suitable tools for machining processes including turning, thread cutting, facing, knurling and drilling.
CO4	Practice on manufacturing of components using workshop trades including fitting and welding

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1			1										
CO2	2			2										
CO3	1			3										
CO4	1			3										
Avg.	1.25			2.25										

Unit 1

1. Safety Precaution: To study the various Safety precautions in workshop.
2. Fitting :

(i) Study of different hand tools and Machine tools used in fitting.
(ii) Preparation of a male and female fitting job by using different hand tools.

Unit 2

3. Machining:

(i) Study of various components and working principle of lathe machine
(ii) Preparation of a cylindrical job by lathe (turning, Thread cutting, knurling)
(iii) Study on Shaper and Milling Machine

Unit 3

4. Welding Practice :

(i) Hand on practice on Electric Arc Welding to prepare Lap Joint, Butt Joint, T Joint and Corner Joint .
(ii) Study of Oxyacetylene Gas welding and Gas cutting.

Teaching Methods: Chalk & Board, Hands on practice.

Reference Books:

1. Elements of Workshop Technology, Vol. I and II by Hajra choudhary, Khanna Publishers
2. Workshop Technology by WAJ Chapman, Viva Books
3. Workshop Manual by Kannaiah / Narayana, Scitech Publicaitons(P) Ltd.

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	BS	BBSBS2010	Engineering Mathematics-II	3	1	0	4
2	BS	BBSBS1021	Engineering Physics	3	0	0	3
		BBSBS1022	Engineering Chemistry				
3	ES	BBSES1031	Basics of Mechanics	3	0	0	3
		BBSES1032	Basics of Thermodynamics				
4	ES	BBSES1041	Basics of Electronics	3	0	0	3
		BBSES1042	Basics of Electrical Engineering				
5	ES	BBSES2050	Data Structure using 'C++'	3	0	0	3
6	HS	BBSHS2060	Communicative English-II	2	0	0	2
PRACTICAL / SESSIONAL							
7	BS	BBSBS1121	Engineering Physics Laboratory	0	0	2	1
		BBSBS1122	Engineering Chemistry Laboratory				
8	ES	BBSES1141	Basics of Electronics Laboratory	0	0	2	1
		BBSES1142	Basics of Electrical Engineering Laboratory				
9	ES	BBSES2150	Data Structures using 'C++' Laboratory	0	0	2	1
10	HS	BBSHS2160	Communicative English-II Laboratory	0	0	2	1
11	ES	BBSES1171	Engineering Drawing	0	0	2	1
		BBSES1172	Engineering Workshop				
12	MC	BBSHS2180	YOGA	-	-	-	0
TOTAL				**17**	**1**	**10**	**23**

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSBS 2010	ENGINEERING MATHEMATICS-II	3	1	0	4	A

Pre -Requisite:

Course Educational Objectives

CEO1	To focus on partial derivative and its methods.
CEO2	To make them understand about laplace and fourier transform.
CEO3	To calculate the gradients and directional derivatives of functions of several variables
CEO4	To introduce the concept of Vector differentiation and integration that finds applications in various fields like solid mechanics, fluid flow, heat problems and potential theory

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	To know how to solve the partial differential equation by suitable method.
CO2	To Solve Ordinary differential and integral equation by using Laplace transform, Execute the technique of Fourier Integral and transform for learning in advanced Engineering Mathematics.
CO3	To relate gradient, curl and divergence and its application in fluid dynamics.
CO4	To evaluate multiple integrals by using Green's, Stokes' and divergence theorem to give physical interpretation of the curl and divergence of a vector field .

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3				2		1					1		
CO2	3	3			1									
CO3	2				1									
CO4	2				2							1		
Avg.	2.5	0.75			1.5		0.25					0.5		

SYLLABUS

UNIT - I **(07 Hours)**

INTRODUCTION OF PARTIAL DIFFERENTIAL EQUATIONS:

Formation of Partial differential equations, Linear partial differential equation of first order: Lagrange's linear differential equation, Non-Linear partial differential equation of first order by Charpit's method.

UNIT-II **(20 Hours)**

Laplace Transforms: Definition, existence of Laplace Transforms, Properties of Laplace Transforms, Evaluation of integrals by Laplace Transforms, Inverse transforms, convolution theorem, transforms of unit step function, unit impulse function, periodic function. Simple application to ordinary differential equations by Laplace Transform method, Definition of Fourier Integral and Fourier transform

UNIT - III **(10 Hours)**

Vector differential calculus: vector and scalar functions and fields, Derivatives, Curves, tangents and arc Length, gradient, divergence, curl and their simple application

UNIT – IV **(13 Hours)**

Vector integral calculus: Definition and evaluation of double integration and triple integration, Evaluation of line integral, Surface integral and volume integral and their applications, Transformations theorems- Green's Theorem in plane , Stoke's Theorem,Gauss Divergence Theorem and their applications.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Prescribed Books

1. Advanced Engineering Mathematics by E. Kreyszig, John Willey & Sons Inc. 10th Edition

References:

1. Higher Engineering Mathematics by B. V. Ramana , Mc Graw Hill Education.
2. Higher Engineering Mathematics by BS Grewal : Khanna Publishers, New Delhi.
3. Advanced Engineering mathematics by H. K. Dass.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSBS1021	ENGINEERING PHYSICS	3	0	0	3	A

Pre –Requisite: Knowledge in +2 Physics and Mathematics

Course Educational Objectives

CEO1	Providing fundamental knowledge about the oscillations and waves
CEO2	To familiar with structure and properties of materials.
CEO3	Providing knowledge of mathematical concepts to solve electromagnetic problems and fundamental information about Quantum mechanics with applications.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand and analyze the concept of oscillation and wave mechanics.
CO2	Describe the principle of lasing and optoelectronics devices in communication system.
CO3	Explain the ideas of crystal structure, crystal diffraction and classification of materials.
CO4	Interpret the fundamentals of electromagnetism and deduce the electromagnetic wave equations.
CO5	Express the basics of quantum mechanics and illustrate the quantum mechanical problems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		3	2											
CO2					3		1							
CO3		3			1									
CO4	3		2											
Avg.	0.75	1.5	1		1		0.25							

SYLLABUS

UNIT:01 **(12 Hours)**

Interaction of Wave and Matter

Simple Harmonic Oscillator, Damped harmonic oscillator and Forced harmonic oscillator, and coupled oscillator, Waves and its Characteristics, Superposition of Waves, Interference by division of wave front (Bi-prism experiment) and division of amplitude (Newton's Ring experiment). Introduction to Diffraction, types of diffraction.

LASER, spontaneous & stimulated emission, Einstein's relation, Ruby Laser and He-Ne Laser, Semiconductor laser, application of Laser. Optical fiber, Acceptance angle, Numerical aperture, Skip distance, Step index and Graded index fibers, Attenuations in optical fibers, applications of optical fiber in communication systems.

UNIT:02 **(12 Hours)**

Physics of Materials Introductions to materials, Crystallography, Crystal structure, crystal direction and plane, Miller indices, Inter planar spacings, Reciprocal Lattice and its characteristics, Reciprocal Lattice of SC, FCC and BCC, Brillouin Zone, Bragg's law. Energy bands in solids (conduction band, valence band and Fermi level), Classification of materials on the basis of band theory. Magnetic properties of Materials & their applications. Nano materials and applications (particulates, thin films, nano structures, etc.)

UNIT:03 **(10 Hour)**

Electromagnetic theory and wave Review of grad, divergence and curl, Gauss divergence theorem and Stoke's theorem (no derivations), fundamental laws of electrostatics, magneto-statics and electromagnetism, displacement current and conduction current, Maxwell's equations. Electromagnetic wave and its characteristics, electromagnetic wave equation for free space and in charge free conducting medium, electromagnetic energy, Poynting vector and Poynting theorem.

UNIT:04 **(12 Hours)**

Quantum Mechanics Introduction to dual nature: Black body radiation, photoelectric effect, Compton effect (qualitative idea only), de-Broglie's hypothesis, Heisenberg's uncertainty principle and its application to non-existence of electron inside the nucleus and ground state energy of one dimensional harmonic oscillator, Basic postulates of Quantum Mechanics, Wave function and its characteristics, probability density , normalization, eigen values, eigen functions and expectation values, Schrödinger's equation (time dependent and time independent). Application of Schrödinger equation to one dimensional potential well, potential step and potential barrier (qualitative ideas).

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Engineering Physics by D. K. Bhattacharya and Poonam Tanden, Oxford University Press.
2. Engineering Physics, H K Malik and A K Singh, Tata McGraw Hill, MGH.

Reference Books:

1. Materials Science & Engg., V. Raghvan, Prentice Hall of India.
2. Concepts of Modern Physics, A. Beiser, S. Mahajan, S.R. Choudhary, Tata McGraw Hill.
3. Lasers & Optical engineering, P Dass, Narosa Publishers, Springer Publisher.
4. Engineering Physics by B. B. Swain and P. K. Jena, Kitab Mahal,Cuttack
5. Quantum Mechanics by SatyaPrakash, Kitab Mohal, etc. Kedar Nath Ram Nath Publisher

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSBS1022	ENGINEERING CHEMISTRY	3	0	0	3	A

Pre –Requisite: Chemistry

Course Educational Objectives

CEO1	To impart the knowledge of application of chemical sciences in the field of engineering
CEO2	To focus on microscopic chemistry in terms of atomic and molecular levels.
CEO3	The course aims at elucidating principles of applied chemistry in water treatment.
CEO4	To give detailed account about the reactivity of metals w.r.t prevention of corrosion.
CEO5	To enlighten the students with the applications of polymers.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Analyze microscopic chemistry in terms of atomic and molecular orbital and Explain the ranges of the electromagnetic spectrum by electronic transition
CO2	Identify water treatment techniques for domestic and industrial purposes
CO3	Compare types of corrosion, and it's control measures.
CO4	Understand various types of polymers, their preparation along with applications

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2		2	3							
CO2	3	3	1	2		2	3							
CO3	3	3	2	1		2	3							
CO4	3	3	2	1		2	3							
Avg.	3	2.75	1.75	1.5		2	3							

SYLLABUS

UNIT-1 ATOMIC AND MOLECULAR STRUCTURE (13 Hours)

Schrodinger's wave equation(no derivation), Significance of wave functions, Particle in a box, Application for conjugated molecule, Molecular Orbital theory and Energy level diagram for Diatomic molecules, Spectroscopic techniques and applications: Electronics spectroscopy, Vibrational and rotational spectroscopy of diatomic molecules.

UNIT-2 WATER CHEMISTRY (13 Hours)

Types of Hardness, Determination of Hardness by EDTA method, Treatment of water for Domestic use, Water softening processes Lime-soda process, Ion Exchange method, Boiler feed water, Scale and Sludge, Caustic embrittlement, Carbonate and phosphate conditioning, Colloidal conditioning, Calgon conditioning.

UNIT-3 CORROSION (10Hours)

Thermodynamic functions: Entropy, Free energy, Relation between E.M.F and free energy, The Nernst's equation and application, Definition of corrosion, Types of corrosion: Dry corrosion and wet corrosion, Galvanic corrosion, Concentration cell corrosion, Factors influencing corrosion, Corrosion control: Cathodic protection (Sacrificial anodic protection and Impressed current cathodic protection), Inhibitors, Protective coatings: Galvanization and Tinning.

UNIT -4 POLYMER CHEMISTRY (12 Hours)

Introduction, polymer, Classification of polymers, Plastics: Thermosetting and thermo plastic, PVC, PE, PS, PMMA, PTFE, Bakelite,Nylon-6,6,Nylon-6, Fiber reinforced plastic.

*ADD-ON COURSES: Conducting Polymer (Polyaniline, Polyacetylene), Bio-Degradable and Non-Bio Degradable polymer, Nano composite.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books: 1.Engineering chemistry by Jain & Jain, Dhanpat Rai publishing company (p) Ltd

Reference Books:

1. A Text Book of Engineering Chemistry by S.S.Dara, S Chand Publishers.
2. A Text Book of Engineering Chemistry by SashiChawla, Dhanpat Rai Publishing house.
3. Text Book of Engineering Chemistry, 2nd edition, by R.Gopalan, D.Venkapaya & Sulochana Nagarajan, Vikas Publishing House Pvt. Ltd.
4. B. Tech Chemistry- I and II by P. K. Kar, S. Dash, B. Mishra kalyani publishers.
5. Physical Chemistry By P.W Atkins
6. Engineering Chemistry(NPTEL Web Book) by B . L Tembe, Kamaluddin and M.S. Krishna
7. Fundamentals of Molecular spectroscopy By C . N Banwell
8. University chemistry by B.H. Mahan

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1031	BASICS OF MECHANICS	3	0	0	3	A

Pre –Requisite: Physics, Mathematics

Course Educational Objectives

CEO1	To apply the established engineering method to complex engineering problem.
CEO2	To understand the vectorial and scalar representation of forces and moments.
CEO3	To evaluate the different forces exhibit in truss member.
CEO4	To obtain the knowledge on kinematics and kinetics of particle to analyze simple and practical problems

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Determine the resultant force and moment for given force system.
CO2	Evaluate the forces in members of trusses, frames and problems related to friction.
CO3	Analyze the properties of surface in relation to centroid and moment of inertia
CO4	Adapt the laws of motion, kinematics of motion and their interrelationship

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	2	3												
CO3	3	3												
CO4	2	3												
Avg.	2.5	2.75												

SYLLABUS

UNIT:1 **[16 Hours]**

STATICS OF PARTICLES

Fundamental concepts and principles of engineering mechanics. Resolution of forces Resultant of several concurrent forces Free body diagram. Principles of transmissibility. Moment of a force Varignon's theorem Equivalent system of forces Types of supports and corresponding reactions.

UNIT:2 **[12 Hours]**

ANALYSIS OF TRUSSES AND FRICTION

Introduction to Truss Analysis of Trusses Method of joints, Method of sections.
Laws of Friction Angle of Friction Angle of Repose Ladder and Wedge Friction

UNIT:3 **[12 Hours]**

PROPERTIES OF SURFACES

Determination of first moment area of plane figures by integration – Determination of centroid of composite figures by using standard formula.
Determination of second moment area of plane figures by integration Parallel and perpendicular axis theorems
Determination of area moment of inertia of composite figures by using standard formula Polar moment of inertia Radius of gyration.

UNIT:4 **[10 Hours]**

DYNAMICS OF PARTICLES

Rectilinear motion: uniform velocity and uniformly accelerated motion Newton second law D'Alembert's principle and its applications work and energy equation Impulse and Momentum Impact of elastic bodies.

Teaching Methods: Chalk& Board/ PPT/ Guest Lecture

Text Books:

1. Timoshenko, and Young, "Engineering Mechanics", Tata Mc Graw Hill Book
2. S. S. Bhavikatti, "Engineering Mechanics", New Age International

Ref. Books:

1. Dr. Bansal.R.K, & Sanjay Bansal, "A Text book of Engineering Mechanics", Lakshmi publications.
2. A.K.Tayal, "Engineering Mechanics Statics And Dynamics", Umesh Publications
3. Rajasekaran.S, & Sankarasubramanian.G, "Engineering Mechanics", Vikas Publishing House Pvt Ltd, 2011

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1032	BASICS OF THERMODYNAMICS	3	0	0	3	A

Pre –Requisite: Physics, Chemistry and Mathematics

Course Educational Objectives

CEO1	Learn to classify the fundamentals of thermodynamics like pressure, temperature etc.
CEO2	Apply principle and law of thermodynamics to analysis of different systems
CEO3	Become aware of relevance of environmental and social issues on the analysis process of systems.
CEO4	To understand the basics of properties of pure substance like steam and its conditions and Application of Thermodynamics in engineering practices

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Explain the basic concepts of system, control volume, thermodynamic properties, thermodynamic equilibrium, temperature, work and heat energy.
CO2	Apply the laws of thermodynamics to refrigerators, heat engines, heat pumps compressors and nozzles etc.
CO3	Interpret and apply the concept of entropy to thermodynamic systems
CO4	Evaluate properties of pure substances, gases and their mixtures and to derive and apply to thermodynamic problems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	2	3												
CO3	2	3												
CO4	3	3												
Avg.	2.5	2.75												

SYLLABUS

UNIT 1 **(15 Hours)**

Basic concepts & definition, scope of thermodynamics. Macroscopic & microscopic approach. Definition of fixed mass (closed) system & control volume (open) system, isolated system. Thermodynamic properties (extensive & intensive), state & its representation on a property diagram, process and its representation, cyclic process Characteristics of properties (point & path function), reversible & irreversible process, Quasistatic Process. Thermodynamic equilibrium. Pressure, Types of pressure, Zeroth law of thermodynamics & temperature scales, calibration of thermometers. Ideal gasses & their P V T relation. Energy transfer; Work transfer(definition & calculation), different modes of work Displacement work for various process, Free expansion work, Heat transfer; modes of heat transfer, basic laws in conduction, convection & radiation.

UNIT 2 **(13 Hours)**

First law of thermodynamics, formal statement (using cyclic process) first law for processes of fixed masses (closed system) Introduction of internal energy, enthalpy as thermodynamic properties Definition of sp.heats (C_p & C_v) and their use in calculation of internal energy & enthalpy with emphasis on ideal gas. Application of first law to control volume (Steady Flow); nozzle, diffuser, compressor, turbine, throttling device.

UNIT 3 **(12 Hours)**

Second law of thermodynamics, Kelvin Planck & Clausius statements, Carnot cycle. Reversible & irreversible engines and their efficiency (Thermal and maximum Efficiency)

Entropy concepts, Clausius inequality, Entropy Principle.

UNIT 4 **(10 Hours)**

Properties of pure substance, P v, T s, h s diagram for steam , Steam properties, Introduction to steam table with respect to specific volume, pressure, temperature, enthalpy & entropy, Mollier Diagram. Application of thermodynamics: Steam power plant, Refrigerators and Heat Pump, I C Engines (working principle with schematic diagrams only)

Teaching Methods: Chalk& Board/ PPT

Text Books:

1 Engineering Thermodynamics by P.K.Nag, Publisher: TMH
2 Basic Engineering Thermodynamics by D S Kumar, Publisher: S K Kataria & Sons New Delhi.

Ref. Books:

1. Fundamental of Engineering Thermodynamics by E. Rathakrishnan, publisher. PHI
2. Thermodynamics: An Engineering Approach by Yunus A. Cengel, Michael A. Boles Publisher: Mcgraw Hill Education
3. Thermal engineering by R.K.Rajput, Laxmi Publications Pvt. Ltd.
4. Steam Tables in SI Units by K. Ramalingam, Scitech Publications (P) Ltd.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1041	BASICS OF ELECTRONICS	3	0	0	3	A

Pre-requisites (if any):

Course Educational Objectives

CEO1	Identify the basic tools and test equipment used to construct, troubleshoot, and maintain standard electronic circuits and systems.
CEO2	Explain the construction and application of standard circuit configurations and identify the component types and connections used to build functioning electronic circuits.
CEO3	Design simple combinational and sequential logic circuits
CEO4	Identify functions of digital multimeter, cathode ray oscilloscope and transducers in the measurement of physical variables

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Recognize different components such as transistors, resistors, capacitors and diodes which fit on a small chip with each leg of the chip connecting to a point within the circuit.
CO2	Apply modern modelling software for drafting different electronic circuits.
CO3	Analyze modern electronic circuits and systems.
CO4	Formulate mathematical descriptions and procedures in designing new electronic systems and technically present

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1			2		2							
CO2	1			2	3	1		1						
CO3														
CO4		2		3							1			
Avg.	0.25	0.75		1.25	1.25	0.25	0.5	0.25			0.25			

SYLLABUS

UNIT-1

Semiconductor Devices:- Classification of material, Energy band diagram, properties of semiconductors, Types of semiconductors, Semiconductor diode (no bias, forward, reverse),temperature effects, diode equivalent circuit, zener diode, LED , Half wave rectifier, full wave rectifier, clippers ,clampers.

UNIT-2

Bipolar Junction Transistors (BJTs):- Introduction, transistor operation, Simplified structure and physical operation of n-p-n and p-n-p transistors in the active region, Common–Base configuration, Common–emitter configuration, Common-collector configuration Current-voltage characteristics of BJT, BJT as an amplifier and as a switch.

Field Effect Transistors (FETs):- Introduction, construction and characteristics of JFETs, transfer characteristics, D-MOSFET, E –MOSFET.

UNIT-3

Communication Systems: -Analog and digital signals, block diagram of basic communication system, need for modulation, methods of modulation,AM/FM transmitters & receivers (Block diagram description only)

Electronic Instruments:- Basic principle of Oscilloscope, Function of the sweep generator, Block diagrams of oscilloscope, Measurement of frequency and phase by Lissajous method, Application of oscilloscope for measurement of voltage, period and frequency, Block diagram of standard signal generator, AF sine and square wave generator, and Function generator.

UNIT-4

Digital Systems and Binary Numbers:-Digital systems, Binary numbers, number system conversion, octal &hexa decimal number, 1's& 2's compliments, signed binary numbers, binary codes, binary logic.

Logic Gates and Boolean Algebra:- The inverter, The AND, OR, NAND NOR, Exclusive-OR and Exclusive-NOR gate, Boolean operations and expressions, Laws and Rules of Boolean algebra, DeMorgan's theorem, Boolean analysis of logic circuits, Standard forms of Boolean expressions, Boolean expression and truth table Combinational Logic and Their Functions: Basic combinational logic circuits, Implementation of combinational logic, The universal properties of NAND and NOR gates, Basic adders

Teaching Methods: Chalk& Board/ PPT/Video Lectures
Text Books: 1. Electronic Devices (Seventh Edition), Thomas L. Floyd, Pearson Education, 482 FIE, Patparganj, Delhi – 110 092 (Selected Portions). 2. Digital Fundamentals (Eighth Edition), Thomas L. Floyd and R.P. Jain, Pearson Education, 482 FIE, Patparganj, Delhi – 110 092. 3. Electronic Instrumentation, H.S. Kalsi, Tata McGraw-Hill Publishing Company Limited, New Delhi.
Reference Books: 1. Microelectronic Circuits (Fifth Edition), Adel S. Sedra and Kenneth C. Smith, Oxford University Press, YMCA Library Building Jai Singh Road, New Delhi – 110 001. 2. Electronic Devices and Circuit Theory (Ninth Edition), Robert L. Boylestad and Louis Nashelsky, Pearson Education, 482 FIE, Patparganj, Delhi – 110 092. 3. Electronics Principles (7th Edition), Albert Malvono and David J. Bates, Tata McGraw-Hill Publishing Company Limited, New Delhi.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1042	BASICS OF ELECTRICAL ENGINEERING	3	0	0	3	A

Pre -Requisite: Physics and Mathematics

Course Educational Objectives

CEO1	Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
CEO2	This course provides comprehensive idea about DC & AC circuit analysis, magnetic circuit analysis, working principles of machines and common measuring instruments.
CEO3	Emphasize the effects of electric shock and precautionary measures. Improve the ability to function on multi-disciplinary teams.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the basic concepts of magnetic, AC & DC circuits.
CO2	Explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
CO3	Gain knowledge about the fundamentals concepts of power generation, domestic wiring, electric shock and preventive measures
CO4	Understand Electrical power generation and transimission process in India and function on multi-disciplinary teams.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1	2											
CO2		2	2											
CO3		1	2											
CO4		2	2											
Avg.		1.5	2											

SYLLABUS

UNIT-1 **(15 Hours)**

DC Circuits:

Introduction to electrical terminology, Ohm's Law, Equivalent Resistance, series-parallel circuits, star-delta transformation, types of elements, ideal and practical voltage & current sources; Kirchhoff's Law, Mesh and Nodal Analysis.

Network theorems:

Superposition Theorem, Thevenin theorem, Maximum power transfer theorem excited by independent sources, Transients in RL & RC series circuits.

UNIT-2 **(13 Hours)**

Single phase & Three phase Ac circuits:

AC Fundamentals: RMS & Average value, form and peak factors, Complex algebra, concepts of reactance, impedance and their representation, AC through pure R, L, C, series RL, series RC, series RLC circuit, Concept of power & power factor; expression of power in complex notation.

Three-phase AC circuits:

Comparison between 1-ph & 3-ph AC circuit, Star & Delta connection, relation between line and phase quantities, Measurement of 3-phase power using 2-wattmeter method.

Magnetic circuits:

Magnetic flux, Magnetic flux density, Magnetic fields intensity, Relation between B & H, B-H curve, Analogy between Electric and Magnetic circuit, Leakage flux.

UNIT-3 **(12 Hours)**

DC Machines:

Introduction, working principle of DC Generator, Construction, Types, EMF equation, working principle of DC Motor Back e.m.f, Application of DC machines.

AC Machines:

Introduction, Principle of operation of AC machines, Transformers, Construction, EMF equation, Turn ratio, Ideal transformer on no load with phasor diagram, 3-phase Induction motor principle of operation, Rotating magnetic field, Types of rotors, Synchronous speed and slip, Introduction to 1-phase Induction motor, 1-phase motors types, appli cations of 3-phase and 1-phase motors, AC generator and motors, Principle of operation, types of rotors, Synchronous motor operating principle.

UNIT-4 **(10 Hours)**

Measuring Instruments:

Introduction, Classification of instruments, construction and working principles of PMMC and moving iron type Instruments.

Introduction to Power System &Domestic Wiring:

General layout of electrical power system and functions of its elements, Generation of electricity (Hydro, Thermal and Nuclear power plant), standard transmission and distribution voltages, Service main, Meter board, Fuse, MCB, Earthing (pipe & plate earthing), House wiring, Electric shock & precautions.
Teaching Methods: Chalk& Board/ PPT
Text Books: 1. V. Del Toro, "Principles of Electrical Engineering" Prentice Hall International. 2. P.V. Prasad, S.Sivanagaraju, R.PrasadBasic Electrical and Electronics Engineering; CENGAGE Learning. 3. I.J. Nagarath, " Basic Electrical Engineering" Tata McGraw Hill 4. D.E. Fitzgerald & A. Grabel Higginbotham, " Basic Electrical Engineering Mc- Graw Hill.
Reference Books: 1. Edward Hughes, " Electrical Technology" Longman 2. T.K. Nagsarkar & M.S. Sukhija, "Basic Electrical Engineering" Oxford University Press. 3. H. Cotton, " Advanced Electrical Technology" Wheeler Publishing 4. W.H. Hayt & J.E. Kennely, "Engineering Circuit Analysis" Mc Graw Hill. 5. Theory and Problems of Basic Electrical Engineering by D.P.Kothari & I.J. Nagrath PHI. 6. Fundamentals of Electrical Engineering and Electronics by B. L. Theraja, S. Chand & Company Ltd, Reprint Edition 2013.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES 2050	DATA STRUCTURES USING 'C++'	3	0	0	3	A

Pre –Requisite:

Course Educational Objectives

CEO1	Understand the object oriented concepts and to develop C++ programs for performing different operations on arrays, stack, Queue, linked list. Analyze the difference between them and understand different applications.
CEO2	Understand different searching and sorting methods and compare them in terms of performance and applications.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Develop algorithms for performing different operations on 1D array, matrix, stack, Queue, analyze the difference between them and understand different applications.
CO2	Understand different searching and sorting methods, Linked lists and them compare them in terms of performance and applications.
CO3	Understand the Binary Tree and its memory representation; analyze Binary search Tree and its applications, compare the BST with AVL Tree and examine the advantages.
CO4	Design Heap Tree, observe its applications in sorting. Understand the memory representation of graph; analyze traversal methods and applications of graph. Analyze the Hashing techniques in compare with other sorting techniques.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	3											
CO2	3	2												
CO3	3	3												
CO4	3	3	3											
Avg.	2.75	2.5	1.5											

SYLLABUS

Unit I **[12 hours]**

Basic concepts: Data abstraction, Algorithm specification, Memory Representation of 1D and 2D Array. Stack: Introduction to stack, basic operations and implementation of stack using arrays

Queue: Introduction to linear queue, basic operations and implementation of linear queue using arrays, circular queue, basic circular queue operations& Representation of Double ended Queue.

Applications on stack – Recursion, infix to postfix conversion, Evaluation of postfix

Unit II **[12 hours]**

Searching: Linear search and Binary search using linear array

Sorting: Bubble sort, Insertion sort, Selection sort, Quick sort, Bucket Sort using linear array.

Linked Lists: Basic operations of singly, doubly and circular linked lists, implementation of stack and queue using singly linked list.

Unit III **[12 hours]**

Trees: Introduction, Terminology, Binary Trees, Representation of Binary Trees using arrays and linked lists, Binary tree traversals, Creation of binary tree from in-order & pre-order sequences - Creation of binary tree from in-order & post-order

Binary Search Trees: definition, basic operations of BST (Searching, Insertion and deletion)

Introduction to AVL trees, Height of an AVL Tree, Balancing AVL tree by rotations after insertions and deletions of a data node.

Unit IV **[12 hours]**

Heaps: Introduction to binary heaps, definition of a Max-heap, Min-heap, creating Max-Heap, Applications: Heap sort, Priority queue.

Graphs: Definitions, Graph representation - Adjacency matrix, Incidence Matrix, adjacency lists, Graph Traversals (BFS & DFS), Single source shortest path algorithm (Dijkstra's Algorithm) Topological Sorting.

Hashing: Hashing Functions, Open hashing (chaining), closed hashing (Open addressing – linear probing, quadratic probing, double hashing), rehashing.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Gilberg and Forouzan: "Data Structure- A Pseudo code approach with C" by Thomson Publication.
2. "Data structure in C" by Tanenbaum, PHI publication / Pearson publication.
3. Pai: "Data Structures & Algorithms; Concepts, Techniques & Algorithms "Tata McGraw Hill.

Reference Books:

1. "Fundamentals of data structure in C" Horowitz, Sahani & Freed, Computer Science Press.

2. "Fundamental of Data Structure" (Schaums Series) Tata-McGraw-Hill.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSHS 2060	COMMUNICATIVE ENGLISH AND TECHNICAL COMMUNICATION	2	0	0	2	A

Pre –Requisite:

Course Educational Objectives

CEO1	To develop the communication skills and soft skills of the students
CEO2	To enhance the ability of the students to develop employability and entrepreneurial skills
CEO3	To enable students to successfully participate in GDs and PIs
CEO4	To make students communicate effectively using technologies and techniques
CEO5	To inculcate a sense of professionalism in students

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the nature and scope of corporate communication and try to be industry ready
CO2	Able to use language skills for professional growth
CO3	Distinguish fact from opinion in reading passages from different text books
CO4	Create professional documents like Resume, Job Application letter for their career needs

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								2	2	3				
CO2										3	2			
CO3						1				3				
CO4										3	1			
Avg.						0.25		0.5	0.5	3	0.75			

SYLLABUS

UNIT-1 Introduction to Technical Communication **[7 hours]**

1.1 Essence of Technical Communication 1

1.2 Nature and Scope of Technical Communication: 1 +1 +1

Technical Communication -- Interactive and Adaptable; Technical Communication -- Reader Centered; Technical Communication and teamwork; Technical Communication Has Ethical, Legal, and Political Dimensions; Technical Communication – its International and Cross-Cultural nature; Technical communication and use of ICT.

1.3 Need of Technical communication for career development 1

1.4 Computer Assisted Language Learning (CALL) – Self learning through use of technology, Effectiveness of CALL for developing English Language Skills; Use of Internet 1 +1

UNIT - 2 Career Communication **[17 hours]**

2.1. Career making: Setting Goals, SWOT analysis 1

2.3 Preparing a Résumé: Elements of a Résumé; Types of Résumés: Chronological Résumé, Functional Résumé; Use of job portals 1 +1 +1

2.4 Effective Job Application Letter/Cover letter 1 +1

2.5 Group Discussion 1 +1

2.6 Job Interview 1 +1 +1+1 +1

2.7 Effective Oral Presentation 1+1

2.7 Handling a Meeting 1+1

UNIT-3 Technical Approach to Reading **[8 Hours]**

3.1 Know your Reading speed; Advantages of speed reading 1

3.2 SQ4R Techniques of Reading 1+1

3.3. Techniques of Rapid reading: skimming, scanning 1+1

3.4 Understanding coherence and cohesion 1

3.5 Note taking, Mind maps 1+1

UNIT-4 Technical Writing **[14 hours]**

4.1 Writing a technical paper 1+1

4.2 Writing business letters – significance, purpose, structure and elements, layout; types of business letters 1+1+1+1

4.3 Memos 1+1

4.4 Business Reports and Technical proposals 1+1+1+1

4.5 Using the Social media for better communication 1+1

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Business Communication Today by Bovee, Courtland L., Thill, John V. Prentice Hall.

2. Technical Communication Today by Richard Johnson-Sheehan. Edition 5. Pearson.

3. Communicative English for Engineers and Professionals by Nitin Bhatnagar and Mamta Bhatnagar. Published by DK/Pearson.

Reference Books

1. Basic Communication Skills for Technology by Andre J. Rutherford, Pearson Education Asia, Patparganj, New Delhi.
2. Business Communication by Varinder Kumar and Bodh Raj. Kalyani Publishers.
3. A Textbook of English Phonetics for Indian Students by T. Balasubramanian
4. Technical Communication, Principle and Practice by Meenakshi Raman & Sangeeta Sharma, Oxford University Press.
5. How to Read better and Faster by Norman Lewis. 4th Edition. Publisher: Crowell.

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSBS1121	ENGINEERING PHYSICS LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	Students will understand the basic principles of physics and their mathematical description.
CEO2	Students will be able to use the laws of physics and calculus to solve problems
CEO3	Students will be able to work together in collaborative groups to perform experiments, gather data and reach conclusions.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the uses of various Basic Instruments for different Physical measurements.
CO2	Apply the Physical Laws and verify those using standard Experiments.
CO3	Organize experiments to determine different Physical quantities and anlyze those for different application to Physical Systems.
CO4	Evaluate the magnitudes of Physical quantities systematically through experiments and design new experiments with the theoretical knowledge

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2		2					1	2			
CO2	3	3	3		3	3	1			2				
CO3		3	2	3	3					2				
CO4	3	3	3	3	3				2	3	3			
Avg.	2.25	3	2.5	1.5	2.75	0.75	0.25		0.5	2	1.25			

SYLLABUS

List of Experiments:

1. Study of frequency of an electric tuning fork by meld's experiment.
2. Study of the acceleration due to gravity by using Bar/Kater's pendulum.
3. Study of the law of transverse vibration by using sonometer.
4. Study of wavelength of light by Newton's Rings apparatus.
5. Study of wavelength of light by Fresenel's bi-prism/Michelson inter ferometer.
6. Study of grating element of a plane diffraction grating.
7. Study of double slit interface due to He-Ne laser.
8. Study of monochromaticity and divergence of the given laser beam
9. Study of reflection and total internal reflection by optical fibers
10. Study of Hall-coefficient of a semiconductor
11. Study of dielectric constant of given solid by Leacher wire method.
12. Study of the resistivity of a semiconductor with temperature by four- probe method.
13. Study of band gap energy of PN junction (Ge/Si) diode.
14. Study of plank's constant using photo-voltaic cell.
15. Study of B-H curve of ferromagnetic substance.
16. Study of magnetic susceptibility of sollds.

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSBS1122	ENGINEERING CHEMISTRY LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To train the students about the applications of chemical sciences in the field of engineering and technology

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand the basic methods of chemical analysis and instrumentations involved
CO2	Standardize of Chemicals
CO3	Estimate the hardness, ions in salts and compositions in ores.
CO4	Synthesizes the drugs and know about their applications

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		2		2			2		2		3			
CO2							3		3		2			
CO3		2		2			2		2		2			
CO4		2		2			2		2		2			
Avg.		1.5		1.5			2.25		2.25		2.25			

SYLLABUS

List of Experiments:

1. Determination of total hardness of water by using EDTA.
2. Determination of amount of NaOH and Na_2CO_3 present in mixture of two.
3. Standardization of $KMnO_4$ using sodium oxalate.
4. Determination of ferrous ion in Mohr's salt by standardized $KMnO_4$.
5. Determination of % of dissolved oxygen in given water sample.
6. Estimation of available chlorine in bleaching powder solution.
7. Determination of rate constant of acid catalyst Hydrolysis reaction.
8. Preparation of aspirin
9. Estimation of calcium in limestone.
10. Estimation of Zinc in brass.
11. To determine the strength of HCl and acetic acid from the mixture of acid by strong alkali (NaOH) by Conductrometry
12. Preparation of nanoparticle.
13. Determination of partition coefficient of iodine in benzene and water.
14. Preparation and determination of pH of buffer solution.
15. To determine the molecular weight of polymer by viscosity measurement.

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSES1141	BASICS OF ELECTRONICS LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To provide students engineering skills by way of breadboard circuit design with electronic devices and components.
CEO2	To design and analyze various Electronic circuits such as multivibrators, applications of operational amplifiers, RC coupled amplifiers, oscillators, digital circuits etc. so that students are able to understand the practical aspects of basic electronics theory.
CEO3	To enable the students to simulate and test the Analog, Digital and mixed Electronics circuits .

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Generate sine, square and triangular waveforms with required frequency & amplitude using function generator.
CO2	Demonstrate introductory knowledge of software for schematic capture, circuit simulation, and circuit board layout.
CO3	Analyze the characteristics of different electronic devices and circuits such as diodes, transistors, rectifiers, amplifiers etc.,
CO4	Plan new electronic systems and technically present them

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1	1											
CO2		2	2											
CO3		1	1											
CO4		2	2											
Avg.		1.5	1.25											

SYLLABUS

List of Experiments:

EXPERIMENTS: 1 Familiarization of electronic components and devices (Testing of semiconductor diodes and transistors using digital multi meter)

EXPERIMENTS: 2 Study and use of Oscilloscope, signal generator to view waveforms and measure amplitude and frequency of a given waveform.

EXPERIMENTS: 3 V-I characteristics of semiconductor diode

EXPERIMENTS: 4 Studies on half-wave and full-wave rectifier circuits without and with capacitor filter; recording of the waveforms and measurement of average and rms values of the rectifier output.

EXPERIMENTS: 5 Studies on clipper circuit.

EXPERIMENTS: 6 Studies on clamper circuit.

EXPERIMENTS: 7 V-I characteristic of an n-p-n or p-n-p transistor, DC biasing the transistor in common-emitter configuration and determination of its operating point (i.e., various voltages and currents).

EXPERIMENTS: 8 MOSFET I-V characteristics

EXPERIMENTS: 9 Studies on Logic gates (Truth table verification of various gates).

EXPERIMENTS: 10 Studies and experiments using ADDER CIRCUITS ICs

LAB CODE	NAME OF THE LAB	L	T	P	C	QP
BBSES1142	BASIC ELECTRICAL ENGINEERING LABORATORY	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To know the basic concepts on different types of circuits.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Illustrate the transformers and single phase motors constructional features
CO2	Analyse various electrical quantities with combination of loads
CO3	Examine the characteristics of AC and DC machines
CO4	Distinguish the methods of speed control of DC motors

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		1	2											
CO2		2	2											
CO3		1	2											
CO4		2	2											
Avg.		1.5	2											

SYLLABUS

List of Experiments:

1. Study of different electrical equipment's(transformer, single phase motors)
2. Power factor improvement using capacitor for fluorescent lamp.
3. Verification of Superposition and Thevenin's theorem
4. Measurement of reactive power by using single watt-meter method
5. 3phase Power measurement by using two wattmeter methods.
6. Calculation of current, voltage and power in series R-L-C circuit excited by single-phase AC supply and calculation of power factor.
7. Determination of open circuit characteristics (OCC) of DC shunt generator
8. Starting and speed control of a dc shunt motor by (a) field flux control method, and (b) armature voltage control method.
9. V-I characteristics of incandescent lamps and time-fusing current characteristics of a fuse.
10. Connection and testing of a single-phase energy meter.

SUBJECT CODE	COURSE TITLE	L	T	P	C	QP
BBSES2150	DATA STRUCTURES USING 'C++' LABORATORY	0	0	2	1	

Pre -Requisite:

Course Educational Objectives

CEO1	Develop algorithms for performing different operations on arrays, stack, Queue, linked list. Analyze the difference between them and understand different applications.
CEO2	Understand different searching and sorting methods and compare them in terms of performance and applications. Understand and analyze Binary search Tree, AVL Tree, Heap Tree and their applications.
CEO3	Understand the memory representation of graph, its traversal methods and applications. Analyze the Hashing techniques in compare with other sorting techniques.

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Understand and implement the object oriented concepts by in developing the programs for different operations.
CO2	Develop programs for performing different operations on 1D array, matrix, stack, Queue, analyze the difference between them and understand their applications.
CO3	Design code for different searching and sorting methods and analyze their performance.
CO4	Develop the codes for different operations on Linked lists and compare with other data structures.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	3	1	1									
CO2	2	3	3	3	2									
CO3	3	3	3	3	2									
CO4	2	2	3	3										
Avg.	2.25	2.5	3	2.5	1.25									

SYLLABUS

Lab1: introduction to OOPs (C++ features), cin, cout, object, class, Simple programs.

Lab2: Access Specifiers, inline, private, public, arrays of objects, programs on them. Lab3: Experiment No.1

1) Write a C++ program to create a class called student to store your rollno, name, age. Create an array of object to input 5 students data and then display where age>=20.

Write a C++ program to create a class having methods for operations insertion, deletion and display to perform operations on 1D array of elements.

Lab4: Experiment No.2

Write a C++ program to create a class having methods: insertion, multiply and display for performing multiplication on a matrix of elements.

Lab5: Experiment No.3

Write a program using C++ to create a stack using class and perform:
(i) push operation (ii) pop operation (iii) display operation

Lab6: Experiment No.4

Write a C++ program that uses Stack operations to converting an infix expression into equivalent postfix expression.

Lab7: Experiment No.5

Write a C++ program to create a linear queue and perform the following operations: (i) insertion ii) deletion and iii) Traversal

Lab8: Experiment No.6

Write C++ programs that use both recursive and non-recursive functions to perform the linear & binary search operation for a Key value in a given list of integers.

Lab9: Experiment No.7

Write a C++ menu driven program to implement bubble sort, selection sort and insertion sort for a given list of integers in increasing order

Lab10: Experiment No.8

Write a C++ program to implement quick sort to a given list of integers to sort in ascending order.

Lab11: Experiment No.9

Write a C++ program that uses functions to perform the following operations on linear linked list: i) Creation ii) Insertion iii) Deletion iv) Traversal

Lab12: Experiment No.10

Write a C++ program that uses functions to perform the following operations on Double linked list: i) Creation ii) Insertion iii) Deletion iv) Traversal.

SUBJECT CODE	NAME OF THE SUBJECT	L	T	P	C	QP
BBSHS 2160	COMMUNICATIVE ENGLISH AND TECHNICAL COMMUNICATION LABORATORY	0	0	2	1	

Course Educational Objectives

CEO1	To enable students to successfully participate in GDs and PIs.
CEO2	To make students communicate effectively by classroom practice.
CEO3	To inculcate a sense of professionalism in students.

Course Outcomes: ***The students will be able to:***

CO1	Prepare professional documents for career needs (e.g. Job application letter, résumé) and professional needs (e.g., Memo and E-mail writing)
CO2	Effectively participate in GD and PI.
CO3	Emerge as an effective presenter/public speaker
CO4	Understand the practical needs at workplace (e.g., organize a meeting)

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1										2				
CO2										2				
CO3										2				
CO4										2				
Avg.										2				

SYLLABUS

1. Writing an Effective Job Application Letter/Cover letter [4 hours]
2. Writing a winning resume and posting in job portals [4 hours]
3. Group Discussion [8 hours]
4. Job Interview [8 hours]
5. Oral presentation [6 hours]
6. Organizing a Meeting [4 hours]
7. Note making and Note taking [4 hours]
8. Memo writing [2 hours]
9. Profiling a company [4 hours]
10. Summarizing books/research paper/news report

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Form and Finesse, Business Communication and Soft skills by Shruti Das, Published by Orient Black Swan.
2. Business Communication Today by Bovee, Courtland L., Thill, John V. Prentice Hall.
3. Technical Communication Today by Richard Johnson-Sheehan. Edition 5. Pearson.
4. Communicative English for Engineers and Professionals by Nitin Bhatnagar and Mamta Bhatnagar. Published by DK/Pearson.

Reference Books:

1. Basic Communication Skills for Technology by Andre J. Rutherford, Pearson Education Asia, Patparganj, New Delhi.
2. Business Communication by Varinder Kumar and Bodh Raj. Kalyani Publishers.
3. A Textbook of English Phonetics for Indian Students by T. Balasubramanian
4. How to Read better and Faster by Norman Lewis. 4th Edition. Publisher: Crowell.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1171	ENGINEERING DRAWING	0	0	2	1	

Pre –Requisite:

Course Educational Objectives

CEO1	To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions
CEO2	To enable students to acquire requisite knowledge, techniques and attitude required for advanced study of engineering drawing

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Demonstrate the views of different solid object.
CO2	Construct projection of plane surface and solids.
CO3	Develop Sections of various Solids surface.
CO4	Identify the projection in isometric scale.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2			2										
CO2	1			3										
CO3	2			3										
CO4	1			2										
Avg.	1.5			2.5										

Unit 1

1. Introduction: Introduction to Standards for Engineering Drawing practice, Line work and Dimensioning. [1 – Sheets]
2. Co ordinate system and reference planes: Definitions of HP, VP, RPP & LPP. Selection of drawing size and scale. Representation of point and line. [1 – Sheets]

Unit 2

3. Orthographic Projections : Introduction, Definitions Planes of projection, reference line, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only),True and apparent lengths, True and apparent inclinations to reference planes. [1 – Sheets]
4. Orthographic Projections of Plane Surfaces (First Angle Projection Only): Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, hexagon and circle. [1 – Sheets]
5. Projections of Solids (First Angle Projection Only) : Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, cylinders and cones in different positions. [1 sheet]

Unit 3

6. Sections and Development of Lateral Surfaces of Solids : Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP [2 – Sheets]

Unit 4

7. Isometric Projection (Using Isometric Scale Only) : Introduction, Isometric scale, Isometric projection of tetrahedron, cones and spheres. [1 – Sheets]

Teaching Methods: Chalk& Board

TEXT BOOKS

1. Engineering Drawing N.D. Bhatt & V.M. Panchal, Charotar Publishing House, Gujarat.
2. Computer Aided Engineering Drawing S. Trymbaka Murthy, I.K. International Publishing House Pvt. Ltd., New Delhi
2. 3. Engineering Drawing by N. S. Parthasarathy and Vela Murali Oxford University Press.

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BBSES1172	ENGINEERING WORKSHOP	0	0	2	1	

Pre Requisite:

Course Educational Objectives

CEO1	To enable students to work on different trades like Fitting, Carpentry, Black smithy etc… which makes the students to learn how various joints are made using wood and other metal pieces
CEO2	To familiarize with the basic manufacturing processes and to study the various tools and equipment used, hands on training is given in different sections

Course Outcomes: ***Upon successful completion of this course, students should be able to:***

CO1	Explain various safety precaution and use of various hand tools
CO2	Demonstrate the process configuration and basic mechanism of different machines like Lathe, Shaper and Milling machine.
CO3	Identify and apply suitable tools for machining processes including turning, thread cutting, facing, knurling and drilling.
CO4	Practice on manufacturing of components using workshop trades including fitting and welding

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1			1										
CO2	2			2										
CO3	1			3										
CO4	1			3										
Avg.	1.25			2.25										

Unit 1

1. Safety Precaution: To study the various Safety precautions in workshop.
2. Fitting :

(i) Study of different hand tools and Machine tools used in fitting.

(ii) Preparation of a male and female fitting job by using different hand tools.

Unit 2

3. Machining:

(iii) Study of various components and working principle of lathe machine

(iv) Preparation of a cylindrical job by lathe (turning, Thread cutting, knurling)

(v) Study on Shaper and Milling Machine

Unit 3

4. Welding Practice :

(vi) Hand on practice on Electric Arc Welding to prepare Lap Joint, Butt Joint, T Joint and Corner Joint .

(vii) Study of Oxyacetylene Gas welding and Gas cutting.

Teaching Methods: Chalk & Board, Hands on practice.

Reference Books:

1. Elements of Workshop Technology, Vol. I and II by Hajra choudhary, Khanna Publishers
2. Workshop Technology by WAJ Chapman, Viva Books
3. Workshop Manual by Kannaiah / Narayana, Scitech Publicaitons(P) Ltd.

UG IN CHEMICAL ENGINEERING

III Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses		Mathematics-III	3	1	0	4
2	Engineering Science Courses		Object Oriented Programming	3	0	2	4
3	Professional Core Courses		Heat Transfer	3	0	2	4
4	Professional Core Courses		Fluid Mechanics	3	0	2	4
5	Professional Core Courses		Chemical Process Calculation	3	0	0	3
6	Humanities and Social Sciences including Management Courses		Organizational Behavior / Optimization In Engineering	2	0	0	2
7	Project		Summer Industry Internship	-	-	2	1
8	Mandatory Courses		Constitution of India / Essence of Indian Traditional Knowledge	-	-	-	0
			Total Credits:	**17**	**1**	**8**	**22**

Subject code	Course Title	L	T	P	C	QP
	MATHEMATICS-III	**3**	**1**	**0**	**4**	

Pre-Requisites (If any) –

CEO1: To test the nature of complex function

CEO2: To identify the different methods for complex integration

CEO3: To analyze error by using different methods.

CEO4: To know about different types of probability distributions.

Course Outcomes

CO1	To know Analytic function and their properties.
CO2	To Evaluate Real Integrals by using residue integration method.
CO3	To apply numerical methods in Engineering Mathematical Problems
CO4	To investigate Probability distribution problems and least square method to fit a curve and to evaluate the correlation coefficient and regression lines for the data.

Mapping of course outcomes with programme outcomes

COURSE OUT COMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2		_	_	_	_	_	_	_	_	_
CO2	1	3	_	_	_	_	_	_	_	_	_	_
CO3	1	3	_	_	_	_	_	_	_	_	_	_
CO4	2	3		_	_	_	_	_	_	_	_	_

UNIT I **(12 Hours)**

Complex Analysis: Analytic function, Cauchy-Riemann equations, Harmonic Function, Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula.

UNIT II **(8 Hours)**

Taylor's series, Laurent's series, Singularities and zeros, Residues, Cauchy Residue theorem, Evaluation of real integrals.

UNIT-III **(10 Hours)**

Numerical methods: Errors, Solving of algebraic and transcendental equations by using fixed point iteration and Newton-Raphson's method. : Newton divided differnterpolation,Lagrange interpolation ,Newton's forward and backward interpolation.Numerical Differentiation,Numerical integration:The trapezoidal rule, The simpson's rules, Ordinary differential equation: Modified Euler's method, Runge-kutta methods.

UNIT-1V **(18 Hours)**

PROBABILITY: Random variables, Probability distributions, Mean and variance of distribution,

Binomial, Poisson and uniform distributions, Normal distribution, Random sampling, Estimation of Parameters (maximum likely hood method),Confidence intervals, Testing of hypothesis ,Acceptance sampling ,Regression and correlation analysis, fitting of straight line by least square method.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.

Text Books

E. Kreyszig," Advanced Engineering Mathematics:, Eighth Edition, Wiley India
Numerical method for Engineers by M. K. Jain and Iyenger.

Reference Books

Higher Engineering Mathematics by B S Grewal : Khanna Publishers, New Delhi.
Numerical Analysis by Dutta and Jena

Subject Code	Course Title	L	T	P	C	QP
	OBJECT ORIENTED PROGRAMMING SYSTEMS	**3**	**0**		**3**	

Pre -Requisite:

Course Educational Objective

CEO1	The model of object oriented programming: abstract data types, encapsulation, inheritance and polymorphism
CEO2	Fundamental features of an object oriented language like Java: object classes and interfaces, exceptions and libraries of object collections
CEO3	How to take the statement of a business problem and from this determine suitable logic for solving the problem; then be able to proceed to code that logic as a program written in Java.
CEO4	How to test, document and prepare a professional looking package for each business project using javadoc.

Course Outcome

CO1	Students will be able to map real world problems into the Programming language with oop features and Implement object oriented principles for reusability.
CO2	Students will be able to write programs using basic data types and strings, using loops, Array.
CO3	Student will be able to Assign priorities and resolve run-time errors with Multithreading and Exception Handling techniques
CO4	Students will be able to Interpret Events handling techniques for interaction of the user with GUI and Develop client/server applications using socket programming

COs	PROGRAMME OUTCOMES											PSOs	
	1	2	3	4	5	6	8	9	10	11	12	1	2
CO1	2			2		1			1		1		
CO2	2			1					1		1		
CO3	1			1		1			1		1		
CO4	2			2					1		1		

UNIT:1 **(10 Hours)**

An introduction Object Oriented Programming, Features of Object Oriented Programming Introduction to Java. Difference between C/C++ and Java, Features of Java, First Java Program, Writing the java program, Compiling the program, JVM and its significance in executing a program?, Architecture of JVM. Understanding, Java Tokens, Datatypes, Operators, Control Structures and Arrays, Conditional Statements, Loops/ Iterators, Jumping Statements, Java Arrays, Multidimensional Arrays, Taking Input from keyboard, Command Line Arguments, Using Scanner Class, Using Buffered Reader class.

UNIT:2 **(12 Hours)**

Introduction to Classes and Objects. Constructors, static Keyword , this Keyword, Array of Objects, Access Modifiers (Public, Private, Protected, Default). Inheritance ,Types of Inheritance and Java supported Inheritance, super, Polymorphism, Method Overloading, Constructor Overloading, Method Overriding, Dynamic Method Dispatching. String Manipulations. Wrapper classes, Auto boxing and unboxing. Abstract classes, Interfaces, Multiple Inheritance Using Interfaces, Java API Packages, User-Defined Packages, Accessing Packages, Error and Exception Handling, Types of exceptions Hierarchy of Exception classes, try, catch, finally, throw, throws, Commonly used Exceptions and their details ,User defined exception classes.

UNIT:3 **(12 Hours)**

Multithreading , Thread in Java, Thread execution prevention methods. (yield(), join(), sleep()), Concept of Synchronization, Inter Thread Communication, Basics of Deadlock, Demon Thread, Improvement in Multithreading, Inner Classes, Introduction, Member inner class, Static inner class, Local inner class, Anonymous inner class. IO Streams (java.io package) , Byte Stream and Character Stream, Files and Random Access Files, Serialization, Collection Frame Work (java.util), Util Package interfaces, List, Set, Map

UNIT:4 **(10 Hours)**

Applet Introduction, Life Cycle of an Applet, GUI with an Applet, Abstract Window Toolkit (AWT), Introduction to GUI, Description of Components and Containers, Component/Container hierarchy, Understanding different Components/Container classes and their constructors, Event Handling, Different mechanisms of Event Handling, Listener Interfaces, Adapter classes.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Programming in Java. Second Edition. Oxford higher education. (Sachin Malhotra/ Saurav Choudhary)
2. Core Java for beginners. (Rashmi Kanta Das), Vikas Publication

Ref. Books

1. JAVA Complete Reference (9th Edition) Herbalt Schelidt

Graphs: Definitions, Graph representation - Adjacency matrix, Incidence Matrix, adjacency lists, Graph Traversals (BFS & DFS), Single source shortest path algorithm (Dijkstra's Algorithm) Topological Sorting

Hashing: Hashing Functions, Open hashing (chaining), closed hashing (Open addressing – linear probing, quadratic probing, double hashing), rehashing

Subject code	Course Title	L	T	P	C	QP
	Heat Transfer	3	0	0	3	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1:To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

Course Outcome

CO1	Explain the basic concepts and laws of the three modes of heat transfer
CO2	Apply analytical techniques to the solution of conduction heat-transfer problems
CO3	Make use of empirical equations to solve forced and natural convection heat-transfer problems
CO4	Solve simple radiation heat transfer problems

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0	-	-	-	-	-	-	-	2		1	
CO2	2	2	1	1			3						2	
CO3	2	2	1	-	-	-	-	-	-	-	-	-	1	
CO4	1	0	0	-	-	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Modes of heat transfer, Basic laws of heat transfer, Conduction: Steady-state one, two and three dimensional heat conduction, Heat transfer from extended surfaces, Unsteady state heat conduction in finite and semi-infinite solids, Critical insulation thickness.

Unit:2 **10(Hours)**

Convection : The convective heat transfer coefficient, introduction to thermal boundary layer, Dimensionless numbers in heat transfer and their significance. Dimensional analysis: Forced Convection, Analogy between heat and momentum transfer: Reynolds's Pradtl and Colburn analogies. Natural Convection: Grashoff number, Natural convection from vertical and horizontal surfaces. Heat Transfer with phase change: Heat transfer from condensing vapors: film and drop-wise condensation. Nusselt equation. Effect of non-condensable gases. Heat transfer to boiling liquids.

Unit:3 **10 (Hours)**

Heat Exchanges : Types of heat exchangers, LMTD. Energy balances, Overall heat transfer Coefficients, Heat Exchanger effectiveness. Fouling factors, Design and description of heat transfer equipment. Types of evaporators, capacity and economy, Boiling point elevation and Duhring's rule, Methods of feeding.

Unit:4 **10 (Hours)**

Heat transfer by radiation : Thermal radiation, Black body radiation, Kirchhoff's law, emissivity, grey body, laws of black body radiation, geometric factor, Radiation in enclosures with black surfaces and grey surfaces. Large parallel plates, concetric, cylindrical, spheres. Combined heat transfer by conduction, convection and radiation

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Mc Cabe W. L. & Smith J. C. & Harriot P, Unit Operations of Chemical Engineering (5th Edition),Mc Graw Hill, New York

2: Arora, Damkundwar, A Course in Heat & Mass Transfer

Ref. Books 1: Kern D. Q., Process Heat Transfer

2: R.K Rajput Heat and mass transfer, S. Chand publication

Subject code	Course Title	L	T	P	C	QP
	Fluid Mechanics	**3**	**0**	**0**	**3**	

Pre-Requisites (If any)-Mathematics, Mechanics

CEO1:To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics through pipes and porous medium, flow measurement and fluid machineries

CEO2: To introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations.

Course Outcome

CO1	Rephrase the basic principles of fluid mechanics
CO2	Analyze fluid flow problems with the application of the momentum and energy equations
CO3	Explain the pipe flows, mixing processes & fluid machinery
CO4	Compare and distinguish fluid particle systems and equipment and conveying system

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	
CO3	2	3	-	-	-	-	-	-	-	-	-	-	1	
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	

Unit: 1 **15 (Hours)**

Classification of fluid, Fluid statics – basic equation, equilibrium of fluid element – Hydrostatic Pressure, Pressure measuring Devices. Flow in boundary layers. Its formation & growth in tubes & plates. Fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices; Venturi, Orifice, Pitot tube & Rotameter

Unit: 2 **10 (Hours)**

Flow of incompressible fluid in pipes, Relation between skin friction & wall shear. Laminar flow in pipes, Hagen-Poiuilles equation, Friction factor, Friction from changes in velocity or direction, Flow of compressible fluids: Basic equations.

Unit: 3 **10 (Hours)**

Flow past immersed bodies, Drag Co-efficient. Motion of particles through fluids. Its mechanics, terminal Velocity. Dimensional analysis, Mechanism of fluidization, Application of fluidization.

Unit: 4 **10 (Hours)**

Transportation of fluids, Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans. Concept of slip, piping & fittings.

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Unit operations of Chemical Engg. by Mc Cabe & Smith
2: Fluid Mechanics for Chemical Engg. by Noel Drevers

Ref. Books 1: A Text book of Fluid Mechanics & Hydralic Machines by R.K.Bansal
2: Transport processes and unit operations by Christie J. Geankopolis, PHI

Subject code	Course Title	L	T	P	C	QP
	Chemical Process Calculations	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-Mathematics,Chemistry,Thermodynamics

Pre-Requisites (If any)-Mathematics,Chemistry,Thermodynamics

Course Educational Objective

CEO1:To teach fundamentals of calculation and its application to solution of mass and energy balance equations for single and network of units

Course Outcome

CO1	Demonstrate material balances on unit operations and processes.
CO2	To follow the material balance calculations involving with and without chemical reactions
CO3	Evaluate the degrees of freedom to analyze the system.
CO4	Make use of the concept of humidity and usage of psychometric chart

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	0	0	-	-	-	-	-	-	-	-	2	
CO2	3	3	1	0	-	-	-	-	-	-	-	-	1	
CO3	2	2	2	1	-	-	-	-	-	-	-	-	1	
CO4	1	0	0	0	-	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Units, dimensions and conversions, Fundamental concept of stoichiometry- mole concept, density, specific gravity and its scale, composition of solids, liquids and gases- weight fraction, mole fraction, ppm, molarity, normality, molality, Ideal gas laws, equation of state.

Unit:2 **12 (Hours)**

Solution: Ideal solution, Raoult's law, Non-ideal solution, Henry's law; Vapor pressure, Clausius-Clapeyron equation, Antoine equation, vapors pressure plots, humidity- dry bulb temperature, wet bulb temperature, dew point, saturation, adiabatic saturation temperature, humidity, relative humidity & percent humidity, saturated humidity, humid heat, humid volume, use of humidity chart.

Unit:3 **11 (Hours)**

Material balances &unit operation- Drying, Evaporation, Dissolution and crystallization, Mixing. Solving material balance with Chemical reaction: The chemical equation & stoichiometry, concept of limiting & excess reactants, conversion, degree of conversion, yield etc. recycle, bypass & purge calculations. Combustion processes.

Unit:4 **10 (Hours)**

Energy Energy balance concepts & units, Heat capacity, Enthalpy changes with phase change, Heat effects accompanying chemical reaction, Standard heat of reaction at constant pressure & constant volume, effect of temperature on heat of reaction, Adiabatic reaction of temperature ,heat of solution & heat of mixing.

Teaching Mentod (s):Chalk & Board/PPT

Text Books 1: Stoichiometry & process Calculations by-K.V. Narayanan & B-lakshmikatty

2: Basic principles and calculation in chemical engineering by Himmelblau D.H. 5th Edition. PHI, 2001.

Ref. Books 1: Chemical process principles- Hoejen, Watson, John Wiley & Asia pub.

2: Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata Mc Graw Hill publishingcompany Ltd.New Delhi (1996)

Subject Code	Name of the Subject	L	T	P	C	QP
	Organisational Behaviour	**3**	**0**	**0**	**3**	**A**

Course Educational Objectives

CEO1	To develop an understanding of the behaviour of individuals and groups inside organizations
CEO2	To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
CEO3	To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Course Outcomes

CO1	Define, explain and illustrate a range of organizational behaviour theories.
CO2	Analyse the behaviour of individuals and groups in organizations in terms of organizational behaviour theories, models and concepts.
CO3	To explain group dynamics and demonstrate skills required for working in groups (team building)
CO4	Communicate effectively in oral and written forms about organizational behaviour theories and their application using appropriate concepts, logic and rhetorical conventions.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						3		2			1	1			
CO2						2		2			2	1			
CO3						1		1			2	1			
CO4						1		1			3	1			
Avg.						1.75		1.5			2	1			

Unit – I **[14Hrs]**

Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behaviouristic and social cognitive), Limitations of OB.

Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behaviour and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.

Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Unit - II **[12Hrs]**

Foundations of Group Behaviour: The Meaning of Group & Group behaviour & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.

Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Unit – III **[14 Hrs.]**

Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Unit – IV **[8 Hrs.]**

Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change.

Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change &Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books/Reference books:

1. *Understanding Organizational Behaviour, Parek, Oxford*
2. *Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.*
3. *Organizational Behaviour, K. Awathappa,HPH.*
4. *Organizational Behaviour, VSP Rao, Excel*
5. *Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.*
6. *Organizational Behaviour, Hitt, Miller, Colella, Wiley*

Subject code	Course Title	L	T	P	C	QP
	Optimization In Engineering	**3**	**0**		**3**	

Pre -Requisite:

CEO1:To introduce the students how to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science

CEO2:To provide students with opportunity using various software package for solving liner programming and integer programming models

CEO3:To introduce the students to use of basic methodology for solution of linear programs and integer programs

CEO4:To introduce the students to advance methods for large scale transportation and assignment problems

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

CO1	**Analyze,** formulate and solve linear programming problems using appropriate techniques.
CO2	**Conduct** and **interpret** post-optimal and sensitivity analysis and explain the primal-dual relationship
CO3	**Develop** mathematical skills related to transportation and assignment problem can analyze and solve integer programming problem arising from a wide range of applications.
CO4	**Communicate** ideas, explain procedures and interpret results and solutions related to nonlinear programming problem

UNIT:1 **[14 Hours]**

Introduction: Historical overview of operations research, fundamentals of OR Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, Big-M method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 **[14 Hours]**

Transportation and Assignment Problems : Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models-branch-and-bound technique.

UNIT:3 **[10 Hours]**

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 **[10 Hours]**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/PPT

Text Books:

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010Book
2.KantiSwarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books:

1. P.K.Gupta, D.S.Hira, “Operations Research”, S.Chand and Company Ltd
2. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.

Subject code	course title	L	T	P	C	QP
	Heat Transfer Lab			**2**	**1**	

Pre -Requisite:

Course Educational Objective

CEO1:To enable the students to develop a sound working knowledge on different types of heat transfer equipments

Course Educational Objective	
CO1	Explain the basic concepts and laws of the three modes of heat transfer
CO2	Apply analytical techniques to the solution of conduction heat-transfer problems
CO3	Make use of empirical equations to solve forced and natural convection heat-transfer problems
CO4	Solve simple radiation heat transfer problems

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	0	1								2		1	
CO2	2	1	2	1			3						2	
CO3	2	1	2		-	-	-	-	-	-	-	-	1	
CO4	1	0	0		-	-	-	-	-	-	-	-	2	

LIST OF EXPERIMENTS:

1 Study of parallel flow and counter flow heat exchanger

2. Study of Calendria type evaporator

3. Study of Shell and Tube heat exchanger

4. Study of Vertical and Horizontal condenser

5. Study of Composite Wall

6. Study of Bare and Fin Tube heat exchanger

7. Study of Film wise and Drop wise condensation apparatus

8. Study of Jacketed Vessel

9. Determination of Thermal Conductivity of Liquid

Subject code	CourseTtitle	L	T	P	C	QP
	Fluid Mechanics LAB	**0**	**0**	**2**	**1**	

Course Educational Objective

CEO1:To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics

CEO2: Students should be able to calculate velocity profiles by simplification of equations of motion in simple 1-D flows.

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

CO1	Rephrase the basic principles of fluid mechanics
CO2	Analyze fluid flow problems with the application of the momentum and energy equations
CO3	Explain the pipe flows, mixing processes & fluid machinery
CO4	Differentiate the types of flow by calculating the Reynolds number.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	
CO2	2	3	-	-	-	-	-	-	-	-	-	-	1	
CO3	2	3	-	-	-	-	-	-	-	-	-	-	1	
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	

List of experiment:

1. Venturi Meter – Determination of flow rate of fluid flowing inside a pipe.
1. Orifice Meter – Determination of flow rate of fluid flowing inside a pipe.
2. Reynolds's Apparatus – Flow pattern characterization using Reynolds's Apparatus.
3. Bernoulli's Apparatus – To verify the Bernoulli's Equation using Bernoulli's apparatus.
4. Pitot tube – Determination of point velocity of fluid by using Pitot tube.
5. V-Notch – Determination of flow rate of a fluid by using V – Notch.
6. Packed Bed – Determination of pressure drop of fluid flowing through a packed bed and Fluidised bed
7. Determination of minimum fluidization velocity and pressure drop in a fluidized bed apparatus.

9. Centrifugal Pump –To draw the characteristics curves and find out the efficiency in a centrifugal pump.
10. Reciprocating Pump – To draw the characteristics curves and find out the efficiency of a reciprocating pump.

Subject Code	Course Title	L	T	P	C	QP
	JAVA PROGRAMMING LAB			**2**	**1**	

Course Educational Objective

CEO1:	The model of object oriented programming: abstract data types, encapsulation, inheritance and polymorphism
CEO2:	Fundamental features of an object oriented language like Java: object classes and interfaces, exceptions and libraries of object collections
CEO3:	How to take the statement of a business problem and from this determine suitable logic for solving the problem; then be able to proceed to code that logic as a program written in Java.
CEO4:	How to test, document and prepare a professional looking package for each business project using java doc.

Course Outcome

CO1	Students will be able to map real world problems into the Programming language with oop features and Implement object oriented principles for reusability
COI2	Students will be able to write programs using basic data types and strings, using loops, Array.
CO3	Student will be able to Assign priorities and resolve run-time errors with Multithreading and Exception Handling techniques
CO4	Students will be able to Interpret Events handling techniques for interaction of the user with GUI and Develop client/server applications using socket programming

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	3	2	1											
	3	3			2		1		1					
	3	2			2							1		
	3	3	3	2		1								

JAVA programs on:

1. Introduction, Compiling & executing a java program.
2. Data types & variables, decision control structures: if, nested if etc.
3. Loop control structures: do, while, for etc.
4. Classes and objects.
5. Data abstraction & data hiding, inheritance, polymorphism.
6. Threads, exception handlings and applet programs
7. Interfaces and inner classes, wrapper classes, generics

UG IN CHEMICAL ENGINEERING

IV Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Engineering Science Courses		Material Science	3	0	2	4
2	Professional Core Courses		Numerical Methods in Chemical Engineering	3	0	0	3
3	Professional Core Courses		Mass Transfer-I	3	0	2	4
4	Professional Core Courses		Mechanical Operations	3	0	2	4
5	Professional Core Courses		Chemical Engineering Thermodynamics	3	0	2	4
6	Humanities and Social Sciences including Management Courses		Organizational Behavior / Optimization In Engineering	2	0	0	2
7	Mandatory Courses		Environmental Sciences	-	-	-	0
			Total Credits:	**17**	**0**	**8**	**21**

Subject Code	MATERIALS SCIENCE	L	T	P	C	QP

		3	**0**		**3**	

Pre -Requisite:

Course Educational Objective

CEO1: Provides a basic knowledge about the material properties and testing methods along with crystal structures and deformations.

CEO2: Explains the importance of phase diagrams and study of variousinary and ternary phase diagrams

Course Outcome

CO1	Illustrate the crystal structure, mechanical properties; classify the materials and their suitability for applications
CO2	Classify cast irons and study their applications.
CO3	Interpret the phase diagrams of materials.
CO4	Select suitable heat-treatment process to achieve desired properties of metals and alloys

UNIT:1 **(12No of Hours)**

Classification of Engineering Materials, Characteristic property of metals, bonding in solids, ionic, covalent and metallic bond, Crystal systems, crystallographic planes and directions, atomic packing efficiency, crystal imperfection and voids in common crystal systems. Solidification of pure metal, Homogeneous and heterogeneous nucleation processes, cooling curve, concept of super cooling, microstructures of pure metals.

UNIT:2 **(10No of Hours)**

Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, iron-iron carbide phase diagram, cold, hot working of metals, recovery, recrystallization and grain growth. Microstructure, properties and applications of ferrous and non-ferrous alloys.

UNIT:3 **(10No of Hours)**

Equilibrium cooling behavior of hypo, eutectoid, hyper eutectoid steels. Microstructure and properties of different alloys. Heat treatment of steels, microstructural effects brought about by these processes and their influences on mechanical properties, factor affecting hardenability.

Alloy steels: Stainless steel, tool steel, HSS, high strength low alloy steel, heat treatment, properties, microstructure and applications. Types of cast irons, their microstructures and typical uses.

UNIT:4 **(12No of Hours)**

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres.
Plastic-: Thermosetting and thermoplastics.
Ceramics: Types, structure, Mechanical properties, application
Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Glass fiber reinforced plastics, Carbon fibre reinforced plastics, fibre reinforced plastics, laminated plastic sheets. Teflon, Properties of composites, Metal matrix composites.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Introduction to physical metallurgy – Sydney Avner

Fundamentals of materials science and engineering W. Callister

Ref. Books

1. Mechanical Metallurgy by Dieter, Tata MacGraw Hill

Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow.

Subject code	Course Title	L	T	P	C	QP
	Numerical Methods in Chemical Engineering	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-	
CO1	Solve a linear system of equations and non-linear algebraic or transcendental equation using an appropriate numerical method
CO2	To find a interpolation polynomial by using different methods and also know the numerical integration.
CO3	Solve ordinary differential equation by using numerical methods.
CO4	Explain partial differential equations using an appropriate numerical method .

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-		-	-	-	-	-	-	-	2	
CO2	2	2	-	1		-	-	-	-	-	-	-	2	
CO3	2	1	1	-		-	-	-	-	-	-	-	1	
CO4	1	2	-	2	-	-	-	-	-	-			2	

Unit:1 **10hrs**

Errors, types of errors solution of algebraic and transcendental equations ; bisection method, false –position method, fixed point iteration, Newton raphson method,

Linear algebraic equation ;LU Decomposition method, the matrix method,gauss-siedel method.

Unit:2 **10hrs**

Interpolation:

PiecewiseLinearInterpolation,PiecewiseQuadraticInterpolation,PiecewiseCubicHermiteInterpolation,.NumericalDifferentiation: First Derivative, ,Partial Derivatives, Richardson's Extrapolation. Romberg algorithm for numerical integration. Chemical engineering problems where the above mentioned numerical schemes will be illustrated in details

Unit:3 **10hrs**

Ordinary Differential Equations: eulers method,improved eulers method,runge-kutta method. Multistep methods ; Adams-Bashforth Methods, Adams-Moulton Methods, Adams Predictor-Corrector methods, (Simpson's method and Milne's method). Application in chemical and bio-chemical reaction.

Unit:4 **10hrs**

Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method. Hyperbolic Partial Differential Equation.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1. M. K. Jain, S. R. K. Iyengar and R.K. Jain : Numerical Methods for Science and Engineering Computations (Fourth Edition) New Age International Publishers

2.S.kalavathy "NUMERICAL METHODS" Thomson/Cengage india

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Ref. Books 1: Applied Numerical Analysis Using MATLAB, 2nd ed. by L V Fausett, Pearson.

2. Atkinson, K.E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.

3: Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012. Press,

Subject Code	Course Title	L	T	P	C	QP
	MASS TRANSFER-I	3	1	0	4	

Course Outcome
Pre-Requisites (If any)-
CEO1: Students will learn to determine mass transfer rates under laminar and turbulent conditions
CEO2:To provide introduction to physical and thermodynamic principles of mass transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity

Course Outcome	
CO1	To demonstrate about the diffusion process
CO2	Familiar with special distillation techniques such as steam distillation and azeotropic distillation
CO3	Distinguish the mechanism of absorption, distillation and humidification
CO4	Design the distillation column, absorption tower

Cos	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0								2			1
CO2	2	2	1	1			3							1
CO3	2	2	1	-	-	-	-	-	-	-	-	-		2
CO4	1	0	0	-	-	-	-	-	-	-	-	-		1

Unit:1 **12(Hours)**

Diffusion: Introduction to Mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolal counter current diffusion, Stefan-Maxwell equation, diffusivity of gases and liquids, application of molecular diffusion, mass transfer coefficients, in laminar and turbulent flow, Interphase mass transfer, Film theory, Penetration theory, surface-renewal theories, analogy between mass, heat and momentum transfer.

Unit:2 **10 (Hours)**

Absorption : Solubility of gases in liquids, two components system, multi component system, ideal and non -ideal solutions, choice of solvent for absorption, single component absorption material balance, counter current multistage operations, dilute gas mixtures, non -isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU,NTU concepts for single component absorption.

Unit:3 **10 (Hours)**

Distillation: Principle of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation steam distillation, azeotropic and extractive distillation. Continuous distillation: Mc Cabe -Thiele method, Ponchon -Savarit method, Tray efficiencies, introduction to multi component distillation.

Unit:4 **13 (Hours)**

Humidification operations: Definition of fundamental terms, Psychometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, Gas liquid contact, Dehumidification, AdiabaticHumidification. Equipments: Natural Circulation, Natural draft, Mechanical draft, Spray tower, Spray chamber, Spray pond. Humidity Measurement: Direct chemical method, Hygrometer method, Sling psychrometer, Dew point method, Mirror method.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures /MOOC/ Internship/Industry Guest Lecture

Text Books 1: Mass Transfer Operations by R E Treybal, McGraw Hill.
2:Unit Operations of Chemical Engineering, 7th ed. by W L McCabe, J C Smith, and P Harriott, McGraw-Hill.

Ref. Books 1: Principles of Mass Transfer and Separation Processes by B K Dutta, PHI.
2: Mass Transfer Operations by A Suryanarayana, New Age International.

Subject code	Course Title	L	T	P	C	QP
	Mechanical Operation	3	1	0	4	

Pre-Requisites (If any)-Fluid Dynamics, Mathematics

CEO1:TO learn about the characterization of solids, size reduction, techniques of solid – fluid separation and mixing

CEO2: To introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations and those in which particle fluid interactions are important.

Course Outcome

CO1	Understand and apply the basic methods of characterization of particles and bulk solids.
CO2	Analyze and evaluate the technology of mechanical processing of solid material in order to achieve defined characteristics.
CO3	Describe the operation, as well as constriction and exploitation characteristics of machines for mechanical operations.
CO4	Illustrate the usage of wide specter and sources of information as well as individual and team work.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		
CO2	3	2	-	-	-	-	-	-	-	-	-	-		
CO3	3	2	-	-	-	-	-	-	1	-	-	-		
CO4	3	2	-	-	-	-	-	-		-	-	-		

Unit:1 **10 (Hours)**

Particle size, shape, Specific surface area, etc. Storage and Transportation of solids Size Reduction: Laws of grinding, Jaw, roll and gyratory crushers, revolving mills, Ball mill, attrition mill, fluid energy mill, open Circuit & closed Circuit grinding,

Unit:2 **10 (Hours)**

Size Separation, screening, screening equipments, Trammels, Capacity & effectiveness of screens, Magnetic and Electrostatic Separators.

Unit:3 **10 (Hours)**

Motion of particles through fluid, drag Coefficient, Free and hindered setting, Thickeners, Cyclones, Classifications: Sink & float method, Jigging, Tabling, Forth flotation

Unit:4 **10 (Hours)**

Fillration, Theory, plats & frame filter Press, Leaf filter, Rotary filter, Mixing & Agitation, Power consumption of Mixer, Liquid Mixing, Solid Mixing, Mixing equipment.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Mc Cabe & Smith ,Unit operations of Chemical engineering, Mc Graw lim
2: Coulson & Richabol Vol-2 Chemical Engineering pergammmic Press.

Ref. Books 1: Mechanical Operation for chemical engineers,Narayan and Bhattacharjee
2:Mechanical Operation by Swain. Publisher, Tata McGraw-Hill Education, 2011.

Subject code	Course Title	L	T	P	C	QP

	CHEMICAL ENGINEERING THERMODYNAMICS	3	0	0	3	

Pre-Requisites (If any)-

CEO1:To apply the fundamentals of chemical engineering thermodynamics and to apply the application of thermodynamics to various processes.

Course Outcome

CO1	Apply fundamental concepts of thermodynamics to engineering applications Determine thermodynamic efficiency of various energy related processes
CO2	Estimate thermodynamic properties of substances in gas and liquid states
CO3	Explain the vapor-liquid equilibrium for a system
CO4	Explain the chemical reaction equilibrium for a system

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	0	0	-	-	-	-	-	-	-	-	3	
CO2	3	3	0	0	-	-	-	-	-	-	-	-	2	
CO3	2	2	2	1	-	-	-	-	-	-	-	-	1	
CO4	1	0	0	0	-	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

The first law of Thermodynamics, the thermodynamic state and state function, Constant volume & constant pressure process, Properties of pure fluids; PVT behavior of pure substances, Virial equations of state, The ideal gas, Applications of Virial equations, Cubic equation of state, Theorem of corresponding states. Second Law: Entropy, work function, Introduction to third law.

Unit:2 **10 (Hours)**

Phase Equilibria: Criteria of phase equilibrium. Vapor/Liquid Equilibrium: The nature of equilibrium, the phase rule, VLE qualitative behavior, Raoult's law; Dew point and Bubble point calculations using Raoult's law and Modified Result's law. Henry's law, VLE from K-value correlation, flash calculations.

Unit:3 **10 (Hours)**

Solution Thermodynamics: Theory- Property relations for homogeneous phases. Fundamental property relation, The chemical potential and phase equilibria, Thermodynamics of Mixtures: Partial Molar Properties, The Gibbs–Duhem Equation, Partial properties in binary solution, The ideal gas mixture model, Fugacity and fugacity coefficient: Pure species, Species in solution, The ideal solution model, The Lewis/Randal rule, Excess properties; The Excess Gibbs energy and Activity coefficient, Excess property relation, The nature of excess properties

Unit:4 **10 (Hours)**

Chemical Reaction Equilibria: The reaction coordinate, application of equilibrium criterion to chemical reactions, the standard Gibb's energy change and the equilibrium constant, feasibility of a reaction, Effect of temperature on equilibrium constant, Evaluation of equilibrium constant, Relation of equilibrium constant to composition, Equilibrium conversion for single reaction; single phase reactions, reactions in heterogeneous systems, and multiple reactions, Phase rule and Duhem's theorem for reacting systems, Multireaction equilibria, Fuel Cells.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books:

1.Introduction to Chemical Engg. Thermodynamics by Smith and H.C. Vannes and M. Abbot (7th editation) Tata McGraw Hill, 2009

2:S.Sandler, "Chemical, Biochemical and Engineering Thermodynamics", 4th edition,Wiley,India.

Ref. Books

1. Chemical Engg. Thermodynamics by Y.V.C. Rao – University Press
2. Chemical Engg. Thermodynamics by K.V.Narayan, PHI, 2000
3. Engineering and Chemical Thermodynamics by Milo D. Koretsky- 2nd Edition, Wiley publication

Subject Code	Name of the Subject	L	T	P	C	QP

	Organisational Behaviour	3	0	0	3	A

Course Educational Objectives

CEO1	To develop an understanding of the behaviour of individuals and groups inside organizations
CEO2	To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
CEO3	To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Course Outcomes

CO1	Define, explain and illustrate a range of organizational behaviour theories.
CO2	Analyse the behaviour of individuals and groups in organizations in terms of organizational behaviour theories, models and concepts.
CO3	To explain group dynamics and demonstrate skills required for working in groups (team building)
CO4	Communicate effectively in oral and written forms about organizational behaviour theories and their application using appropriate concepts, logic and rhetorical conventions.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						3		2			1	1			
CO2						2		2			2	1			
CO3						1		1			2	1			
CO4						1		1			3	1			
Avg.						1.75		1.5			2	1			

Unit – I **[14Hrs]**

Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behaviouristic and social cognitive), Limitations of OB.

Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behaviour and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.

Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Unit - II **[12Hrs]**

Foundations of Group Behaviour: The Meaning of Group & Group behaviour & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.

Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Unit – III **[14 Hrs.]**

Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining

Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Unit – IV **[8 Hrs.]**

Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change.

Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change &Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books/Reference books:

1. *Understanding Organizational Behaviour, Parek, Oxford*
2. *Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.*
3. *Organizational Behaviour, K. Awathappa,HPH.*
4. *Organizational Behaviour, VSP Rao, Excel*
5. *Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.*
6. *Organizational Behaviour, Hitt, Miller, Colella, Wiley*

Subject code	Course Title	L	T	P	C	QP

	Optimization In Engineering	3	0		3	
Pre -Requisite:						
CEO1:To introduce the students how to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science						
CEO2:To provide students with opportunity using various software package for solving liner programming and integer programming models						
CEO3:To introduce the students to use of basic methodology for solution of linear programs and integer programs						
CEO4:To introduce the students to advance methods for large scale transportation and assignment problems						
Course outcomes: At the end of the course, the student will be able to:						
CO1	**Analyze,** formulate and solve linear programming problems using appropriate techniques.					
CO2	**Conduct** and **interpret** post-optimal and sensitivity analysis and explain the primal-dual relationship					
CO3	**Develop** mathematical skills related to transportation and assignment problem can analyze and solve integer programming problem arising from a wide range of applications.					
CO4	**Communicate** ideas, explain procedures and interpret results and solutions related to nonlinear programming problem					

UNIT:1 **[14 Hours]**

Introduction: Historical overview of operations research, fundamentals of OR Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, Big-M method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 **[14 Hours]**

Transportation and Assignment Problems : Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models-branch-and-bound technique.

UNIT:3 **[10 Hours]**

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 **[10 Hours]**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/PPT

Text Books:

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010Book
2.KantiSwarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books:

1. P.K.Gupta, D.S.Hira, “Operations Research”, S.Chand and Company Ltd
2. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.

Subject code	Course Title	L	T	P	C	QP
	ENVIRONMENTAL ENGINEERING & SAFETY	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1:The course introduces the students to the environmental consequences of industries

CEO2: To provide minimization of their impacts through technology and legal systems.

Course Outcome

CO1	Students will understand the ecological system of environment.
CO2	They will learn about treatment of water/waste water
CO3	Students should know about cause and remedies of environment pollution and technological approaches
CO4	They will understand the importance of environmental safety.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2			2		1	1			1		1		
CO2	2			1						1		1		
CO3	1			1		1				1		1		
CO4	2			2						1		1		

UNIT:1 **(10 Hours)**

Ecological Concepts: Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle etc., Environmental gradients, Tolerance levels of environment factor, EU, US and Indian Environmental Law. Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry. Noise pollution- Noise standards, measurement and control. Water Treatment: water quality standards and parameters, Ground water. Water treatment processes, Pre-treatment of water, Conventional process, Advanced water treatment process.

UNIT:2 **(12 Hours)**

Waste Water Treatment: DO and BOD of Waste water treatment process, pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobicdigestion,Reactor configurations and methane production. Air Pollution: Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change –greenhouse gases, non-criteria pollutants, Air pollution meteorology, Atmospheric dispersion. Industrial Air Emission Control. Flue gas desulphurization, NOxremoval,Fugitive emissions.

UNIT:3 **(10 Hours)**

Solid waste, Hazardous waste management, Solid Waste Management, Source classificationand composition of MSW: Separation, storage and transportation, Reuse and recycling, WasteMinimization Techniques. Hazardous Waste Management, Hazardous waste and theirgeneration, Transportation and treatment: Incinerators, Inorganic waste treatment. E.I.A.,Environmental auditing.

UNIT:4 **(10 Hours)**

OccuptionalSafety and Health Acts, Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error. Hazard Control Measures in steel industry, Petroleum Refinery, Pharmaceutical industry. Fire Prevention -Detection, Extinguishing Fire, Safety Management- Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Hydro Carbons Wastes. Personal Protective Equipments.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Environmental Engineering, Irwin/ McGraw Hill International Edition, 1997, G. Kiely,

.Environmental Engineering by Prof B.K. Mohapatra, Seven Seas Publication,
Cuttack
3. Environmental Engineering and Safety ,Raut&Sen Scientific Publishers.

Ref. Books 1. Environmental Engineering by Arcadio P. Sincero&Gergoria A. Sincero PHI Publication
2 Environmental Science, Curringham&Saigo, TMH

Course Title						
Subject Code	**Material Testing Lab**	**L**	**T**	**P**	**C**	**QP**
				2	**1**	

Pre -Requisite: Bonding in Solids, Grain, Crystal Structure, Packing Density

Course Educational Objective

CEO1: Project an introductory view of the field of materials science within the framework of science and engineering disciplines.

CEO2: Provide a smooth link between the basic knowledge of science and engineering courses.

CEO3: Better prepare would-be materials engineers on ways to tackle day-to-day materials problems in professional engineering careers.

CEO4: Able to operate as effective engineers or scientists in metallurgical and materials industries or related fields.

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

CO1	**Identify** the branches of physical metallurgy and the causes of various types of crystal imperfections.
CO2	**Understand** the properties of materials and their applications based on the properties.
CO3	**Classify** steels and cast iron based on microstructure.
CO4	**Evaluate** the hardness and hardeneability of various treated and untreated steels.

List of experiment:

1. Preparation of crystal models SC, BCC, FCC,CPH crystals
2. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al.
3. Preparation and study of the Microstructure of Mild steels, low Carbon steels, high Carbon steels.
4. Study of the Micro Structures of White cast iron, Grey Cast Irons, Malleable cast iron, Nodular cast iron etc.
5. Study of the Micro Structures of Non-Ferrous alloys Brass, Bronze, aluminum alloys.
6. Study of the Micro structures of Heat treated steels Annealed Normalized, Hardened.
7. Hardeneability of steels by Jominy End Quench Test.
8. To find out the hardness of various treated and untreated steels.

code						
	Mass Transfer-I Lab			**2**	**1**	

Pre -Requisite:

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

CEO:To train the students to develop sound working knowledge on different types of mass transfer equipments

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

CO1	Explain about the diffusion process
CO2	Describe the operation of cooling tower
CO3	Distinguish the mechanism of absorption, distillation and humidification
CO4	Design the distillation column

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0								2		2	
CO2	2	2	1	1			3						2	
CO3	2	2	1	-	-	-	-	-	-	-	-	-	1	
CO4	1	0	0	-	-	-	-	-	-	-	-	-	2	

LIST OF EXPERIMENTS:

1. Determination of diffusion coefficient for carbon tetrachloride -air system by using vapour-air diffusion apparatus.

2. Study of vapour –liquid equilibrium curve for methanol-water system.

3. Verification of Rayleigh's equation through simple distillation for binary mixture of water and ethanol.

4. Determination of vaporization and thermal efficiencies in steam distillation of the given organic liquid i.e. nitrobenzene or aniline.

5. Study of lab scale bubble cap distillation column at different reflux ratios.

6. Calculation of height equivalent to a theoretical plate (HETP) of packed bed distillation column at total reflux for a binary system of methanol and water using Fenske's equation.

7. Determination of number of plates of packed bed distillation column at varying reflux ratios for a binary mixture of methanol and water using Mc Cabe Thiele diagram.

8. Study of the phenomenon of surface evaporation and determine the Humus equation constant.

Course Title						
Subject Code	**Mechanical Operations Lab**	L	T	P	C	QP
				2	**1**	

Pre -Requisite:

CEO1:To enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators

CEO2: To Know the significance and usage of different particulate characterization parameters, and equipment to estimate them.

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

CO1	Describe the operation, as well as constriction and exploitation characteristics of machines for mechanical operations.
CO2	Analyze and evaluate the technology of mechanical processing of solid material in order to achieve defined characteristics.
CO3	Make use of knowledge in real time.
CO4	Illustrate the usage of wide specter and sources of information as well as individual and team work.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	1	
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	

List of experiment:

1. To find out the average size of particles of a sample (Volume-surface mean dia).
2. To determine the critical speed and time of grinding in a ball mill for producing a product with 80% passing a given screen.
3. To separate a mixture into two fractions using flotation column.
4. Determination of the effectiveness of a vibrating screen.
5. To verify the Rittinger's and Kick's law using Blake jaw crusher.
6. To study the characteristics of batch sedimentation using coal sample.
7. To determine the specific cake resistance and filter medium resistance of slurry in Plate and frame filter press.
8. To separate a mixture of sand and iron powder by means of tabling.
9. To find out the reduction ratio in Roll Crusher and Hammer Mill.
10. To study the separation characteristics of sample of mixture by Jigging and Tabling.

Subject Code	Thermo physical Lab	L	T	P	C	QP
				2	1	

Pre -Requisite:

Course Educational Objective

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

CO1	Practical knowledge of Equation of state and thermodynamic property changes in mixing
CO2	Analysis of the experimental results in mixing .
CO3	Make use of knowledge in real time.
CO4	Illustrate the usage of wide specter and sources of information as well as individual and team work.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
	3	2	-	-	-	-	-	-	-	-	-	-	1	
CO1	2	3	-	-	-	-	-	-	-	-	-	-	1	
CO2	2	3	-	-	-	-	-	-	-	-	-	-	1	
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	
CO4														

List of experiment:

1. Study of EOS and verification for isothermal, adiabatic and isobaric process.
2. Determination of volume change in mixing of two liquids
3. Determination of enthalpy change in mixing of two liquids
4. Study of vapor liquid equilibrium.
5. Calculation of upper critical solution temperature and lower critical solution temperature in LLE.
6. Study of solid-liquid equilibrium

V Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Chemical Process Technology	3	0	2	4
2	Professional Core Courses		Chemical Reaction Engineering- I	3	0	2	4
3	Professional Core Courses		Transport Phenomenon	3	0	0	3
4	Professional Core Courses		Mass Transfer-II	3	0	2	4
5	Professional Elective Courses		Computational Fluid Dynamics Process utility and Industrial Safety Biotechnology Biochemical Engineering	3	0	0	3
6	Open Elective Courses		Open Elective - 1	3	0	0	3
7	Project		Summer Industry Internship	-	-	2	1
			Total Credits:	**18**	**0**	**8**	**22**

Subject code	Course Title	L	T	P	C	QP
	CHEMICAL PROCESS TECHNOLOGY	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1:To gain knowledge on various aspects of production engineering and understand the practical methods of production in a chemical factory

Course Outcome

CO1	Relate the manufacturing of various inorganic and organic chemicals
CO2	Interpret the process flow diagram and various process parameters
CO3	Analyze the various solve engineering problems during production
CO4	Elaborate the modified process to be adopted in the process industry.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-	-	-	-	-	1			2
CO2	2	2	1	0			3	-	-	-	-	-		1
CO3	2	2	1	1	-	-	-	-	-	-	-	-		2
CO4	1	0	0	0	-	-	-	-	-	-	-	-		1

Unit:1 **10 (Hours)**

Unit operations and unit processes, functions of chemical engineer, new emerging areas, Indian chemical industry - An overview, Manufacture of Heavy Chemicals: Caustic Soda & Chlorine, HCL, Soda Ash, Sulphuric acid.

Unit:2 **10 (Hours)**

Natural Products:-Edible and essential oils, Extraction and Refining of Oil, hydrogenation of Oil, soaps and detergents, glycerin, pulp and paper industry, manufacture of sugar, starch and its derivatives, Industrial & absolute alcohol, paints and varnishes, Natural dyes.

Unit:3 **12 (Hours)**

Cement: Chemical composition of Portland cement, raw materials, dry and wet process for manufacturing cement clinker, setting and hardening of cement. Glass: Composition of glass, raw materials, manufacturing method of glass- pot furnace and tank furnace, annealing of glass. Ceramic: Basic raw materials, white-wares, manufacturing process of porcelain and their forming operations.

Unit:4 **13 (Hours)**

Polymerization industry: Fundamentals, polymerization technology, Production of thermoplastic and thermo-setting resins: polyethylene, PVC, polypropylene, Polystyrene, ABS resins, Phenol formaldehyde, Urea formaldehyde, Epoxy resins, Poly vinyl acetate, Polylactic acid , natural and synthetic rubber(SBR, Butyl rubber) and natural and synthetic fibers(Viscose Rayon, polyamides, polyesters, Terelyne)

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Shreve's Chemical Process Industries, 5th ed. by G T Austin, McGraw-Hill.
2: Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997

Ref. Books 1: Faith, W.L., Keyes, D.B. and Clark, R.L., Industrial Chemicals, 4th Edition, John Wiley.
2: "Textbook of chemical Technology" Vol-1 & Vol-2 by G N Pandey, Vikas Publishing

Subject code	Course Title	L	T	P	C	QP
	Chemical Reaction Engineering-I	**3**	**0**	**0**	**3**	

Course Educational Objectives

1.Students gain knowledge on different types of chemical reactors,

2.Design of chemical reactors under isothermal and non-isothermal conditions

Course Outcome

Pre-Requisites (If any)-Mass Transfer-I, Heat Transfer, Chemical Process Calculations

CO1	Know the basic knowledge about chemical reactions and development of rate laws for homogeneous reactions.
CO2	Design and analysis of ideal reactors for single and complex reactions
CO3	Determine optimal ideal reactor design for multiple reactions for yield or selectivity
CO4	Predict reactor performance when for non-isothermal reactor.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-	-	-	-	-	-	-	2	
CO2	1	3	2	0	-	-	-	-	-	-	-	-	2	
CO3	2	1	3	0	-	-	-	-	-	-	-	-	1	
CO4	0	1	0	3	-	-	-	-	-	-	-	-	2	

Unit:1 Kinetics of Homogeneous Reactions **10 (Hours)**

Introduction and overview of the subject, kinetics of homogeneous reactions, elementary and non-elementary reactions, Concentration and temperature dependent term of a rate equation, Collision theory, Transition - state theory and Arrhenius theory.

Unit:2 Interpretation of batch reactor data **12 (Hours)**

Constant volume batch reactor, Variable volume batch reactor, Integral and differential methods of kinetic analysis, empirical reactions of nth order, irreversible reactions in series and parallel, Autocatalytic reactions, Analysis of total pressure data obtained in a constant-volume system, First and second order reversible reactions, Reactions of shifting order,)

Unit:3 Isothermal Reactor Design **10(Hours)**

Ideal reactors for a single reaction - Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug flow reactors; Design for single reactions - Size comparison of single reactors, Multiple reactor systems, Recycle reactor

Unit:4 **13(Hours)**

Design for Multiple Reactions and Temperature & Pressure Effects .

Introduction to design of parallel reactions, Qualitative and quantitative discussion on product distribution, Contacting patterns, Reactor Size and arrangement, Selectivity & Yield Reversible first order reaction, First order followed by zero order reaction, Zero order followed by first order reaction

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Levenspiel O. Chemical Reaction Engineering, Wiley International
2: Fogler H. S., Chemical Kinetics and Reactor Calculation.

Ref. Books 1: Smith J. M., Chemical Engineering Kinetics, Mc Graw Hill.
2: Wales J. M., Kinetics for Chemical Engineering, Mc Graw Hill.
3. Froment G.F & K.B. Bischoff, "Chemical Reaction Analysis and Design", John Wiley and Sons, 1979

Subject code	Course Title	L	T	P	C	QP
	TRANSPORT PHENOMENA	3	0	0	3	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To Understand the fundamental connections between the conservation laws in heat, mass, and momentum.

CEO2: To develop sound physical understanding of flows.

CEO3: To familiarize various aspects of velocity, temperature and concentration distribution in laminar and turbulent flow.

CO1	Understanding of transport processes.
CO2	Ability to do heat, mass and momentum transfer analysis.
CO3	Ability to analyze industrial problems along with appropriate boundary conditions.
CO4	Ability to develop steady and time dependent solutions along with their limitations.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0		-	-	-	-	-	-	-	-	2	
CO2	2	3			-	-	-	-	-	-	-	-	2	
CO3	2	2	3	-	-	-	1	-	-	-	-	-	1	
CO4	1	2	-	-	1	-	-	-	-	-	-	-	2	

Unit:1 **11 (Hours)**

Momentum Transport: Viscosity and the mechanism of momentum transport, Shell momentum balances and pressure and velocity distributions in falling film, circular tube, annulus, slit, Flow of Two Adjacent Immiscible Fluids- Creeping Flow around a Sphere. Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems,

Unit:2 **12 (Hours)**

Energy transport: Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits. Energy equations, use of equations of change,

Unit:3 **11 (Hours)**

Mass Transport: Diffusivity, temperature and pressure effect, Fick's law of diffusion, mechanism of mass transport, theory of diffusion in gases and liquids, shell mass balances, concentration distribution in solids and in laminar flow : stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst. The equation of continuity, summary of equations of change and fluxes, use of equations of change,

Unit:4 **10 (Hours)**

Dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions, Inter phase transport in isothermal systems, temperature distribution for turbulent flow in tubes, jets, empirical expressions for turbulent mass flux.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books

1.Transport Phenomena, 2nd ed. by R B Bird, W E Stewart, and E N Lightfoot, John Wiley & Sons.
2.Analysis of Transport Phenomena, William M. Deen, Oxford University Press

Ref. Books

1. Introduction to Transport Phenomena: Momentum, Heat, and Mass by B Raj, PHI.
2. Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London,1999.

Subject code	Course Title	L	T	P	C	QP
	MASS TRANSFER – II	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-Mass Transfer-I, Heat Transfer, Chemical Process Calculations

Course Educational Objective

CEO1: To teach the students different separation techniques.

CEO2:At the end of the study students will come to know the design of a adsorber and calculations involved in liquid-liquid extraction and solid liquid extraction

Course Outcome

CO1	Understanding fundamentals of some major Mass transfer operations like adsorption, drying
CO2	Analyse the situations where liquid–liquid extraction might be preferred to distillation leaching
CO3	Development of design processes for cooling tower, fixed-bed adsorption.
CO4	Building foundation for process intensification and innovations for novel systems of mass transfer

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2	1	0								2		2	1	
2	2	1	1			3						2	2	
2	2	1	-	-	-	-	-	-	-	-	-	2	1	
1	0	0	-	-	-	-	-	-	-	-	-	1	2	

Unit:1 **10 (Hours)**

Liquid - liquid Operations : Extraction : Introduction, liquid - liquid equilibrium, analytical and graphical solutions for single and multistage operations, continuous, counter current operation without and with reflux, equipments for liquid liquid extraction.

Unit:2 **10 (Hours)**

Leaching: Operation of solid, steady and unsteady state operation, analytical methods for single and multistage operations, Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments.

Unit:3 **13 (Hours)**

Adsorption: Theory of adsorption, Industrial adsorbents, adsorption equilibrium, Adsorption isotherms, single and multistage operations, Ion – Exchange: Principle of Ion exchange, techniques and applications. Introduction to crystallization, Mier's super saturation theory, crystallization equipment: continuous vacuum crystallizer, Draft tube-baffle crystallizer Swenson-walker crystallizer. Material and energy balance calculations in batch crystallizers.

Unit:4 **10 (Hours)**

Drying: Equilibria, Drying rate curve, Batch and continuous drying. Time of drying and calculations, mechanism of batch drying, equipments for batch and continuous drying operations. Design of dryers.

Teaching Mentod (s): Chalk & Board/PPT/Video Lectures

Text Books 1: Treybal R. E., Mass Trasnfer Operation, Mc Graw Hill.
2:Mc Cabe & Smith. Unit Operation in Chemical Engineering, Mc Graw Hill & Kogakusha.

Ref. Books 1: C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition,Prentice Hall, India, 1993.
2: Mass Transfer Operations by A Suryanarayana, New Age International.

Subject code	Course Title	L	T	P	C	QP
	COMPUTATIONAL FLUID DYNAMICS	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1:To learn various computational techniques for analyzing and solving chemical engineering problems.

CO1	Explain the basic principles of mathematics and numerical concepts of fluid dynamics.
CO2	Develop governing equations for a given fluid flow system.
CO3	Adapt finite difference techniques for fluid flow models.
CO4	Solve computational fluid flow problems using finite volume techniques.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1			-	-	-	-	-	-	-	2	
CO2	2	1	2		1	-	-	-	-	-	-	-	2	
CO3	1	1	2		2	-	-	-	-	-	-	-	1	
CO4	1	1	0		1	-	-	-	-	-	-	-	2	

Unit:1 **11(Hours)**

Introduction to CFD, Conservation laws of fluid motion-Governing equations of fluid flow and heat transfer, Equation of state, Navier Stokes equations for a Newtonian fluid – Governing equations of the flow of compressible Newtonian fluid, Differential and integral forms of the general transport equations, Turbulence and its modeling-effect of turbulence on time-averaged Navier-stoke equations, characteristics of turbulent flow, turbulent models, inviscid flow, boundary layer approximation.

Unit:2 **13 (Hours)**

Basic Computational techniques, Finite volume method for diffusion problems-One-dimensional, two dimensional and three dimensional steady state diffusion problems, The finite volume method for convective-diffusion problems- Steady one-dimensional convection and diffusion , Assessment of the central differencing scheme for convective diffusion problems, The upwind differencing scheme, The hybrid differencing scheme , Higher order differencing schemes for convective diffusion, Finite volume method for unsteady flow-one dimensional unsteady heat conduction, Discretisation of transient convection-diffusion equation.

Unit:3 **12(Hours)**

Solution algorithms for pressure-velocity coupling in Steady flows-Introduction, The staggered grid , The momentum equations , The SIMPLE algorithm, The SIMPLER algorithm, The SIMPLEC algorithm, The PISO algorithm, Transient SIMPLE algorithm. Solution of discretised equations-introduction, the tri-diagonal matrix algorithm, Application of TDMA to two dimensional problems, Application of the TDMA method to three-dimensional problems.

Unit:4 **10 (HourS)**

Advanced topics and Application-combustion modeling, body fitted coordinate system, advanced applications, aerospace applications, automobile applications, biomedical applications.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd ed. by H Versteeg and W Malalasekra, Pearson.

Reference Books

1. Computational Fluid Dynamics: The Basics with Applications, J D Anderson, McGraw-Hill.
2. Fundamentals of Computational Fluid Dynamics, T K Sengupta, University Press.

Subject code	Course Title	L	T	P	C	QP
	PROCESS UTILITY AND INDUSTRIAL SAFETY	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: This course will provide effective use of chemical industries utilities.

CEO2: Emphasis on the knowledge of loss prevention, personal safety, industrial safety, hazard analysis, toxicology and personal proactive equipments.

CO1	Calculate the requirements of water and air and their applications as utilities.
CO2	Calculate the steam requirement and its applications as utility.
CO3	Evaluate and apply the various risk assessment methods in industries.
CO4	Do the hazard analysis for different industries using HAZOP.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	-	-	-	-	2	3	-	-	-	-	-	2	
CO2	2	-	-	-	-	3	2	-	-	-	-	-	2	
CO3	2	-	-	-	-	2	2	-	-	-	-	-	1	
CO4	0	-	-	-	-	1	0	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Water resources, Storage and characterization, Conditioning, Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

Unit:2 **10 (Hours)**

Steam Boilers, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler, Steam Handling and distribution, Scaling and Trouble Shooting, Steam nozzles, Condensate utilization, Steam traps and Accessories, Flash tank analysis, Safety valves, Pressure reduction valves, Desuperheaters.

Unit:3 **13 (Hours)**

Air compressors, Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Slip Factor, Impeller Blade Shape, Vacuum pumps, Air receivers, Distribution systems, Different types of ejectors, Air dryers.

Unit: 4 **12 (Hours)**

Hazards and Safety: Classifications and assessment of various types of hazards, Risk assessment methods, General principles of industrial safety, Hazards due to fire, explosions, toxicity and radiations, Industrial hygiene, Maximum allowable concentration and threshold limit value, Protective and preventive measures in hazards control, Introduction to industrial safety regulations. Case studies of hazardous incidents in industries using HAZOP.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books

1. *Vasandhani, V. P., and Kumar, D. S, Heat Engineering, Metropolitan Book Co. Pvt. Ltd. (2009).*
2. *Crowl, D.A. and Louvar, J.F., Chemical Process Safety-Fundamentals with Applications, Prentice Hall, (2002).*

Ref. Books

a. *Lees, F.P., Prevention in Process Industries. Butterworth's (1996).*
b. *Peavy, H. S., and Rowe, D. R, Environmental Engineering, McGraw Hill (1985).*
c. *Banerjee, S., Industrial Hazards and Plant Safety, Taylor & Francis 2003).*

Subject Code	Course Title	L	T	P	C	QP
	BioTechnology	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide knowledge on different of fermentation process

CEO2:To have theory and practicle knowledge on purification of products

Course Outcome

CO1	Categorize the different cells and their use in biochemical processes
CO2	Assess the role of enzymes in kinetic analysis of biochemical reaction
CO3	Utilize the basic concepts of thermodynamics, mass and energy balances, reaction kinetics and reactor design for biochemical processes
CO4	Analyze bioreactors, upstream and downstream processes in production of bio-products

UNIT:1 **(8Hours)**

Introduction and application of microbiology, Structure and functioning of bacterial cell, Classification and Identification criteria for bacteria. Nutritional requirements and nutritional types of bacteria.

UNIT:2 **(10 Hours)**

Isolation of micro-organisms, pure culture techniques and cultural characteristics. Bacterial growth, measurements and reproduction.

UNIT:3 **(10 Hours)**

Fundamentals of microbiology ecology and ecosystems, microbial associations and interactions. Applications of microbiology.

UNIT:4 **(10 Hours)**

Types of bacteria in water, sanitary examination of water, water purification, average disposal and sewage purification.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Microbiology, 4th ed. by MJPelczar, RDReid, and ECSChan, McGraw-Hill.

2. *Microbial Ecology: Fundamentals and Applications, 4th ed. by R M Atlas and R Bartha, Benjamin Cummings.*

Ref. Books 1Bioprocess Engineering by Bjorn K. Lydersen, et. al ,Wiley India Edition

2 2 Bioprocess Engineering by M.L. Shuler and F.Kargei Person

Subject code	Course Title	L	T	P	C	QP
	BIOCHEMICAL ENGINEERING	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

CO1	Categorize the different cells and their use in biochemical processes
CO2	Assess the role of enzymes in kinetic analysis of biochemical reaction
CO3	Utilize the basic concepts of thermodynamics, mass and energy balances, reaction kinetics and reactor design for biochemical processes
CO4	Analyze bioreactors, upstream and downstream processes in production of bio-products

Unit:1 **10 (Hours)**

Introduction to microbiology and biochemistry; Classification and characteristics of microorganism; Essential chemicals of life- lipids, sugars and polysaccharides, RNA and DNA, amino acids and proteins;

Unit:2 **10 (Hours)**

Enzymes and their classification; Enzyme kinetics; Immobilization of enzymes and whole cells; Immobilized enzyme kinetics Cell metabolism; Regulation; Stoichiometry; End products. Cell growth kinetics; Product formation kinetics

Unit:3 **10 (Hours)**

Transport phenomena in cellular systems; Oxygen transfer rates; Mass transfer coefficient and interfacial area; Mechanical agitation and power requirement. Thermal death kinetics; Media and air sterilization.

Unit:4 **10 (Hours)**

Bioreactors: Type, design, operation and scale-up; Instrumentation and control. Down-stream processing, Industrial production of ethanol, anti-biotics, single cell protein. Bioleaching. Effluent treatment by biological method.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1:. Bailey, J.E. and Ollis, D.F., "Biochemical Engineering Fundamentals", McGraw-Hill.
2:Aiba, S., Humphery, A.E. and Milli, N.R.,"Biochemical Engineering ", Academic Press.

Ref. Books 1:Biochemical Engineering and Biotechnology - 1st Edition. Print Book & E-Book. ISBN9780444528452,
2:Biochemical Engineering and Biotechnology by Ghasem Najafpour

Subject code	Course Title	L	T	P	C	QP
	Chemical Technology Lab			**2**	**1**	

Course Outcome

CEO:To learn basic principles involved in analysis and synthesis of different organic derivatives

Course Outcome

CO1	Relate the manufacturing of various inorganic and organic chemicals
CO2	Interpret the process flow diagram and various process parameters
CO3	Analyze the various solve engineering problems during production
CO4	Design a plant layout.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-	-	-	-	-	1			2
CO2	2	2	1	0			3	-	-	-	-	-		2
CO3	2	2	1	1	-	-	-	-	-	-	-	-		2
CO4	1	0	0	0	-	-	-	-	-	-	-	-		1

LIST OF EXPERIMENTS:

1. Manufacture of soap from vegetable oil.
2. Determination of saponification value of the given oil sample.
3. Determination of acid value of the given oil sample.
4. Estimation of iodine value of oil
5. Estimation of nitrogen in nitrogenous fertilizer.
6. Preparation of phenol formaldehyde resin.
7. Preparation of jam/jelly from red apple.
8. Preparation of coloured pigments and dyes.
9. Determination of CaO in Cement.
10. Determination of alkalinity in water sample.
11. Determination of concentration of sugar solution by Refractometer.
12. Preparation of manganese dioxide nano particles or alumina-particles.
13. Preparation of potash alum.
14. Preparation of urea formaldehyde resin.

Subject code	Course Title	L	T	P	C	QP
	Chemical Reaction Engineering-I LAB					

Pre -Requisite:

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

CO1	To calculate the rate constant for different reactors
CO2	To get knowledge about the order of the reaction
CO3	Design the equipments for separation of feed solution
CO4	Develop a equipment for separation

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-	-	-	-	-	-	-	2	
CO2	1	2	3	0	-	-	-	-	-	-	-	-	1	
CO3	1	2	3	0	-	-	-	-	-	-	-	-	1	
CO4	0	3	0	1	-	-	-	-	-	-	-	-	2	

1. Interpretation of batch reactor data.
2. To study the kinetics of liquid phase irreversible reaction in a batch reactor.
3. To study the kinetics of liquid phase reversible reaction in batch reactor.
4. To perform the kinetic studies to establish the rate constant using CSTR.
5. To determine the rate constant for a reaction in a PFR
6. Saponification of Ethyl Acetate
7. To determine the pseudo first order rate constant. (TBC)

Subject code	Course Title	L	T	P	C	QP
	Mass Transfer-II Lab					

Pre -Requisite:

Course Educational Objective

CEO1:To learn analytical experimental methods using sophisticate instruments an dinterpretation of Experimental data.

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

CO1	Explain the Separation by adsorption
CO2	Describe separation by liquid-liquid Extraction & leaching
CO3	Design the equipments for separation of feed solution
CO4	Develop a equipment for separation

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0		-	-	-	-	-	-	3		2	
CO2	1	1	2	2	-	-	2	-	-	-	-	-	1	
CO3	2	2	1		-	-	-	-	-	-	-	-	1	
CO4	1	0	0		-	-	-	-	-	-	-	-	2	

1. Extraction of oil from a sample of mustard cake.

2. Study of drying characteristics of wet solids in a tray dryer under forced draft condition.

3. Drying of solids in a rotary dryer.

4. Adsorption isotherm & efficiency determination.

5. To study the performance of a Swenson-Walker crystallizer and to determine the crystal yield and the efficiency of crystallizer.

6. To determine that mass transfer coefficients for the given system using the experimental setup.

VI Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses		Process Equipment Design	3	0	2	4
2	Professional Core Courses		Process Control	3	0	2	4
3	Professional Core Courses		Chemical Reaction Engineering- II	3	0	0	3
4	Professional Elective Courses		Process Modeling and Simulation Fuel and Energy Technology Fertilizer Technology Polymer Technology	3	0	0	3
5	Professional Elective Courses		Fluidization Engineering Petroleum Refinery Engineering Mineral Process Engineering Multicomponent Distillation	3	0	0	3
6	Open Elective Courses		Open Elective - 2	3	0	0	3
			Total Credits:	**18**	**0**	**4**	**20**

Subject Code	Course Title	L	T	P	C	QP
	Process Equipment Design	3	0	0	3	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To learn about the design procedures of process equipment used in chemical process plants.

CEO2:To acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments

CO1	Identify equipment and process involved in process flow diagrams.
CO2	Develop a model from process utilizing flow diagrams.
CO3	Explain the different control strategies employed in the process from the instrumentation diagrams
CO4	Design and draw fabrication diagrams by scaling

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0	1	-	-	-	-	-	-	2		2	
CO2	1	2	1	1	-	-	3	-	-	-	-	-	2	
CO3	1	2	1	2	-	-	-	-	-	-	-	-	1	
CO4	1	0	0	-	-	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Fundamentals: Mass and Heat transfer operations, chemical reactions, flow sheets of Petrochemical, Fertilizer and Metal extraction industries. Major and minor equipments of chemical process industries.

Unit:2 **10 (Hours)**

Distillation columns (Tray tower) – for binary mixtures along with tray hydraulics,
Absorbers (Packed Tower) – for counter current binary systems without reactions,

Unit:3 **10 (Hours)**

Heat exchangers – concentric tube, shell and tube types, Condenser. Evaporators – single and multi effects,.

Unit:4 **10 (Hours)**

Design of pressure vessels and storage tanks, Isothermal reactors

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1:. R. E. Treybal, Mass Transfer Operations.
2:. D. Q. Kern, Process Heat Transfer.

1. Ref. Books Ievenspiel O. Chemical Reaction Engineering, Wiley International
2. Mc Cabe W. L. & Smith J. C. & Harriot P, Unit Operations of Chemical Engineering (5th Edition), Mc Graw Hill, New York
3. Joshi M. V., Mahajani V. V, Process Equipment Design. Macmillan India Ltd.
4. Dryden's Outlines of Chemical Technology, East-West press

Subject code	Course Title	L	T	P	C	QP
	PROCESS CONTROL AND INSTRUMENTATION	**3**	**1**	**0**	**4**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To gain the knowledge of different process instruments, , To design various control schemes and to apply the control system in various processes.

CEO2:To understand dynamic modeling of a physical process using first principles and to convert the model to a form amenable to solution and analysis

Course Outcome

CO1	Describe the stages involved in the development of a process model.
CO2	Create a chemical engineering problem as a mathematical model from basic engineering principles.
CO3	Explain the appropriate numerical solutions to be used in solving the models
CO4	Classify various simulation tools for solving the chemical engineering models developed.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	0	-	2	-	-	-	-	-	-	-	2	
CO2	1	1	1	-	2	-	-	-	-	-	-	-	2	
CO3	2	2	1	-	2	-	-	-	-	-	-	-	1	
CO4	1	0	0	-	0	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

Unit:2 **10 (Hours)**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, Block diagram of a Chemical Reactor Control system, principles of pneumatic and electronic controllers, Closed loop transfer functions, transient response of simple control systems, Stability, Root locus.

Unit:3 **10 (Hours)**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, Advanced control strategies- Cascade control, feed forward control, ratio control, Dead time compensation, internal model control, controller tuning and process identification, control valves.

Unit:4 **10 (Hours)**

Introduction to sampled data controllers-sampling and Z-transforms, sampled data control of a first order process with transportation lag, Design of sampled data controllers. Control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, viscosity, pH, concentration, humidity of gases.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books

1. Process Systems Analysis and Control, 3rd ed. by D R Coughanowr and S E LeBlanc, McGraw-Hill.
2. Chemical Process Control: An Introduction to Theory and Practice by G Stephanopoulos, PHI.
2. *Industrial Instrumentation and Control, 3rd ed. by S K Singh, McGraw-Hill.*

Ref. Books 1: Process Dynamics & Control by J M Douglas, PHI.
2: Computer Aided Process Control by S K Singh, PHI

Subject code	Course Title	L	T	P	C	QP
	Chemical Reaction Engineering-II	**3**	**0**	**0**	**3**	

Course Educational Objectives

1. The objective is to study the non-ideal behavior of heterogeneous reactors, gas-solid catalytic and non-catalytic reactors.

2.For solving problems involving heterogeneous reaction systems and to understand and apply the principles of non-ideal flow in the design of reactors

Course Outcome

Pre-Requisites (If any)-Mass Transfer-I, Heat Transfer, Chemical Process Calculations

CO1	Explain various non-idealities in reactor behavior and distinguish between various RTD curves.
CO2	Develop rate laws for heterogeneous reactions.
CO3	Estimate the effects of diffusion, mass and heat transfer in catalyst pellet on reaction rate and predict the performance in porous heterogeneous catalysis
CO4	Develop the rate-controlling model for heterogeneous non-catalytic reactions

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-	-	-	-	-	-	-	2	
CO2	1	3	2	0	-	-	-	-	-	-	-	-	2	
CO3	2	1	3	0	-	-	-	-	-	-	-	-	1	
CO4	0	1	0	3	-	-	-	-	-	-	-	-	2	

Unit:1 Basics of Non-Ideal Flow **12 (Hours)**

Non-ideal flow, Residence time distribution (Importance and interpretation of RTD curve, E, F and C curves and relationship between them in reactor), Statistical Interpretation, RTD measurement, Conversion in non-ideal flow reactors, Diagnosing reactor ills, Dispersion model, Tanks-in-series model

Unit:2 Heterogeneous Reactions and Solid Catalysis **11 (Hours)**

Heterogeneous processes, Rate equations for heterogeneous reactions, adsorption isotherm and rates of adsorption, desorption and surface reaction, concept of rate controlling steps and analysis of rate equation. Classification and preparation of catalysts, Promoters and inhibitors, Catalyst characterization: Surface area and pore size distribution, Poisoning of catalysts

Unit:3 Solid Catalyzed Reactions **12 (Hours)**

Characteristics of catalyzed reaction, Mechanism, Pore diffusion resistance combined with surface kinetics, Single cylindrical pore with first order reaction, Effectiveness factor, Porous catalyst particles, Heat effects during reaction, Performance equation for reactors containing porous catalyst particles, Experimental methods for finding rates, Deactivation of catalysts and mechanism - the rate and performance equations

Unit: Fluid--Particle Reactions **10 (Hours)**

Selection of kinetic model, Shrinking core model for spherical particles of unchanging size: Diffusion through gas film controls, Diffusion through ash layer controls, Chemical reaction controls; Rate of reaction for shrinking spherical particles: Chemical reaction controls, Diffusion through gas film controls, SCM for cylindrical particles of unchanging size, determination of rate controlling step

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Levenspiel O. Chemical Reaction Engineering, Wiley International
2: Smith J. M., Chemical Engineering Kinetics, Mc Graw Hill

Ref. Books 1: Fogler H. S., Chemical Kinetics and Reactor Calculation..
2: J.J. Carberry, Chemical and Catalytic Reaction Engineering, McGrawHill, I
3. K. A. Gavhane, Chemical Reaction Engineering – II, 8th Ed., Nirali Prakashan, 2012
4. Froment G.F & K.B. Bischoff, "Chemical Reaction Analysis and Design", John Wiley and Sons, 1979

Subject code	Course Title	L	T	P	C	QP
	PROCESS MODELLING AND SIMULATION	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: Learn to develop mathematical models of phenomena involved in various chemical engineering processes and solutions for these models.

CEO2:To provide training to solve the model equations using numerical techniques

CO1	Describe the stages involved in the development of a process model.
CO2	Create a chemical engineering problem as a mathematical model from basic engineering principles.
CO3	Explain the appropriate numerical solutions to be used in solving the models
CO4	Classify various simulation tools for solving the chemical engineering models developed.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0	-	-	-	-	-	-	-	-	-	2	
CO2	2	2		-	-	-	-	-	-	-	-	-	2	
CO3	1	2	3	-	-	-	-	-	-	-	-	-	1	
CO4	2	1	2	2	-	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Modeling: Fundamentals of mathematical models and formulation – Continuity equation, Equation of motion, Transport equations, Energy equation, Equations of state, Equilibrium, Chemical kinetics and their applications; Population balance models and applications; Empirical models; Model parameters estimation. Lumped and distributed parameter models.

Unit:2 **10 (Hours)**

Fluid systems, C.S.T.R. (single, series, isothermal, constant hold up, variable hold up, gas phase pressurized and non-isothermal), Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation column, Batch distillation, Heat exchanger, etc.

Unit:3 **10 (Hours)**

Optimization: Single variable optimization (analytical, dichotomous search, Fibonacci, golden section, regulafalsi), Multivariable optimization (analytical, geometric programming, linear programming), Convergence methods (Newton's methods, direct substitution, Wegstein's method).

Unit:4 **12 (Hours)**

Simulation: Techniques of digital simulation – Information flow, from process to information flow diagram, From information flow diagram to numerical form, Recycles, Calculation of a recycle set, etc. Dynamic simulation - Batch reactor, Gravity flow tank, Three CSTR in series, Non-isothermal CSTR; Binary distillation column, Multi-component distillation column, Variable pressure distillation column, Ternary batch distillation with holdup.

Teaching Method (s): Chalk & Board/PPT/Video Lectures /MOOC/ Internship/Industry Guest Lecture/Invited Guest Lecture Demonstration.

Text Books 1:.Process Modeling, Simulation, and Control for Chemical Engineers, 2nd ed. by W L Luyben, McGraw-Hill.

2:.Process Plant Simulation, B V Babu, Oxford University Press

Ref. Books 1: Engineering Optimization: Theory and Practice by S S Rao, New Age.

2: . Process Control: Modeling, Design and Simulation, 1st ed. by B W Bequette, PHI.

Subject Code	Course Title	L	T	P	C	QP
	FUEL AND ENERGY TECHNOLOGY					

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To study various types of conventional and non-conventional energy resources including solid, liquid and gaseous fuels. Also, to understand and practice various characterization techniques for fuels.

CO1	Differentiate solid, liquid and gaseous fuels
CO2	Apply the knowledge of characterization techniques for fuels
CO3	Develop the alternate energy sources
CO4	Explain the modern energy conversion technologies

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2		1	-	-	1	-	-	-	-	-	-		2
CO2	2		2	-	-	3	-	-	-	-	-	-		1
CO3	1		1	-	-	2	2	-	-	-	-	-		2
CO4	1		2	-	-	0		-	-	-	-	-		1

Unit:1 **10 (Hours)**

Fuels: Solid Fuels : Coal - Origin, Chemical composition, calorific value, Classifications, Characteristics & distribution of Indian coals, Storage and spontaneous combustion of coal, Coal washing and blending, Pertrographic constituents of coal, Carbonization of coal, manufacture and properties of metallurgical coke, recovery of by-products.

Unit:2 **10 (Hours)**

Liquid Fuels : Origin and composition of crude oil, crude oil distillation and its products with special reference to gasoline, Kerosene and diesel oil, cracking and reforming, Coaltar distillation Products, Shale oil.

Unit:3 **10 (Hours)**

Gaseous Fuels: Natural gas, coal gas. Coke oven and blast furnace gas, Manufacture of Water gas and producer gas, Carburetted water gas. Synthetic Fuels : Hydrogenation of coal, fischer – Tropsch synthesis

Unit:4 **10 (Hours)**

Nuclear fuels and nuclear reactors, moderators and structural materials.
Combustion : Combustion of solids fuels, Pulverized coal. Calculation of volumes and weights of air necessary for combustion of fuels, gas analysis.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1:.Solid, Liquid and gaseous fuel - Brame and King.
2:.Elements of Fuels, Furnaces and Refractories, O. P. Gupta.

Ref. Books 1: Fuels and Combustion - S. Sarkar
2: Elements of Fuel Technology - Himus

Subject code	Course Title	L	T	P	C	QP
	FERTILIZER TECHNOLOGY					

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: Able to improve knowledge over a varied range of fertilizer production techniques, exposure to Nitrogenous and Complex fertilizer production technologies.

CEO2: Able to understand the best available technology options with cost effective, minimal energy consumption along with the best approaches to safety and environmental management.

CO1	Describe the utility of different fertilizers.
CO2	Apply the knowledge of for production of new types of micro fertilizers for crop production
CO3	Explain about the various types of fertilizers
CO4	Develop the new process of storage technique.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-	-	-	-	-	1			2
CO2	2	2	1	0			3	-	-	-	-	-		1
CO3	2	2	1	1	-	-	-	-	-	-	-	-		2
CO4	1	0	0	0	-	-	-	-	-	-	-	-		1

Unit:1 **10 (Hours)**

Fertilizers: Chemical Fertilizers and Organic manures, Types of Chemical Fertilizers, Fertilizer applications and agronomic details Other Fertilizers: Secondary nutrients, micronutrients, Fluid fertilizers, controlled release fertilizers.

Unit:2 **10 (Hours)**

Nitrogenous Fertilizers : Feedstock for production of Ammonia Gas, Associated Gas, Coke Oven Gas, Naphtha, Fuel Oil, Petroleum Heavy Stock, Coal, Lignite, Coke, Water. Methods of production, characteristics, specification and storage of Ammonium sulphate, ammonium nitrate, urea, calcium ammonium nitrate and ammonium chloride.

Unit:3 **10 (Hours)**

Phosphatic Fertilizers: Raw materials - phosphate rock, sulphur, pyrites. Methods of production, characteristics, specification and storage of single super phosphate, triple super phosphate.
Potassic Fertilizers: Methods of production, characteristics, specification and storage of potassium chloride, potassium sulphate and potassium nitrate.

Unit:4 **10 (Hours)**

Complex and NPK Fertilizers: Methods of production, characteristics specification and storage of ammonium phosphate sulphate, di-ammonium phosphate, nitro phosphates, urea ammonium phosphate, mono ammonium phosphate and various grades of NPK fertilizers.

Teaching Method (s): Chalk & Board/PPT/Video Lectures /MOOC/ Internship/Industry Guest Lecture/Invited Guest Lecture Demonstration.

Text Books

1. Handbook of fertilizer technology, Fertilizer Association of India, New Delhi
2. Fertilizer Industry - An Introductory survey, M. G. Menon, Higginbothams (P) Ltd.

Ref. Books

1. Shreve's Chemical Process Industries, 5th ed. by G T Austin, McGraw-Hill.
2. Unit process in organic systhesis : P.H. Groggins,MGH

Subject Code	Course Title	L	T	P	C	QP
	POLYMER TECHNOLOGY	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To equip students with basic knowledge of polymer synthesis that will help them to develop new materials.

CEO2: To study various processing methods of polymers and elastomers.

CO1	Describe the polymer rheology and properties
CO2	Explain the structure and molecular weight of Polymers
CO3	Apply knowlegde to develop new polymers
CO4	Understand the various process of polymerization

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	0	0	-	-		-	-	-	1			2
CO2	2	2	1	0	-	-	3	-	-	-				1
CO3	2	2	1	1	-	-	-	-	-	-	-	-		2
CO4	1	0	0	0	-	-	-	-	-	-	-	-		1

Unit:1 **10 (Hours)**

Polymers - History of polymers, nomenclature of polymers, functionality, types of polymerization, Chemistry of polymerization, Classification of polymers, Mechanism of addition polymerization, kinetics of polymerization, polymerization techniques- bulk, dispersion, solution, suspension and emulsion polymerizations.

Unit:2 **12 (Hours)**

Elementary idea on polymer rheology & properties of polymers – physical, chemical, mechanical, electrical properties and optical properties of polymers-Crystallinity and glass transition temperature(Tg), macro molecular structure. Molecular weight of polymers and its determination by viscometry, light-scattering and osmotic pressure methods, polydispersity, Polymer degradation.

Unit:3 **13 (Hours)**

Manufacture and uses of important polymers: Thermoplastic Polymers – polyolefins – vinyl polymers – poly vinyl chloride, polyvinyl alcohol, polyvinyl acetate, polyethylene, polypropylene, polystyrene, PMMA, SAN, PAN, Teflon, polyamides, polycarbonates. Thermosetting Polymers – Phenolic resins-UF, MF, polyesters, epoxies, bisphenol-A, polyurethanes, silicone resins. Elastomers: Natural rubber – Isoprene rubber, Synthetic rubbers - Butadiene rubber- Butyl rubber- Styrene Butadiene Rubber-Chloroprene rubber- Nitrile rubber—EPDM rubber and Silicone rubber and their applications.

Unit:4 **10 (Hours)**

Polymer additives, Plastic materials and elastomers as materials of construction in chemical equipments, Introduction to reactor design for polymerization, Polymer processing, Processing of thermoplastics and thermosetting plastics, compounding, processing aids – injection moulding – extrusion moulding – blow moulding. Processing of natural and synthetic rubbers – vulcanisation, mastication, calendaring– reaction injection moulding – sintering - solution casting – SMC and DMC–fibre spinning and drawing.

Application of Polymers –Engineering plastics, Electrical and electronics- conducting polymers, high temperature applications- Polymer blends, alloys and liquid crystals- lithography and water treatment-biomedical, automotives.

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Billmeyer F.W., "Text book of Polymer Science," 3rd edn., Wiley, Singapore, 1984.
2: Polymer Science & Technology, P.Ghosh, TMC

Ref. Books 1: polymer science by joel fried

Subject code	Course Title	L	T	P	C	QP
	FLUIDISATOION ENGINEERING					

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To be Acquainted with the fundamentals of fluidization engineering, different regimes, classification of particles.

CEO2: To enable the students to learn the design aspects of fluidized beds.

CO1	Explain the basic of fluidization.
CO2	Describe the various industrial application of fluidization.
CO3	Explain the various fluidization regime, Classification of particles.
CO4	Describe the staging of fluidized bed reactor.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	3	-	-	-	-	-	-	-	-	-	2	
CO2	2	1	2	-	-	-	-	-	-	-	-	-	2	
CO3	1	2	2	-	-	-	-	-	-	-	-	-	1	
CO4	1	3	0	-	-	-	-	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

The Phenomenon of Fluidization, Liquidlike Behavior of a Fludized Bed, Advantages and Disadvatages of Fluidized Beds for Industrial Operations, Fluidization Quality, Industrial Applications of Fluidized Beds: Coal Gasification, Gasoline from Other Petroleum Fractions, Gasoline from Natural and Synthesis Gases, Synthesis Reactions, Metallurgical and Other Processes .

Unit:2 **12 (Hours)**

Cracking of Hydrocarbons: (FCC), Fluid Coking and Flexi-Coking, Thermal Cracking
Combustion and Incineration: Fluidized Combustion of Coal, Incineration of solid Waste
Carbonization and Gasification: Gasification of Coal and Coke, Activation of Carbon, Gasification of Solid Waste,
Reactions Involving Solids: Roasting Sulfide Ores, Silicon for the Semiconductor and Solar Cell Industries, Chlorination and Fluorination of Metal Oxides, Reduction of Iron Oxide, Biofluidization

Unit:3 **13 (Hours)**

Fixed Beds of Particles: Characterization of Particles, Fixed Beds-One Size of Particles, Fixed Beds-Solids with a Distribution of sizes, Fluidization withour Carryover of Particles: Minimum Fluidizing Velocity, pressure Drop-versus-Velocity Diagram, Effect of Pressure and Temperature on Fluidized Behaviour, Sintering and Agglomeration of Particles at High Temperature, The Geldart Classification of Particles

Unit:4 **10 (Hours)**

Distributor Types: Ideal Distributors, Perforated or Multiorifice Plates, Tuyeres and Caps, Pipe Grids and Spargers ,Pressure Drop Requirements across Distributors Estimation of Bed Properties: Gas Flow in the Emulsion phase, Bubble Gas flow, Bubble Size and Bubbles Growth, Bubble Rise Velocity, Beds with Internals.

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1:Fluidization Engineering: Daizo Kunii and Octave Levenspiel
2: Introduction to Chemical Engg. Thermodynamics by Smith and H.C. Vannes and M. Abbot (7th editation) Tata McGraw Hill, 2009

Ref. Books 1: Shreve's Chemical Process Industries, 5th ed. by G T Austin, McGraw-Hill.
2: Unit process in organic systhesis : P.H. Groggins,MGH

Subject code	Course Title	L	T	P	C	QP
	PETROLEUM REFINERY ENGINEERING	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To learn the testing of petroleum products, crude processing and treatment techniques

CEO2: To familiarize students with the application of chemical engineering principles to petroleum refining.

CO1	Describe the petroleum industry scenario worldwide.
CO2	Explain the different refining processes.
CO3	Develop knowledge of safety and pollution control in the refining industries.
CO4	Illustrate the suitable refining technology for maximizing the gasoline yield.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2		1	-	-	1		-	-	-	-	-	2	
CO2	2		2	-	-	3		-	-	-	-	-	1	
CO3	1		1	-	-	2	2	-	-	-	-	-	1	
CO4	1		2	-	-	0		-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Origin and formation of petroleum, Reserves and deposits of the world. Indian petroleum Industry, composition of petroleum. ,Evaluation of Petroleum, Thermal properties of petroleum fraction, Important products-Properties and Test methods

Unit:2 **10 (Hours)**

Crude pretreatment, dehydration and desalting, Pipe still heater, atmospheric and vacuum distillation of crude oil. Important products – properties and test methods: natural gas, Associated gas, Dissolved gas, Refinery off gas, LPG, Reid vapour pressure, ASTM distillation, Octane number and Cetane number.

Unit:3 **10 (Hours)**

Treatment of products, additives, blending of gasoline. Treatment of gasoline, kerosene, lubes and lubricating oils, waxes.

Unit:4 **10 (Hours)**

Thermal and catalytic cracking, Hydro cracking and hydro treating. Coking, Visbreaking, Alkylation, Isomerization, Asphalt and air blown asphalt.

Teaching Method (s):Chalk & Board/PPT/Video Lectures /MOOC/ Internship.

Text Books 1:Nelson, Petroleum Refinery Engineering, Mc Graw Hill Book.
2:. Rao, B. K. B., Modern Petroleum Refining Processes, Oxford and IBH.

Ref. Books 1: Cox, P.A., "The Elements on Earth", Oxford University Press, Oxford 1995

Subject code	Course Title	L	T	P	C	QP
	MINERAL PROCESS ENGINEERING	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To introduce the theoretical aspects of common mineral processing techniques and the associated equipment utilized now-a-days in mining and extractive metallurgy practices.

CEO2: To introduce students to the principles of ore comminution, liberation and particle size analysis.

CO1	Apply the knowledge of various thermal methods of mineral processing.
CO2	Classify the different mineral processing methods.
CO3	Make use of knowledge in real time practice.
CO4	Assess the separation method in hydrometallurgy

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		2
CO2	3	2	-	-	-	-	-	-	-	-	-	-		1
CO3	3	2	-	-	-	-	-	-	-	-	-	-		2
CO4	3	2	-	-	-	-	-	-	-	-	-	-		1

Unit:1 **12hrs**

Introduction of ores and minerals; characterization of particulate materials, estimation of particle size by different methods, representation of size analysis, size reduction equipment, work index determination, mineral separation including gravity separation, jigging, spiralling, shaking table concentration etc., electrical and magnetic methods of separation, froth flotation chemistry, froth flotation unit operation, flotation equipment and flotation technology; fine particles processing, separation efficiency versus fine particles fine particles processing techniques

Unit:2 **13hrs**

Thermal methods in processing of Ores, Roasting, Sintering, Calcination, Pelletisation and briquetting. Chemical and electrochemical methods in mineral processing, Leaching, leaching process variables, Dump and heap leaching, Acid Leaching, Bacteria leaching.

Unit:3 **10hrs**

Solid-liquid separation in hydrometallurgy, solution purification, Amalgamation and cyanidation. Uranium processing

Unit:4 **10hrs**

Tailings treatment and effluent processing, tailings pond management and environmental concerns; case studies including sulphide minerals flotation.

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Mineral Beneficiation: A Concise Basic Course, D.V. Subba Rao, Pub.: CRC Press, 2011
2:Introduction to Mineral Processing, E.G. Kelly and D.J. Spottiswood, Pub.: Wiley, 1982.

Ref. Books 1: Coulson & Richabol Vol-2 Chemical Engineering pergammmic Press.

Subject code	Course Title	L	T	P	C	QP
	MULTICOMPONENT DISTILLATION	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1:

CEO2:

CO1	
CO2	
CO3	
CO4	

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	-	-	-	-	-	-	-	-	-	-		2
CO2	3	2	-	-	-	-	-	-	-	-	-	-		1
CO3	3	2	-	-	-	-	-	-	-	-	-	-		2
CO4	3	2	-	-	-	-	-	-	-	-	-	-		1

Unit:1 **12hrs**

THERMODYNAMIC PRINCIPLES

Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibrium and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.

Unit:2 **13hrs**

THERMODYNAMIC PROPERTY EVALUATION

Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

Unit:3 **10hrs**

MINIMUM REFLUX RATIO FOR MCD SYSTEM

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of Rm for multi component distillation – Underwood method – Colburn method.

Unit:4 **10hrs**

VARIOUS METHODS OF MCD COLUMN DESIGN

Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books

1. Holland, C.D., “Fundamentals of Multi Component Distillation”, McGraw Hill Book Company, 1981 2. Van Winkle, “Distillation Operations”, McGraw Hill Publications, 1987.

Ref. Books

1. King, C.J., “Separation Process Principles”, Mc Graw Publications, 1986.
2. Treybal, R.E., “Mass Ttransfer Operations”, 5th Edition, Mc Graw Hill publications. 1996.
3. Mc Cabe and Smith, J.C., Harriot, “Unit Operation of Chemical Engineering”, 6th Edition, McGraw Hill, 2001.

Subject code	Course Title	L	T	P	C	QP
	Process Equipment and Design Lab	**3**	**0**		**3**	

Pre -Requisite:

Course Educational Objective

Course Educational Objective

CEO1: To learn about the design procedures of process equipment used in chemical process plants.

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

CO1	Analyze the method to be adopted to calculate equipment cost, and profitability for process.
CO2	Classify internal pressure vessels and external pressure vessels
CO3	Design of shell & tube heat exchanger
CO4	Solve critical problems associated with sieve tray distillation column

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0	1				-	-	-	1		2	
CO2	1	2	1	1			3	-	-	-			2	
CO3	1	2	1	2	-	-	-	-	-	-	-	-	1	
CO4	1	0	0		-	-	-	-	-	-	-	-	2	

1. Design of Double pipe heat exchanger
2. Design of 1-2 shell and tube Heat Exchanger
3. Design of Single effect horizontal tube evaporator.
4. Design of Single effect vertical tube evaporator.
5. Design of Absorption Column (Packed tower).
6. Design of Continuous Distillation Column (Plate tower).
7. Design of Storage tank (fixed roof).

Subject Code	Course Title	L	T	P	C	QP
	Process control Lab					

Pre -Requisite:

Course Educational Objective

To learn about dynamic behavior of nonlinear, distributed and other complex systems, and design their control schemes.

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

CO1	Describe the stages involved in the development of a process model.
CO2	Create a chemical engineering problem as a mathematical model from basic engineering principles.
CO3	Explain the appropriate numerical solutions to be used in solving the models
CO4	Classify various simulation tools for solving the chemical engineering models developed.

1. To study the response of a single tank with step change in inlet flow and to find out time constant graphically.
2. To study the transient response of two interacting tanks with step change in inlet flow rate and to find out the time constant graphically.
3. To study the transient response of two non-interacting tanks with step change in inlet flow rate and to find out the time constant graphically.
4. To study the open loop response and the operation of ON-off electronic temperature controller and determination of its performance to control the temperature of a system having capacity to store thermal energy.
5. To study the open loop response and the operation of ON-OFF electronic pressure controller and determination of its performance to control the pressure of a pressure vessel.
6. To study of effect of PD, PI and PID controller on a temperature control trainer.
7. To study of effect of PD, PI and PID controller on a pressure control trainer.
8. To study the stability of a temperature control trainer.
9. To study the stability of a pressure control trainer.
10. To study Tuning of controller (Open loop method) of a temperature controller trainer.
11. To study Tuning of controller (Open loop method) of a pressure controller trainer.

VII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses		Treatment of Industrial effluent Interfacial Engineering Modern Separation Technique Process Instrumentation	3	0	0	3
2	Professional Elective Courses		Green Technology Plant Safety and Risk Analysis Sustainability Engineering Integrated Solid Waste Management	3	0	0	3
3	Open Elective Courses		Open Elective - 3	3	0	0	3
4	Humanities and Social Sciences including Management Courses		Marketing Management Engineering Economics and Costing Entrepreneurship Development Human Resource Management	2	0	0	2
5	Project		Summer Industry Internship	-	-	2	1
6	Project		Project Work-I	0	0	8	4
			Total Credits:	**11**	**0**	**10**	**16**

Subject Code	Course Title	L	T	P	C	QP
	TREATMENT OF INDUSTRIAL EFFLUENT	**3**	**0**	**0**	**3**	**A**

Pre -Requisite:

Course Educational Objectives

CEO1: Emphasize on this course is on the fundamentals of pollution control aspects and characterization of effluent streams.

CEO2: Know the primary, secondary and advanced wastewater treatment process.

CEO3: Learn about different air pollutants sampling and analysis methods and air pollution control equipments.

CEO4: Understand the solid, hazardous waste and their treatment and disposal methods and Learn pollution control aspects for selected process industries.

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

CO1	Understanding of different types of pollution and apply knowledge for the protection and improvement of the environment
CO2	Select and use suitable wastewater treatment technique
CO3	Identify suitable sampling, analysis and equipment for air pollutants.
CO4	Apply their knowledge in controlling the pollution in process industries

co	**PROGRAM OUT COMES**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	**2**	-	-	**2**	**1**	-	-	-	-	-
CO2	-	-	**1**	-	-	**3**	**2**	-	-	-	-	-
CO3	-	-	**1**	-	-	**2**	**2**	-	-	-	-	-
CO4	-	-	**1**	-	-	**1**	**1**	-	-	-	-	-

UNIT:1 **(10 Hours)**

Types of emissions from chemical industries and effects on environment, Type of pollution and their sources, Effluent guide lines and standards. Characterization of effluent streams, Oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, Controlling of BOD curve, Self purification of running streams.

UNIT:2 **(10 Hours)**

Wastewater treatment Process- Methods of primary treatment; Screening, sedimentation, flotation, neutralization, secondarytreatment: Biological treatment of wastewater and bacterial growth curve, suspended growth processes (activated sludge, aerated lagoon and stabilization pond), attached growth processes (trickling filter and rotating biological contactor); tertiary treatment methods (carbon adsorption, membrane separation, chlorination, and ozonation)

UNIT:3 **(10 Hours)**

Criteria and toxic air pollutants, Air pollution sampling and measurement:Ambient air sampling: collection of gaseous air pollutants, Collection of particulate air pollutants, Stack sampling: Sampling system, particulate and gaseous sampling.

Air pollution control methods and equipments:Source correction methods: raw material changes, process changes and equipment modification, Particulate emission control: collection efficiency, Control equipments like gravity settling chambers, Cyclone separators, Fabric filters, Electrostatic precipitator, Scrubbers (spray towers andventuri scrubbers), Gaseous emission control (SOx, NOx and organic vapor): absorption by liquids and adsorption by solids.

UNIT:4 **(10 Hours)**

Solid waste management: Sources and classification, Methods of collection (HCS and SCS), Disposal methods (Landfill and incineration) Hazardous waste management; Nuclear wastes; Health and environment effects, sources and disposal methods, Chemical wastes; Health and environment effects, Treatment and disposal. Pollution control in selected process industries: Fertilizer industries, Petroleum refineries andThermal power plants.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books:

1. Environmental Pollution and Control Engineering by Rao C.S– Wiley Eastern Limited, India, 1993.

2. Pollution Control in Processes Industries by S.P. Mahajan, TMH., 1985.

Reference Books:

1. Waste water treatment by M.NarayanaRao and A.K.Datta, 3rd Edition, Oxford and IHB, 2008.
2. Air Polution by MN Rao and H V N Rao, Tata McGraw Hill Education Private Limited, India,2010.
3. Environmental Engineering by H.S.Peavy, P.R. Rowe, G. Tchobanoglous, McGraw Hill, 1985.
4. Wastewater engineering treatment and reuse by Metcalf and Eddy, 4th edition, Tata McGraw Hill Edition 2003

Subject Code	Course Title	L	T	P	C	QP
	INTERFACIAL ENGINEERING	**3**	**0**	**0**	**3**	**A**

Pre -Requisite: Knowledge of chemical engineering, particularly thermodynamics, fluid mechanics, mass transfer and reaction engineering

Course Educational Objectives

CEO1: To Develop an understanding of the role that interfaces play in determining the properties of materials.

CEO2: To Identify the intermolecular and surface forces acting in various colloidal suspensions and nanoscale systems and be able to develop quantitative estimates of the strength and magnitude of these forces

CEO3: To understand the phenomena occur in the colloids and the importance of colloids and role of interfacial engineering and study near the interface processes.

CEO4: Role of colloids in industry is also covered like drug delivery, paints and textile etc

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

CO1	Study Cause of formation of self-assembled structures such as micelles of various sizes and shapes, bilayers and vesicles, and link it to 2 and 3 component surfactant phase diagrams.
CO2	Understand the origin of van der Waals attraction between molecules, and the factors that make it strong/weak
CO3	Analyze the Balance of repulsion between charged surfaces due to osmotic pressure buildup and van der Waals attraction between bodies decides kinetic stability of dispersed phase systems using DLVO theory
CO4	identify how interparticle and surface forces could be playing a role in a new system, isolate them by reasoning and additional experiments, and make progress towards engineering desired control on it.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	-	1	-	-	-	-	-	-	-	2	
CO2	1	1	2	-	2	-	-	-	-	-	-	-	2	
CO3	1	2	2	-	1	-	-	-	-	-	-	-	1	
CO4	1	1	0	-	1	-	-	-	-	-	-	-	2	

UNIT:1 **(10 Hours)**

Introduction to colloidal material, surface properties, origin of charge on colloidal particles, preparation & characterization of colloidal particles.

Surfactants type (Anionic, cationic, Zwitterionic, Gemini and non-ionic). Theory of surfactants. CMC. Kraft temperature. Phase behavior of cone surfactant systems, surfactant geometry, bilayers, vesicles and liquid crystals, and packing. Emulsions, Microemulsions & Gels

UNIT:2 **(10 Hours)**

Intermolecular Forces, Van-der-waals forces (Kessom, Debye, and London Interactions). Potential energy curve, Brownian motion and Brownian Flocculation.

Surface and interfacial Tension. Surface free energy, Surface tension for curved interfaces, Surface excess and Gibbs adsorption isotherm. Measurement of Surface tension, Interfacial Tension, Contact angle. Wetting Young-Laplace equation, and Dynamic properties of interfaces. Surface viscosity, Kelvin equation.

UNIT:3 **(10 Hours)**

Electrical phenomena at interfaces (Electronic kinetic phenomena, Electric double layer, short range forces). DLVO theory, capillary hydrostatics. Zeta potential, Electro osmosis phenomena, Streaming potential, Electro viscous flows.

UNIT:4 **(10 Hours)**

Thermodynamics of interfaces, thermodynamics of micelle and mixed micellar formation. Applications in detergents, personal-care products, pharmaceuticals, nanotechnology and food, textile, paint and petroleum industries. \

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books:

1. Adamson, A. W. and Gast, A. P., Physical Chemistry of Surfaces, John Wiley, New York, 1997.
2. Ghosh, P., Colloid and Interface Science, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Hiemenz, P. C. and Rajagopalan, R., Principles of Colloid and Surface Chemistry, Marcel Dekker, New York, 1997.

4. Stokes, R. J. and Evans, D. F., Fundamentals of Interfacial Engineering, Wiley-VCH, New York, 1997.

Reference Books:

1. Baszkin, A. and Norde, W., Physical Chemistry of Biological Interfaces, Marcel Dekker, New York, 2000.
2. Edwards, D. A., Brenner, H. and Wasan, D. T., Interfacial Transport Processes and Rheology, Butterworth-Heinemann, Boston, 1990.
3. Hunter, R. J., Foundations of Colloid Science, Oxford University Press, New York, 2005.
4. Israelachvili, J., Intermolecular and Surface Forces, Academic Press, London, 1992.
5. Slattery, J. C., Interfacial Transport Phenomena, Springer-Verlag, New York, 1990.

Subject code	Course Title	L	T	P	C	QP
	MODERN SEPARATION TECHNIQUES	**3**	**0**	**0**	**3**	

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To acquire in-depth knowledge in the area of membrane separation mechanisms, transport models, membrane permeability computations, membrane types and modules, membrane reactors, etc.

CEO2: to understand the preparation and characterization of membranes for different applications.

CO1	Explain about Types of membrane available in details.
CO2	Describe the various filtration processes.
CO3	Illustrate the idea about electric field separation process
CO4	Develop a separation technique in terms of modeling.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0					-	-	-	3		2	
CO2	1	1	2	2			2	-	-	-	-	-	1	
CO3	2	2	1	-	-			-	-	-	-	-	1	
CO4	1	0	0	-	-			-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Membrane, Classification, characterization and preparation of membrane, Membrane modules, Classification of membrane separation processes, Materials of membrane construction, Advantages of membrane processes, Major areas of application, preparation and characteristics of membranes.

Unit:2 **10 (Hours)**

Principles of membrane separation processes: Reverse osmosis, nano-filtration, ultra-filtration, micro-filtration, osmotic controlled filtration, gel layer controlled filtration. Basic principles and modeling of dialysis.

Unit:3 **10 (Hours)**

Electric field separation process: Zeta potential, electric double layer, Basic modeling of electric field enhanced filtration, Ionic separations like Electro dialysis, Electrophoresis. Ion exchange chromatography.

Unit:4 **10 (Hours)**

Liquid membrane and its modeling. Basic design of gas separation and pervaporation.
Cryogenic separation; Super- critical extraction, Reactive distillation.

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: C. J. King –"Separation Processes", Tata McGraw Hill Publishing Co Ltd.
2:Seperation Process Principle by Seader and Henly

Ref. Books 1: Ullmanns, Encyclopedia of Industrial Chemistry, Vol 32, Wiley - VCH.6.
2: Kausikh Nath-"Membrane separation Praocesses",PHI,New Delhi

Subject code	Course Title	L	T	P	C	QP
	Process Instrumentation	**3**	**0**		**3**	

Pre -Requisite:

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

CO1	Illustrate the operation of temperature measuring instruments used in industries
CO2	Choose suitable pressure measuring devices for different ranges of pressure
CO3	Select the suitable level measuring devices for open and closed vessels
CO4	Classify the various flow measuring devices for industrial opearations.

UNIT:1 **[14 Hours]**

Temperature measuring instruments

Elements of the instruments, Static and dynamic characteristics, Expansion thermometers - Mercury in glass thermometer, Bimetallic thermometer, Pressure spring thermometer, Static accuracy of thermometers, Response of thermometers, Thermo-electric temperature measurements – Thermoelectricity, Industrial thermocouple, Resistance thermometers - Thermal coefficient of resistance, Industrial resistance, Radiation receiving elements, Radiation, Photoelectric and Optical pyrometers

UNIT:2 **[14 Hours]**

Pressure-measuring instruments

Measurement of pressure and vacuum – Liquid column manometers, Measuring the elements for gauge pressure and vacuum, Indicating elements for pressure gauges, Measurement of absolute pressure, Measuring pressure in corrosive liquids, Static accuracy of pressure gauges

UNIT:3 **[10 Hours]**

Level measuring instruments

Relationship between head, density, and specific gravity, Direct measurement of liquid level, Pressure (level) measurements in open vessels, Level measurements in pressure vessels, Measurement of interface level, Density measurements, Level of dry materials

UNIT:4 **[10 Hours]**

Flow-measuring instruments

Differential pressure flow measurement devices - Orifice plate, Venture tube, Pitot tube, Head flow meters, Quantity meters - Nutating disk, Helical gear, Rotary vane and Lobed impeller flow meters, Turbine flow meter, Magnetic flow meter, Thermal flow meter, Mass flow meter, Coriolis flow meter, Viscosity measurements

Teaching Methods: Chalk& Board/PPT

Text Books:

a. D.P.Eckman, Industrial Instrumentation, 1st ed., Wiley eastern, 1950
b. *Industrial Instrumentation and Control, 3rd ed. by S K Singh, McGraw-Hill.*

Ref. Books:

3. Patranabis, Principles of Industrial Instrumentation, 3rd ed., TMH, 2001
4. Johnson, C.D., “Process Control Instrumentation Technology”, Pearson Education, Inc.

Subject code	Course Title	L	T	P	C	QP
	GREEEN TECHNOLOGY					

Course Outcome

Pre-Requisites (If any)-

Course Educational Objective

CEO1:To make students aware of how chemical processes can be designed, developed and operated in a sustainable way.

CEO2:- To facilitate the growth of the Green Technology industry and enhance its contribution to the national economy.

CO1	Understand the principles of green chemistry and engineering
CO2	Design processes that are benign and environmentally viable
CO3	Understand several real world examples where organizations used green Technology to improve the sustainability performance of their products.
CO4	Learn to modify processes and products to make them green safe and economically acceptable.

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	0	-	-			-	-	-	-	-		2
CO2	2	3						-	-	-	-	-		2
CO3	2	3	3				1	-	-	-	-	-		2
CO4	1	2			1			-	-	-	-	-		1

Unit:1 **10 (Hours)**

An overview of green technologies, Applications of green technology, green Chemistry and green engineering, Principles of green Chemistry and engineering, Applications of green chemistry and engineering, Green chemistry metrics: Principles of yield and mass economy, E-factor, Reaction mass efficiency(RME), Examples of green chemistry metrics applied to organic synthesis.

Unit:2 **10 (Hours)**

Design of greener and safer chemicals, Solvent-free methods: Microwave, sono-chemistry. Green catalysts: ionic liquids, zeolites, photocatalyst, PEG, nanocatalyst, and biocatalyst. Green solvents: Supercritical fluids, fluorous phase, and green solvents from plants.

Unit:3 **10 (Hours)**

Life Cycle Assessment – Elements of LCA – Life Cycle Costing – Eco Labelling, Scale-up effect, reactors, separators, Process integration and Process intensification.

Unit:4 **10 (Hours)**

Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Non-conventional energy sources: Solar Energy-solar energy conversion technologies and devices, their principles, working and application, Definition-benefits and challenges – comparison of green fuels with conventional fossil fuels with reference to environmental, economical and social impacts-public policies and market-driven initiatives. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Bio-conversion of renewable,

Teaching Method (s):Chalk & Board/PPT/Video Lectures /MOOC/ Internship/Industry Guest Lecture/Invited Guest Lecture Demonstration.
(can be chosen one or many)

Text Books

1. *Handbook of Green Chemistry, Vol. 1 to 9 by P T Anastas, Wiley VCH.*
2. *Green Chemistry and Engineering: A Practical Design Approach by C J González and D J C Constable, Wiley.*
3. *Green Chemistry and Engineering: A Pathway to Sustainability by A E Marteel Parrish and M A Abraham, Wiley.*
4. Pollution Prevention: Fundamentals and Practice' by Paul L Bishop (2000), McGraw Hill International.

Ref. Books

1. *Green Chemistry for Environmental Sustainability by S K Sharma and AMudhoo, CRC Press.*
2. Handbook of Organic Waste Conversion' by Bewik M.W.M
3. Non-conventional Energy Sources' by Rai G.D.

Subject Code	Course Title	L	T	P	C	QP
	SUSTAINABILITY ENGINEERING	**3**	**0**	**0**	**3**	**A**

Pre -Requisite:

Course Educational Objectives

CEO1: To develop an increased awareness among students on issues in areas of sustainability

CEO2: To make students understand the role of engineering and technology within sustainable development;

CEO3: To know the methods, tools, and incentives for sustainable product-service system development

CEO4: To establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.

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

CO1	have knowledge about the concept and importance of sustainability
CO2	understand different types of pollution and waste generation, their causes, effects and control
CO3	understand environmental management standards and environmental impact assessment
CO4	understand the concepts of biomimicking, green engineering, green building, sustainable habitat, sustainable urbanization

UNIT:1 **(10 Hours)**

Sustainability - Introduction, Need and concept of sustainability, Social- environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.

UNIT:2 **(10 Hours)**

Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste concepts, 3 R concept. Global environmental issues- Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print.

Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India.

UNIT:3 **(10 Hours)**

Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings. Sustainable cities, Sustainable transport.

Energy sources: Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy.

UNIT:4 **(10 Hours)**

Green Engineering, Sustainable Urbanisation, industrialisation and poverty reduction; Social and technological change, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books:

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.

Reference Books:

1. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
2. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
3. Treatise on Sustainability Science and Engineering, by Ibrahim S. Jawahir,Subhas K. Sikdar, and YinlunHuang(eds.), Springer, 2013.
4. Sustainable Development in Practice: Case Studies for Engineers and Scientists, by A. Azapagic and S. Perdan(eds.), Wiley-Blackwell, 2011.

Subject code	Title of The Subject	L	T	P		
	INTEGRATED SOLID WASTE MANAGEMENT	**3**	**0**	**0**		

Pre-Requisites (If any)-

Course Educational Objective

CEO1: To Understand the solid, hazardous waste and their treatment and disposal methods and Learn pollution control aspects for selected process industries.

CEO2:- To study various processing methods of polymers and elastomers.

CO1	Explain about the different types of solid waste
CO2	Understand the various collection and disposal method
CO3	Apply the knowledge to utilize solid waste in different way.
CO4	Develop new method for degradation process of solid waste

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	-	-	2	-	-	2	1	-	-	-	-	-	1	
CO2	-	-	1	-	-	2	3	-	-	-	-	-	2	
CO3	-	-	1	-	-	2	2	-	-	-	-	-	1	
CO4	-	-	1	-	-	1	1	-	-	-	-	-	2	

Unit:1 **10 (Hours)**

Solid waste Management: Sources, Composition and Properties of Municipal Solid Waste, Engineering principles; Generation, Onsite handling, storage and processing including segregation; Collection, Recycling, Transfer and transport,Wasteprocessing, Recovery of resources.

Unit:2 **10 (Hours)**

Waste processing technologies, Biological, chemical and thermal technologies – Composting, Anaerobic digestion, Incineration and pyrolysis,Disposal of solid waste including sanitary landfill, planning, siting, design, closure and post-closure monitoring

Unit:3 **10 (Hours)**

Regional/Integrated solid waste management related issues. Principles of E-waste Management. Biomedical waste: Regulatory framework, categorization; generation, collection, transport, treatment and disposal.

Unit:4 **10 (Hours)**

Hazardous Waste Fundamentals, Definition, Classification, Generation, Regulatory process, Current Management Practices, Treatment and Disposal Methods, Physicochemical processes, Biological processes, Stabilization and solidification; Thermal methods; Land disposal, Remediation of Contaminated Sites.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Edition.

2:3. LaGrega, M.D., Buckingham P.L., and EvansJ.C., Hazardous Waste Management, McGraw-Hill International Editions, 1994

Ref. Books 1:Martin E.J. and Johnson J.H., Hazardous Waste Management Engineering, van NostrandReinhold,1987.

2: Wentz C.A., Hazardous Waste Management, 2nd Edition, McGraw Hill, 1995

Subject Code	Subject	L	T	P	C	QP
BEEPE7042	**Entrepreneurship Development**	3	0	0	3	A

Course Educational Objectives

CEO1	Explore the entrepreneurial mindset and culture that has been developing in companies of all
CEO2	Examine the entrepreneurial process involved in both pursuing an entrepreneurial venture within a large company and the creating and managing a new enterprise for implementation of an entrepreneurial venture.
CEO3	Discuss the dynamics of participating on a business team and the power inherent in a team relative to individual effort
CEO4	Provide the background and tools necessary to understand and participate in the entrepreneurial process within a large company, in a new venture or as an investor

Course Outcomes

CO1	Understand the concepts of entrepreneurship and skills required to be an entrepreneur
CO2	Indentify the Business Opportunities to and evaluate the feasibilities of the Project; Prepare
CO3	Understand the formalities for setting up of a new venture and know the concepts of
CO4	Evaluate different financial institutions supporting small scale industry.
CO5	Develop skills of managing Finanace, Marketing and HR of a business organisation

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						3									
CO2						0		3			3				
CO3						0			2		2				
CO4						0					3				
CO5						0			3						
AVG						0.6		0.6	1		1.6				

SYLLABUS

UnitI **[10Hrs]**

Concept of Entrepreneurship, Motivation for Economic Development and Entrepreneurial Achievement, Enterprise and Society Why and how to start Business – Entrepreneurial traits and skills, Mind Vrs Money in Commencing New Ventures, Entrepreneurial success and failures, Environmental dynamics and change. Entrepreneurial Process Step by step approach to entrepreneurial start up Decision for Entrepreneurial start up.

UnitII **[10Hrs]**

Identifying the Business opportunity - Business opportunities in various sectors, formalities for setting up small enterprises in manufacturing and services, Environmental pollution and allied regulatory and non-regulatory clearances for new venture promotion in SME sector. Writing a Business plan, components of a B-Plan, determining Bankability of the project.

Unit – III **[10 Hrs]**

Central / State level Institution promoting SME. Financial Management in small business. Marketing Management, problems & strategies Problems of HRM – Relevant Labour – laws. Sickness in Small Enterprises. Causes and symptoms of sickness – cures of sickness. Govt. policies on revival of sickness and remedial measures.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Book:

1. Robert Hisrich, & Michael Peters: Entrepreneurship, TMH, 2009.Dollinger:

Entrepreneurship, Pearson, 2009.

Reference Book:

1. Agarwal: Indian Economy, WishwaPrakashan 2009.
2. Dutt&Sundaram: Indian Economy,S.Chand, 2009
3. B D Singh.:Industrial Relations &Labour Laws, Excel, 2009.
4. ArunaKaulgud: Entrepreneurship Management by, Vikas publishing house, 2009.
5. Essential of entrepreneurship and small business management by Thomas W.Zimmerer& Norman M.Searborough, PHI-2009.
6. ND Kapoor: Industrial Law, Sultan Chand & Sons, 2009

Subject Code	Subject	L	T	P	C	QP
BMGHS3061	Engineering Economics & Costing	3	0	0	3	A

Course Educational Objectives

CEO1	To impart the knowledge of economic principles and engineering principles to solve engineering problems
CEO2	To make proficient in the evaluation of engineering proposals in terms of worth and cost
CEO3	To convey various economics concepts and theories towards making rational economic decision

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

CO1	Explain the basic economic concepts on micro economics in terms of the law of demand and supply and price determination in the market.
CO2	Outline the various theories of productions in short run as well as in long run
CO3	Evaluate and appraise the tool of break even analysis to make production decisions of the firm and make use of depreciation calculations
CO4	Formulate and apply interest factors to real life engineering problems and evaluate engineering alternatives with the help of economic analytical techniques
CO5	Understand the financial structure of Indian economy, measuring national income, and measures of control of inflation

CO-PO & PSO Mapping

POS/COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	0	0	0	0	0	1	0	0	0	0	2	2			
CO2	0	0	0	0	0	1	0	0	0	0	3	1			
CO3	0	0	0	0	0	1	0	0	0	0	3	2			
CO4	0	0	0	0	0	2	0	0	0	0	3	1			
CO5	0	0	0	0	0	2	0	0	0	0	3	2			
Avg.	0	0	0	0	0	1.4	0	0	0	0	2.8	1.6			

SYLLABUS

UNIT:1 (No of Hours):12hrs

Engineering Economics –

Meaning, Nature, Scope, Basic problems of an economy, Micro economics and Macro Economics.Demand and Supply Analysis -Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand &its measurement (Simple numerical problems to be solved) Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).Theory of Production -Production function, Laws of returns: Law of variable proportion, Law of returns to scale

UNIT:2 (No of Hours):12hrs

Cost and revenue concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into Fixed and variable costs. Basic understanding of different market structures, Price and output Determination under perfect competition (Simple numerical problems to be solved),

Break Even Analysis -

Linear approach (Simple numerical problems to be solved). Depreciation-Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation (Straight line

method, Declining balance method)

UNIT:3 (No of Hours):12hrs

Time value of money -Interest Analysis - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.

Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects. Sensitivity Analysis, Replacement Analysis- Determination of economic life of an asset, Replacement of existing asset with a new asset.

UNIT:4 (No of Hours):10 hrs

Overview of Indian financial system. Commercial bank, Functions of commercial bank, Credit creation, Central bank, Functions of Central Bank. Inflation-Meaning of inflation, types, causes, measures to control inflation. National Income - Definition, Concepts of national income, Method of measuring national income

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books

1, Vengedasalam, Deviga. Madhavan, Karunagaran, Principles of Economics, Oxford University Press.

2. R. Paneer Seelvan, " Engineering Economics", PHI

3. Ahuja,H.L., "Principles of Micro Economics" , S.Chand & Company Ltd

4.Paul, R.R., Money, Banking and International Trade, Kalyni Publishers.

.

Reference Book:

1. Riggs,J.L., Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India

2. Park, Chan.S, "Fundamental of Engineering Economics", Pearson.

3. Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson

4. Thuesen, G.J.,Fabrycky,. Engineering Economy, PHI.

UG IN CHEMICAL ENGINEERING

VIII SEMESTER [FOURTH YEAR]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses		Safety in Chemical Industries Nanotechnology Physical and Analytical Chemistry Water Conservation and Management	3	0	0	3
2	Open Elective Courses		Open Elective - 4	3	0	0	3
3	Open Elective Courses		Open Elective - 5	3	0	0	3
4	Project		Project Work-II & Dissertation	0	0	12	6
5	Project		Seminar and Comprehensive Viva-Voce	0	0	4	2
			Total Credits:	**9**	**0**	**16**	**17**

Subject code	Course Title	L	T	P	C	QP
BCHPE8021	NANOTECHNOLOGY	3	0	0	3	

Course Outcome

Pre-Requisites (If any)-

CO1	Explain properties on nano particle .
CO2	Make use of various instrument like SEM, TEM , STM and DLS
CO3	Describe about the chemical engineering process and nano synthesis process
CO4	Apply the knowledge of nano technology in different field

Unit:1 **10 (Hours)**

Nano Scale, history and Scope of Nano Technology., Nanomaterials, Morphology. Enhanced properties at nano scale. Comparison with bulk materials.

Unit:2 **13 (Hours)**

Top Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Son chemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Introduction to Instrumentation and characterization Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential,SEM, TEM, AFM, STM, DLS, Spectroscopy. etc.

Unit:3 **12 (Hours)**

Kinetics at Nanoscale,Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH,

Carbon Nanomaterials,Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones ,Difference between Chemical Engineering processes and nanosynthesis processes

Unit:4 **10 (Hours)**

Applications of Nano Technology.Applications in Chemical Engineering like nanocatalyst, bio analytical tools, nano/micro arrays, nano devices

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2.Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.

Ref. Books 1: Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
2:. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.

Subject code	Course Title	L	T	P	C	QP
BCHPE8013	PHYSICAL AND ANALYTICAL CHEMISTRY	3	0	0	3	

Course Outcome

Pre-Requisites (If any)-Organic Chemistry, Inorganic Chemistry

Course Educational Objective

CEO1: To enable the students to acquire knowledge in the field of electrochemistry, solubility behaviour, photochemical reactions and colloidal chemistry, adsorption towards different applications

CEO2 : To enable the students to acquire knowledge in the field of chromatography, spectroscopy for analytic purposes

CO1	Explain the behavior of and interactions between, matter and energy at the atomic and molecular levels
CO2	Apply quantitative reasoning skills to determine quantities of matter and energy involved in physical and chemical changes.
CO3	Analyze the atomic structure, chemical bonding and molecular geometry based model
CO4	Adopt the workings environment to work with various instruments

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	0	0	-	-	-	-	-	-	-	-	3	
CO2	3	3	0	0	-	-	-	-	-	-	-	-	2	
CO3	2	2	2	1	-	-	-	-	-	-	-	-	1	
CO4	1	0	0	0	-	-	-	-	-	-	-	-	2	

Unit:1 **11 (Hours)**

Colloidal system-Introduction and properties of colloidal systems, (preparation details not required), electrical properties, electro kinetic properties: electrophoresis and electro-Osmosis, gels and emulsions Simple mixtures: Partial molar quantities, Theory of mixing; Solution of non-volatile solutes; Colligative properties; Mixture of volatile liquids; Phase rule and phase equilibrium.

Unit:2 **12 (Hours)**

Electro-kinetic phenomena: Ion Transport, Conductivity and Ionic Interactions; Conduct metric titration; Processes at electrode (Electrical double layer, Rate of charge transfer, Over potential and other related aspects); Electrochemical processes; Power generation and storage (Fuel cells, Storage batteries); Corrosion and electrolysis (Elementary idea only).

Unit:3 **10 (Hours)**

Adsorption at surfaces: Growth and structure of solid surfaces; Physical adsorption, and chemical adsorption; applications of adsorption, adsorption of gases by solids Extent of adsorption and adsorption isotherms; Freundlich adsorption isotherm; B.E.T. theory of multilayer adsorption.

Unit:4 **13 (Hours)**

Chromatography and chromatographic methods of analysis. Atomic and molecular spectra: Spectra of simple and complex atoms; General features of spectroscopy; Rotation and vibration of molecules; Electron Spin and Nuclear Magnetic Resonance, Atomic absorption spectroscopy; UV and Visible spectro-photometry; IR absorption spectroscopy; Fluorescence spectroscopy; Mass spectroscopy; Emission spectroscopy; Introduction to NMR spectroscopy; Raman spectroscopy; Moss Bauer spectroscopy.

Teaching Mentod (s):Chalk & Board/PPT

Text Books

1: Puri. B.R., Sharma. L.R.and Madan. S. Pathania, “Principles of Physical Chemistry”, 44th Edn., Vishal Publishing Co, Jallandhar, 2010

2: Samuel. H, Maron and Carl.F, Prutton, Principles of Physical Chemistry, 4th Edn., Amerind Publishing Co., 1972.

Ref. Books

1: Seamus P.J. Higson: Analytical Chemistry.

2: Douglas A. Skoog and Donald M..West: Fundamentals of Analytical Chemistry.

Subject code	Course Title	L	T	P	C	QP
BCHPE8014	**Water Conservation and Management**	**3**	**0**	**0**	**3**	

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

Pre-Requisites (If any)-

CO1	Understand the economic, social and environmental issues associated with water use.
CO2	Calculate peak runoff rates and volumes for storm water in natural and developed landscapes.
CO3	Design and detail water conservation and management projects including water harvesting, constructed wetlands and biological treatment of sewage and storm water.
CO4	Produce designs and technical drawings for drip irrigation and water management plans.

Unit:1 **11 (Hours)**

Concepts of Hydrology: Hydrological cycle, water balance, precipitation, infiltration, evaporation and evapo-transpiration, Rainfall-runoff relationships, Hydrologic instrumentation, Flood flows, Low Flows. Urban Hydrology, Groundwater, Groundwater chemistry, contamination and pollution prevention.

Unit:2 **12 (Hours)**

Water Quality: Physical water quality parameters, Chemical water quality parameters, Biological water quality parameters, Water quality requirements and water quality standards.

Water pollution: Freshwater Pollution, Estuarine water pollution, Marine pollution, Water quality in rivers and lakes: parameters of organic content of water quality, DO and BOD in streams, transformation process in water bodies, oxygen transfer by inter phase transfer in water bodies, turbulent mixing in rivers, water quality in lakes and reservoirs, groundwater quality.

Unit:3 **10 (Hours)**

Water conservation: Global water crisis figures, increased global water stress, Global Climate change, Water availability and usage , water audits, Goals of water conservation, History of water conservation in India, Principles of water harvesting and conservation, traditional and modern Water conservation techniques, cost analysis, Benefits of water conservation, water conservation in homes; water conservation in the work place; water conservation in agriculture; water conservation in process industry; water conservation in construction industry; water conservation in service industry.

Unit:4 **13 (Hours)**

Water governance and water policy issues, water, sustainability, and development, Water Resources Management: Functions of Water Resources Management, Water Scarcity and its impacts, Water Shortages vs. WRM, Water Resources Management in india. Water Demand Management: Concept, Potential Stresses on Water Demand, The Demand Management Approach, Water Demand and Water Quality Management, methods and techniques for water management, Integrated Water Resources Management: Definition of IWRM, IWRM Principles, How to Implement IWRM, Legislative and Organizational Framework, Methods of testing water quality. Preserving water quality, minimizing evaporation, water sanitation,

Teaching Mentod (s):Chalk & Board/PPT

Text Books

1. Environmental Engineering, Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
2. Water Resources Management, by Libor Jansky,

Ref. Books

1. "System Approach to Water Management" by A K Biswas, McGraw-Hill Inc.,US
2. "Water Resources Systems Engineering" by W A Hall and J A Dracup

OPEN ELECTIVE (OE)

DEPARTMENT OF CHEMICAL ENGINEERING				
SL NO.	**OE 1**	**OE 2**	**OE 3**	**OE 4**
1	UPSTRAM PROCESS ENGINEERING	BIOCHEMICAL REACTION ENGINEERING	FUEL AND ENERGY TECHNOLOGY	INTEGRATED SOLID WASTE MANAGEMENT
2	BASIC CHEMICAL ENGINEERING	NOVEL SEPERATION TECHNIQUES	GREEN TECHNOLOGY	POLLUTION AND ITS CONTROL
3	PROCESS UTILITY AND INDUSTRIAL SAFETY	CORROSION ENGINEERING	BATTERY TECHNOLOGY	TREATMENT OF INDUSTRIAL EFFLUENT

OPEN ELECTIVE – 1						
SL NO	**SUBJECT CODE**	**SUBJECT**	**L**	**T**	**P**	**CREDIT**
1	BCHOE5051	UPSTRAM PROCESS ENGINEERING	3	0	0	3
2	BCHOE5052	BASIC CHEMICAL ENGINEERING				
3	BCHOE5053	PROCESS UTILITY AND INDUSTRIAL SAFETY				
OPEN ELECTIVE – 2						
1	BCHOE6051	BIOCHEMICAL REACTION ENGINEERING	3	0	0	3
2	BCHOE6052	NOVEL SEPERATION TECHNIQUES				
3	BCHOE6053	CORROSION ENGINEERING				
OPEN ELECTIVE – 3						
1	BCHOE7051	FUEL AND ENERGY TECHNOLOGY	3	0	0	3
2	BCHOE7052	GREEN TECHNOLOGY				
3	BCHOE7053	BATTERY TECHNOLOGY				
OPEN ELECTIVE – 4						
1	BCHOE8031	INTEGRATED SOLID WASTE MANAGEMENT	3	0	0	3
2	BCHOE8032	POLLUTION AND ITS CONTROL				
3	BCHOE8033	TREATMENT OF INDUSTRIAL EFFLUENT				

Subject Code	Title of The Subject	L	T	P	C	QP
BCHOE5051	UPSTREAM PROCESS ENGINEERING					

Course Outcome

Pre-Requisites (If any)-

CO1	Describe the operation, as well as constriction and exploitation characteristics of machines for mechanical operations.
CO2	Solve simple radiation heat transfer problems
CO3	Make use of empirical equations to solve forced and natural convection heat-transfer problems
CO4	Design the distillation column

Unit:1 **10 (Hours)**

Processing of particulates Properties and handling of particulate solids, size reduction equipments- working principles of crusher, grinder and pulveriser, screening and particle size distribution.

Unit:2 **10 (Hours)**

Methods of analysis and description - fluid as a continuum, Classification of fluid. Fluid statics – basic equation - equilibrium of fluid element – Hydrostatic Pressure, Pressure measuring Devices. Flow in boundary layers. Its formation & growth in tubes & plates. Basic equations of fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices; Venturi, Orifice, Pitot tube & Rotameter.

Unit:3 **12 (Hours)**

Modes of heat transfer, basic laws of heat transfer, Conduction: The Fourier heat conduction equation, Steady-state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces, critical insulation of thickness. Introduction to convection: Natural and forced convection, Natural Convection: Grashoff number, natural convection from vertical and horizontal surfaces. Forced convection, The convective heat transfer coefficient, Types of heat exchangers, log-mean temperature difference, energy balances, overall heat transfer coefficients

Unit:4 **13 (Hours)**

Introduction to Mass transfer operations, moleculardiffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolal counter current diffusion, Stefan-Maxwell equation, diffusivity of gases and liquids,application of molecular diffusion, mass transfer coefficients, in laminar and turbulent flow, Interphase mass transfer, Film theory, Penetration theory, surface-renewal theories, analogy between mass, heat and momentum transfer. relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation steam distillation, azeotropic and extractive distillation. Continuous distillation

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1:.McCabe, Smith and Harriot, Unit Operations of Chemical Engineering
2. Foust et al, Principles of Unit Operations.

Ref. Books 1: Badger and Banchero. Introduction to Chemical Engineering.
2: Foust, Wenzel, Clump, Maus and Andersen, Principles of Unit Operations.

Subject Code	Title of the subject	L	T	P		
BCHOE5052	**PROCESS UTILITY AND INDUSTRILA SAFETY**	3	0	0		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain the different types of safety precaution to be taken in working environment.
CO2	Describe the various safety rules and regulation
CO3	Developed a new safety methods
CO4	Study the different hazardous effect of accident inside the plant.

Unit:1 **10 (Hours)**

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

Unit:2 **10 (Hours)**

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

Unit:3 **10 (Hours)**

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.Compressed air:Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air – Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

Unit:4 **10 (Hours)**

History of Safety movement–Evolution of modern safety concept-general concepts of management–planning for safety for optimization of productivity-productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy.
Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Eckenfelder, W. W, Jr. “Industrial Water Pollution Control” McGraw-Hill: New York, 1966.
2: P. L. Ballaney, “Thermal Engineering”, Khanna Publisher New Delhi, 1986.

Ref. Books 1: P. N. Ananthanarayan, “Basic Refrigeration & Air conditioning”, Tata McGraw Hill, New Delhi,2007

Subject code	Title Of The Subject	L	T	P		
BCHOE6051	BIO-CHEMICAL REACTION ENGINEERING	3	0	0		

Course Outcome

Pre-Requisites (If any)-

CO1	Describe the bioprocess monitoring/control
CO2	Design of ideal reactors for single and complex reactions and non-isothermal reactors
CO3	Illustrate operation and choice of bioreactor
CO4	Explain heat & mass transfer and scale up of bioprocesses

Unit:1 **10 (Hours)**

Material Balance & Energy Balances: Mathematical requisites – use of log-log and semi-log graph paper, triangular diagram, graphical differentiation and graphical integration, material balance without chemical reaction, material balance with chemical reaction, energy balance; enthalpy changes, heat of reaction and its temperature dependence, heats of solution and mixing, adiabatic flame temperature, use of psychometric charts.

Unit:2 **10 (Hours)**

Kinetics of homogeneous reactions: classification of reactions, reaction rate, speed of reaction, rate equation, concentration-dependent term of rate equation, rate constant, order and molecularity, representation of elementary and nonelementary reactions, kinetic models for nonelementary reactions, temperature-dependent term of a rate equation, activation energy and temperature dependency.

Unit:3 **13 (Hours)**

Kinetic analysis of batch reactor data: Integral and differential methods for analyzing kinetic data, interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, half life period, irreversible reaction in parallel and series, auto catalytic reaction. Kinetic interpretation of batch reactor data for single reactions: interpretation of variable volume batch reaction data for zero, first and second order reactions, Ideal batch reactor, steady state CSTR and plug flow reactors and their use for kinetic interpretation. Design for single reaction: size comparison of single reactors, plug flow reaction in series and/or parallel, equal and different size of mixed reactor in series, finding the best system for given conversion, recycle reactor, Design of multiple reactions in batch, CSTR and PFR.

Unit:4 **12 (Hours)**

Biochemical reaction systems: Cell and enzyme fermentation, Monod's model of growth kinetics. Kinetics of Enzyme catalyzed reactions for free and immobilized enzymes. – derivation of Michaelis-Menten equation, Briggs-haldane relationship, the determination and significance of kinetic constants, Lineweaver-burk and Eadie-Hofstee plot, principles of enzyme inhibition – Competitive, noncompetitive and uncompetitiveMichaelish-Menten kinetics, inhibition by foreign substances, kinetics of competitive and noncompetitive inhibitions, microbial fermentation, batch fermentor and mixed flow fermentor, kinetic expressions of fermentation.

Teaching Mentod (s):Chalk & Board/PPT/Video Lecture

Text Books 1:Chemical process Principles (Part I & II), Houge, Watson & Ragatz, Asian Student Edition Asia Publishing House
2.Basic Principles and Calculations in Chemical Engineering, Himmelbalu, Prentice Hall (l) 6th Ed.

Ref. Books 1:Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.
2:Smith & Vanes, Thermodynamics for Chemical Engineers, MGH.

Subject code	Title of the Subject	L	T	P		
BCHOE6052	NOVEL SEPARATION TECHNIQUES	3	0	0		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain about Types of membrane available in details.
CO2	Describe the various filtration processes.
CO3	Illustrate the idea about electric field separation process
CO4	Develop a separation technique in terms of modeling.

Unit:1 **10 (Hours)**

Membrane, Classification, characterization and preparation of membrane, Membrane modules, Classification of membrane separation processes, Materials of membrane construction, Advantages of membrane processes, Major areas of application, preparation and characteristics of membranes.

Unit:2 **10 (Hours)**

Principles of membrane separation processes: Reverse osmosis, nano-filtration, ultra-filtration, micro-filtration, osmotic controlled filtration, gel layer controlled filtration. Basic principles and modeling of dialysis

Unit:3 **10 (Hours)**

Electric field separation process: Zeta potential, electric double layer, Basic modeling of electric field enhanced filtration, Ionic separations like Electro dialysis, Electrophoresis. Ion exchange chromatography.

Unit:4 **10 (Hours)**

Liquid membrane and its modeling. Basic design of gas separation and pervaporation. Cryogenic separation; Super- critical extraction, Reactive distillation.

Teaching Method (s):Chalk & Board/PPT/Video Lectures

Text Books 1: C.J.Geankoplis-"Transport processes and unit Operations", PHI, New Delhi
2.Ronald W.Roussel- Handbook of Separation Process Technology, John Wiley.

Ref. Books 1:Ullmanns, Encyclopedia of Industrial Chemistry, Vol 32, Wiley - VCH.6.
2:Kausikh Nath-"Membrane separation Praocesses",PHI,New Delhi.

Subject code	Title of the subject	L	T	P		
BCHOE6053	**COROSION ENGINEERING**	3	0	0		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain about Types of corrosion available in details.
CO2	Describe the various corrosion controlled processes.
CO3	Illustrate the idea about prevention strategies process
CO4	Develop a microbial influenced corrosion in terms of case studies.

Unit:1 **11 (Hours)**

Corrosion – introduction, definitions and types,Electrochemical cells-definitions and Principles,Potential measurements – galvanic cells, concentration cells.,EMF and Galvanic series – bimetallic couples., Eh-pH diagrams – fundamental aspects.,Construction of Eh – pH diagrams. Fe- H2O-O2 diagram.,Copper, Aluminium and general corrosion diagrams

Unit:2 **10 (Hours)**

Electrode – solution interface –definition and types of polarization.Exchange current density – polarization relationships.,Polarization techniques – corrosion rate determination.,Mixed potentials – concepts and Basics.,Mixed potential theory – bimetallic couples,Mixed potential theory – activation and diffusion controlled processes

Unit:3 **12 (Hours)**

Prevention strategies – design and coatings, Prevention strategies – inhibitors and surface engineering. Cathodic protection – principles and classification.,Cathodic protection – influencing factors and monitoring., Design aspects for cathodic protection. Stray current corrosion.,Passivity – definitions and influencing parameters,Passivity – application of mixed potential theory,Passivity – design of corrosion resistant alloys. Anodic protection

Unit:4 **12 (Hours)**

Microbially influenced corrosion (MIC– definitions, environments and microbiology,MIC - Electrochemical aspects and general mechanisms., MIC – Bacterial transport, attachment and affected materials. MIC - Role of aerobic and an aerobic microorganisms Mechanisms and models for SRB corrosion. MIC and Biofilms. MIC – case studies and mechanisms

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures /MOOC/ Internship/Industry Guest Lecture/Invited Guest Lecture Demonstration.
(can be chosen one or many)

Text Books 1:Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).
2.M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company (NY) (1987).

Ref. Books 1:H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).
2:M.Pourbaix, Atlas of Electrochemical Equilibria in aqueous solutions, NACE, Houston (1974).

Subject code	Title of the Subject	L	T	P		
BCHOE7051	**FUEL TECHNOLOGY** **Course Educational Objective**					
Course Outcome						
Pre-Requisites (If any)-						
CO1	Differentiate solid, liquid and gaseous fuels					
CO2	Apply the knowledge of characterization techniques for fuels					
CO3	Develop the alternate energy sources					
CO4	Explain the modern energy conversion technologies					
Unit:1 **10 (Hours)** Fuels: Solid Fuels : Coal - Origin, Chemical composition, calorific value, Classifications, Characteristics & distribution of Indian coals, Storage and spontaneous combustion of coal, Coal washing and blending, Pertrographic constituents of coal, Carbonization of coal, manufacture and properties of metallurgical coke, recovery of by-products						
Unit:2 **10 (Hours)** Liquid Fuels : Origin and composition of crude oil, crude oil distillation and its products with special reference to gasoline, Kerosene and diesel oil, cracking and reforming, Coaltar distillation Products, Shale oil.						
Unit:3 **10 (Hours)** Gaseous Fuels: Natural gas, coal gas. Coke oven and blast furnace gas, Manufacture of Water gas and producer gas, Carburetted water gas. Synthetic Fuels : Hydrogenation of coal, fischer – Tropsch synthesis,						
Unit:4 **10 (Hours)** Gaseous Fuels: Natural gas, coal gas. Coke oven and blast furnace gas, Manufacture of Water gas and producer gas, Carburetted water gas. Synthetic Fuels : Hydrogenation of coal, fischer – Tropsch synthesis.						
Teaching Mentod (s):Chalk & Board/PPT/Video Lectures						
Text Books 1: Fuels and Combustion - S. Sarkar 2.Elements of Fuel Technology - Himus						
Ref. Books 1:Solid, Liquid and gaseous fuel - Brame and King. 2: Elements of Fuels, Furnaces and Refractories, O. P. Gupta						

Subject code	Title of the subject	L	T	P		
BCHOE7052	**GREEEN TECHNOLOGY** **Course Educational Objective**	**3**	**0**	**0**		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain the industrial ecology in green technology
CO2	Understand the material and energy balance
CO3	Compare benefit of non conventional ennergy over conventional energy
CO4	Apply the knowledge for utilization of non conventional energy

Unit:1 **10 (Hours)**

Green Technology – definition- Importance – Historical evolution – advantages and disadvantages of green technologies-factors affecting green technologies- Role of Industry, Government and Institutions – Industrial Ecology – role of industrial ecology in green technology.

Unit:2 **12 (Hours)**

Definition – Importance – Historical evolution – Principles of Cleaner Production–Benefits–Promotion – Barriers – Role of Industry, Government and Institutions – clean development mechanism, reuse, recovery, recycle, raw material substitution-Wealth from waste, case studies. Overview of CP Assessment Steps and Skills, Process Flow Diagram, Material Balance, CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives – Total Cost Analysis – CP Financing – Preparing a Program Plan – Measuring Progress-ISO 14000.

Unit:3 **10 (Hours)**

Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement, carbon credit, carbon sequestration, carbon trading, Life Cycle Assessment – Elements of LCA – Life Cycle Costing – Eco Labelling.

Unit:4 **13 (Hours)**

Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Non-conventional energy sources: Solar Energy-solar energy conversion technologies and devices, their principles, working andapplication. Definition-benefits and challenges – comparison of green fuels with conventional fossil fuels with reference to environmental, economical and social impacts- public policies and market-driven initiatives. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures
(can be chosen one or many)

Text Books 1: Pollution Prevention: Fundamentals and Practice' by Paul L Bishop (2000), McGraw Hill International.

2:Pollution Prevention and Abatement Handbook – Towards Cleaner Production' by World Bank Group (1998), World Bank and UNEP, Washington D.C.

Ref. Books 1:Handbook of Organic Waste Conversion' by Bewik M.W.M

2:Non-conventional Energy Sources' by Rai G.D.

Subject code	Title of the subject	L	T	P		
BCHOE7053	**BATTERY TECHNOLOGY** Course Educational Objective					
Course Outcome						
Pre-Requisites (If any)-						
CO1	Explain about Types of battery available in details.					
CO2	Describe the various battery manufacturing processes.					
CO3	Illustrate the idea about fuel cell.					
CO4	Apply the knowledge for recycle and reuse of battery.					

Unit:1 **10 (Hours)**

General background on alternative energy sources and sustainability, Introduction to electric-based transportation, Introduction to battery, Dry Cell, Alkaline Battery, Li-ion batteries (main focus) ,Principle of operation ,Battery components and design ,Electrode, cell and battery fabrications ,Building block cells, battery modules and packs ,Li, polymer, batteries and applications ,All solid state batteries and future developments ,Li-S battery, future battery ,Li-Air battery, frontier battery.

Unit:2 **10 (Hours)**

Sodium-battery ,Magnesium battery ,Aluminum battery ,Silicon battery, Nickel Metal Hydride Battery :Advance Ni-MH batteries for transportation ,Future prospects of Ni-MH batteries vs. lithium ion batteries, Lead-acid battery Advance lead-acid batteries Horizontal plate Pb-Acid batteries for transportation Cylindrical Pb-Acid battery vs. flat plate system,High temperature batteries for back-up applications Zebra cell Li-iron sulfide cells Li-S cells Flow batteries for load leveling and large scale grid application Vanadium and iron based batteries Semi-fluid flow batteries Ni-Hydrogen batteries for space and marine applications Ni-H2 cells for space applications

Unit:3 **10 (Hours)**

Introduction to fuel cells PEM and alkaline fuel cells for transportation Solid oxide fuel cells Hydrogen storage systems Solid state hydrogen storage tanks Gas phase hydrogen storage tanks Cryogenic hydrogen storage tanks Liquid phase hydrogen storage tanks Fuel reformers Advanced fuel reformers

Unit:4 **10 (Hours)**

Technology and economic aspects of battery recycling ,Battery Applications for Stationary and Secondary Use, Regulations and Safety Aspects of High Voltage Batteries ,Code and Standards Safe handling of Lithium Batteries ,Safety of high voltage devices

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures
(can be chosen one or many)

Text Books 1: G-A. Nazri and G. Pistoa, Lithium Batteries, Science and Technology, Kluwer Academic Publisher, 2003.

2:H. A. Kiehne, “Battery Technology Handbook,” Marcel Dekker, NYC, 2003.

Ref. Books 1:. James Larminie and John Lowry, “Electric Vehicle Technology Explained,” John Wiley, 2003.

2:.D. Linden and T. S. Reddy, “Handbook of Batteries,” 3rd Edition, McGraw-Hill, 2002.

Subject code	Title of the subject	L	T	P		
BSHOE8033	**TREATMENT OF INDUSTRIAL EFFULUENT** **Course Educational Objective**	**3**	**0**	**0**		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain about the various disposal and biological treatment process
CO2	Describe various air and water treatment methods
CO3	Apply the knowledge in developing new digester for treatment process
CO4	Make use of various chemical and biological process for effluent treatment.

Unit:1 **10 (Hours)**

General Characteristics of Industrial effluents, effects on Environment –ISI tolerance limits for discharging industrial effluents into surface water, into public sewers and on to land for Irrigation.

Unit:2 **10 (Hours)**

Hazardous Waste Fundamentals, Definition, Classification, Generation, Regulatory process, Current Management Practices, Treatment and Disposal Methods, Physicochemical processes, Biological processes.

Unit:3 **10 (Hours)**

Necessity of treatment –Segregation – Process changes – Salvaging –By Product Recovery –Ion Exchange, Electro dialysis, Solvent Extraction,Floatation – Removal of Nitrogen and Phosphorus – Boiler water treatment methods and cooling water treatment methods.

Unit:4 **10 (Hours)**

Sources, characteristics and treatment of Sugar, Dairy, Distilleries,treatment of power plants, oil refineries,cement and steel.,Paper and pulp, tanneries, textiles, fertilizers and pharmaceuticals

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures
(can be chosen one or many)

Text Books 1:Rao, M.N. & Dutta, A.K. “Waste Water Treatment”, 3rd Edition, IBH Publishers, 1982
2. Metcalf and Eddy. “Waste water Engineering – Collection, Treatment, Disposal and Reuse”, Mc Graw Hill Pub. Co., 1995.

Ref. Books 1:Numersorn. N.L., “Liquid Waste from industry – theories, Practice and Treatment”.
2: Bhide, A.D. & Sunderesan, B.B. “Solid Waste Management”, INSDOC, NEERI, Nagpur 1994

Subject code	Title of the subject	L	T	P		
BCHOE8032	**POLUTATION AND ITS CONTROL** Course Educational Objective	3	0	0		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain about the different types of solid waste
CO2	Understand the various collection and disposal method
CO3	Apply the knowledge to utilize solid waste in different way.
CO4	Develop new method for degradation process of solid waste

Unit:1

10hrs Air Pollution: Air pollution Control Methods–Particulate control devices – Methods of Controlling Gaseous Emissions – Air quality standards.Noise Pollution: Noise standards, Measurement and control methods – Reducing residential and industrial noise – ISO14000

Unit:2 **10 (Hours)**

Industrial wastewater Management: – Strategies for pollution control – Volume and Strength reduction Neutralization – Equalization – Proportioning – Common Effluent Treatment Plants – Recirculation of industrial wastes – Effluent standards.

Unit:3 **11 (Hours)**

Solid Waste Management: solid waste characteristics – basics of on-site handling and collection – separation and processing – Incineration- Composting-Solid waste disposal methods – fundamentals of Land filling. Environmental Sanitation: Environmental Sanitation Methods for Hostels and Hotels, Hospitals, Swimming pools and public bathing places, social gatherings (melas and fares), Schools and Institutions, Rural Sanitation-low cost waste disposal method

Unit:4 **12 (Hours)**

Hazardous Waste: Characterization – Nuclear waste – Biomedical wastes – Electronic wastes – Chemical wastes – Treatment and management of hazardous waste-Disposal and Control methods. Sustainable Development: Definition- elements of sustainable developments-Indicators of sustainable development-Sustainability Strategies- Barriers to Sustainability–Industrialization and sustainable development – Cleaner production in achieving sustainability- sustainable development

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Environmental Engineering, by Ruth F. Weiner and Robin Matthews – 4th Edition Elesevier, 2003.

2: Environmental Science and Engineering by J.G. Henry and G.W. Heinke – Pearson Education.

Ref. Books 1 Environmental Engineering by Mackenzie L Davis & David A Cornwell. McGraw Hill Publishing

Subject code	Title of the Subject	L	T	P		
BCHOE8031	**INTEGRATED SOLID WASTE MANAGEMENT** Course Educational Objective	3	0	0		

Course Outcome

Pre-Requisites (If any)-

CO1	Explain about the different types of solid waste
CO2	Understand the various collection and disposal method
CO3	Apply the knowledge to utilize solid waste in different way.
CO4	Develop new method for degradation process of solid waste

Unit:1 **10 (Hours)**

Solid waste Management: Sources, Composition and Properties of Municipal Solid Waste, Engineering principles; Generation, Onsite handling, storage and processing including segregation; Collection, Recycling, Transfer and transport,Wasteprocessing, Recovery of resources.

Unit:2 **10 (Hours)**

Waste processing technologies, Biological, chemical and thermal technologies – Composting, Anaerobic digestion, Incineration and pyrolysis,Disposal of solid waste including sanitary landfill, planning, siting, design, closure and post-closure monitoring

Unit:3 **10 (Hours)**

Regional/Integrated solid waste management related issues. Principles of E-waste Management. Biomedical waste: Regulatory framework, categorization; generation, collection, transport, treatment and disposal.

Unit:4 **10 (Hours)**

Hazardous Waste Fundamentals, Definition, Classification, Generation, Regulatory process, Current Management Practices, Treatment and Disposal Methods, Physicochemical processes, Biological processes, Stabilization and solidification; Thermal methods; Land disposal, Remediation of Contaminated Sites.

Teaching Mentod (s):Chalk & Board/PPT/Video Lectures

Text Books 1: Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Edition.

2:3. LaGrega, M.D., Buckingham P.L., and EvansJ.C., Hazardous Waste Management, McGraw-Hill International Editions, 1994

Ref. Books 1:Martin E.J. and Johnson J.H., Hazardous Waste Management Engineering, van NostrandReinhold,1987.

2: Wentz C.A., Hazardous Waste Management, 2nd Edition, McGraw Hill, 1995