

ACADEMIC YEAR
R-2023
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

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

www.giet.edu

4 Year B.Tech Degree Programme

Regulation 2023

Choice Based Credit System

Outcome Based Assessment

Chemical Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

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

PEO1: To produce highly qualified, well-rounded, and motivated graduates with a strong foundation in Chemical Engineering, equipped to pursue successful careers as professional chemical engineers in the Chemical and Allied Industries.

PEO2: To produce graduates well-prepared to pursue postgraduate studies and research in emerging and allied fields of Chemical Engineering.

PEO3: To provide students with opportunities to work in multidisciplinary teams, fostering the development of professional integrity, ethical values, and leadership skills.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Apply professional engineering knowledge to identify, analyze, and solve problems in chemical and allied fields, utilizing principles of Chemical Engineering and interdisciplinary skills

PSO2: Design eco-friendly chemical process systems with safety measures, using modern tools individually or in teams.

PSO3: Practicing engineering with professional ethics for the benefit of society with proper communication to the community.

PROGRAMME OUTCOMES (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

PO8: Individual and Collaborative Teamwork: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

Summary

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER								TOTAL CREDITS	%
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities, Social & Management Study (HS)	3	3	2	2	0	0	0	0	10	6.10
2	Management Course	0	1	0	0	2	2	0	0	5	3.05
3	Basic Sciences (BS)	4	7	4	0	0	0	0	0	15	9.15
4	Engineering Sciences (ES)	15	11	4	4	0	0	0	0	34	20.73
5	Professional Core (PC)	0	0	11	15	12	11	9	0	58	35.37
6	Professional Electives (PE)	0	0	0	0	3	3	3	6	15	9.15
7	Open Electives (OE)	0	0	0	0	3	3	3	3	12	7.32
8	Project Work, Seminar and/or Internship in Industry or elsewhere	0	0	1	1	3	2	4	4	15	9.15
9	Mandatory Courses (MC)			0	0					0	0
	TOTAL	22	22	22	21	23	21	20	13	164	100

I SEMESTER [First Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	BS	23BBSBS11001	Engineering Mathematics-I	3	1	0	4	40	60
2	BS	23BBSBS10002	Engineering Physics/	3	0	0	3	40	60
		23BBSBS10003	Engineering Chemistry						
3	ES	23BBSES10001	Basic Electrical and Electronics Engineering /	3	0	0	3	40	60
		23BBSES10002	Elements of Mechanical Engineering	3	1	0	4		
4	ES	23BBSES11003	Programming for Problem Solving	2	0	0	2	40	60
5	HS	23BBSHS11001	Communicative English and Soft Skills	2	0	0	2	40	60
6	HMS/ES	23BBSHS10002	Human Value & Professional Ethics/	1	0	0	1	Project Evaluation	
		23BBSES10004	Dietetics & Nutrition	1	0	0	1		
PRACTICAL / SESSIONAL									
1	BS	23BBSBS10102	Engineering Physics Laboratory	0	0	2	1	35	15
		23BBSBS10103	Engineering Chemistry Laboratory						
2	ES	23BBSES10101	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1	35	15
3	ES	23BBSES11103	Programming for Problem-Solving Laboratory	0	0	4	2	70	30
4	HS	23BBSHS11101	Communicative English and Soft Skills Laboratory	0	0	2	1	35	15
5	ES	23BBSES10105	Engineering Graphics & Design	1	0	2	2	70	30
		23BBSES10106	Engineering Workshop						
6	MC	23BBSMC11101	Induction Program(3 weeks)	0	0	0	0	0	0
TOTAL CREDIT							22		

II Semester [First Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	BS	23BBSBS12001	Engineering Mathematics-II	3	1	0	4	40	60
2	BS	23BBSBS10002	Engineering Physics/	3	0	0	3	40	60
		23BBSBS10003	Engineering Chemistry						
3	ES	23BBSES10001	Basic Electrical and Electronics Engineering /	3	0	0	3	40	60
		23BBSES10002	Elements of Mechanical Engineering	3	1	0	4		
4	ES	23BBSES12003	Data Structure & Algorithms	2	0	0	2	40	60
5	HS	23BBSHS12001	Communicative English & Technical Communication	2	0	0	2	40	60
6	ES/HMS	23BBSES10004	Dietetics & Nutrition/	1	0	0	1	Project Evaluation	
		23BBSHS10002	Human Value & Professional Ethics	1	0	0	1		
PRACTICAL / SESSIONAL									
1	BS	23BBSBS10102	Engineering Physics Laboratory	0	0	2	1	35	15
		23BBSBS10103	Engineering Chemistry Laboratory						
2	ES	23BBSES10101	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1	35	15
3	ES	23BBSES12203	Data Structure & Algorithms Laboratory	0	0	4	2	70	30
4	HS	23BBSHS12201	Communicative English and Technical Communication Laboratory	0	0	2	1	35	15
5	ES	23BBSES10105	Engineering Graphics & Design	1	0	2	2	70	30
		23BBSES10106	Engineering Workshop						
6	MC	23BBSMC12201	NSS/YOGA	0	0	0	0	0	0
TOTAL CREDIT							22		

III Semester [Second Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	BS	23BBSBS23001	Engineering Mathematics-III	3	1	0	4	40	60
2	ES	23BCSES23001	Object Oriented Programming using Java	3	0	0	3	40	60
3	PC	23BCHPC23001	Heat Transfer	3	0	0	3	40	60
4	PC	23BCHPC23002	Fluid Mechanics	3	0	0	3	40	60
5	PC	23BCHPC23003	Chemical Process Calculation	3	0	0	3	40	60
6	HS	23BBSHS23001	Intermediate Communication Skills and Critical Thinking	2	0	0	1	40	60
PRACTICAL / SESSIONAL								240	360
7	ES	23BCSES23101	Object Oriented Programming Using Java Lab	0	0	2	1	100	0
8	PC	23BCHPC23101	Heat Transfer Lab	0	0	2	1	100	0
9	PC	23BCHPC23102	Fluid Mechanics Lab	0	0	2	1	100	0
10	HS	23BBSHS23101	Intermediate Communication Skills and Critical Thinking - Lab	0	0	2	1	100	0
11	PSI	23BCHPW23101	Summer Industry Internship	0	0	2	1	100	0
12	MC	23BCHMC20010	Constitution of India /Essence of Indian Traditional Knowledge	0	0	0	0	0	0
				17	1	8	22	500	0
Total Credits:							22	740	360

IV Semester [Second Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	ES	23BCSES24001	Data Base Management System	3	0	0	3	40	60
2	PC	23BCHPC24001	Chemical Engineering Thermodynamics	3	0	0	3	40	60
3	PC	23BCHPC24002	Mass Transfer-I	3	0	0	3	40	60
4	PC	23BCHPC24003	Mechanical Operations	3	0	0	3	40	60
5	PC	23BCHPC24004	Numerical Methods in Chemical Engineering	3	0	0	3	40	60
6	HS	23BBSHS24001	Advanced Communication Skills and Professional Ethics	2	0	0	1	40	60
PRACTICAL / SESSIONAL								240	360
7	PC	23BCHPC24101	Thermo-physical Lab	0	0	2	1	100	0
8	PC	23BCHPC24102	Mass Transfer-I Lab	0	0	2	1	100	0
9	PC	23BCHPC24103	Mechanical Operations Lab	0	0	2	1	100	0
10	HS	23BBSHS24101	Advanced Communication Skills and Professional Ethics Lab	0	0	2	1	100	0
11	PSI	23BCHPW24101	Project	0	0	2	1	100	0
12	MC	23BBSMC24401	Environmental Sciences	0	0	2	0	0	0
				17	0	12	21	500	
Total Credits:							21	740	360

V Semester [Third Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	PC	23BCHPC35001	Chemical Process Technology	3	0	0	3	40	60
2	PC	23BCHPC35002	Chemical Reaction Engineering- I	3	0	0	3	40	60
3	PC	23BCHPC35003	Mass Transfer-II	3	0	0	3	40	60
5	PE	23BCHPE35001	Computational Fluid Dynamics	3	0	0	3	40	60
			Biochemical Engineering						
			Process Utility and Industrial Safety						
			Multicomponent Distillation						
6	OE	23BCHOE35001	Open Elective – 1(MS)	3	0	0	3	40	60
7	MS	23BCHHS35001	Organizational Behavior	2	0	0	2	40	60
			Engineering Economics and Costing						
PRACTICAL / SESSIONAL								240	360
7	PC	23BCHPC35101	Chemical Process Technology Lab	0	0	2	1	50	0
8	PC	23BCHPC35102	Chemical Reaction Engineering- I Lab	0	0	2	1	50	0
9	PC	23BCHPC35103	Mass Transfer-II Lab	0	0	2	1	50	0
10	PSI	23BCHPW35101	Summer Industry Internship	0	0	2	1	50	0
11	PSI	23BCHPW35102	Minor Project-I	0	0	2	2	50	0
				18	0	12	23	250	
Total Credits:							23	490	360

VI Semester [Third Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	PC	23BCHPC36001	Process Equipment Design	3	0	0	3	40	60
2	PC	23BCHPC36002	Process Control	3	0	0	3	40	60
3	PC	23BCHPC36003	Chemical Reaction Engineering- II	3	0	0	3	40	60
4	PE	23BCHPE36001	Fluidization Engineering	3	0	0	3	40	60
			Mineral Process Engineering						
			Fuel and Energy Technology						
			Fertilizer Technology						
			Polymer Technology						
5	OE	23BCHOE36001	Open Elective – 2(OE)	3	0	0	3	40	60
6	MS	23BCHHS36001	Organizational Behavior	2	0	0	2	40	60
			Engineering Economics and Costing						
PRACTICAL / SESSIONAL								180	420
7	PC	23BCHPC36101	Process Equipment Design Lab	0	0	2	1	100	0
8	PC	23BCHPC36102	Process Control Lab	0	0	2	1	100	0
9	PSI	23BCHPW36101	Minor Project-II	0	0	2	2	100	0
				17	0	6	21	300	0
Total Credits:							21	480	420

VII Semester [Fourth Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	PC	23BCHPC47001	Transport Phenomenon	3	0	0	3	40	60
2	PC	23BCHPC47002	Process Modeling and Simulation	3	0	0	3	40	60
3	PC	23BCHPC47003	Petroleum Refinery Engineering	3	0	0	3	40	60
4	PE	23BCHPE47001	Interfacial Engineering	3	0	0	3	40	60
			Process Instrumentation						
			Plant Safety and Risk Analysis						
			Sustainability Engineering						
			Modern Separation Technique						
5	OE	23BCHOE47001	Open Elective – 3(IE)	3	0	0	3	40	60
PRACTICAL / SESSIONAL								150	350
6	PSI	23BCHPW47103	Technical Seminar	0	0	2	1	100	0
7	PSI	23BCHPW47101	Summer Industry Internship	0	0	0	1	100	0
8	PSI	23BCHPW47102	Major Project Work-I	0	0	6	2	100	0
				15	0	6	19	300	0
Total Credits:							19	450	350

VIII Semester [Fourth Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
			THEORY						
1	PE	23BCHPE48001	Safety in Chemical Industries	3	0	0	3	40	60
			Pollution and its control						
			Physical and Analytical Chemistry						
			Water Conservation and Management						
2	PE	23BCHPE48002	Integrated Solid Waste Management	3	0	0	3	40	60
			Treatment of Industrial effluent						
			Green Technology						
			Coal processing technology						
3	OE	23BCHOE48001	Open Elective – 5(CPT)	3	0	0	3	40	60
PRACTICAL / SESSIONAL									
7	PSI	23BCHPW48101	Major Project Work-II & Dissertation	0	0	6	3	100	0
8	PSI	23BCHPW48102	Technical Seminar	0	0	2	1	100	0
				9	0	6	13	290	210
Total Credits:							13	290	210

DETAILED SYLLABUS

III Semester [Second Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
			THEORY						
1	BS	23BBSBS23001	Engineering Mathematics-III	3	1	0	4	40	60
2	ES	23BCSES23001	Object Oriented Programming using Java	3	0	0	3	40	60
3	PC	23BCHPC23001	Heat Transfer	3	0	0	3	40	60
4	PC	23BCHPC23002	Fluid Mechanics	3	0	0	3	40	60
5	PC	23BCHPC23003	Chemical Process Calculation	3	0	0	3	40	60
6	HS	23BBSHS23001	Intermediate Communication Skills and Critical Thinking	2	0	0	1	40	60
			PRACTICAL / SESSIONAL					240	360
7	ES	23BCSES23101	Object Oriented Programming Using Java Lab	0	0	2	1	100	0
8	PC	23BCHPC23101	Heat Transfer Lab	0	0	2	1	100	0
9	PC	23BCHPC23102	Fluid Mechanics Lab	0	0	2	1	100	0
10	HS	23BBSHS23101	Intermediate Communication Skills and Critical Thinking - Lab	0	0	2	1	100	0
11	PSI	23BCHPW23101	Summer Industry Internship	0	0	2	1	100	0
12	MC		Constitution of India /Essence of Indian Traditional Knowledge	0	0	0	0	0	0
				17	1	8	22	500	0
Total Credits:							22	740	360

Subject code	Course Title	L	T	P	C									
23BCHPC23001	Heat Transfer	3	0	0	3									
Pre-Requisites: Chemical Process Calculations, Fluid Mechanics														
Course Educational Objective														
CEO1: To enable the students to learn heat transfer by conduction, convection and radiation														
CEO2: To enable the students to solve combined heat transfer problem														
CEO3: To enable the students to design heat transfer equipment's 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	Calculate heat transfer coefficients for forced and natural convection.													
CO4	Make use of empirical equations to solve forced and natural convection heat-transfer problems													
CO5	Able to do preliminary design calculations for double pipe and shell & tube heat Exchangers and evaporator													
CO6	Solve simple radiation heat transfer problems													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	1	0	-	-	2	-	-	-	-	2		2	
CO2	2	2	2	1	-	1	-	-	-	-	-		2	
CO3	2	2	1	-	-	0	-	-	-	-	-		1	
CO4	1	0	0	-	-	2	-	-	-	-	-		2	
CO5	2	2	1	-	-	1	-	-	-	-	-		1	
CO6	2	0	1	2	-	3	-	-	-	-	-		2	
Unit:1 10 (Hours)														
Modes of heat transfer, Basic laws of heat transfer, Conduction: Steady-state one, two and three dimensional heat conduction, Conduction through bodies in series(wall, pipe and sphere) , Heat transfer from extended surfaces, Unsteady state heat conduction in finite and semi-infinite solids,.														
Unit: 2 10(Hours)														
Convection: Concept of heat transfer coefficient; Individual and overall heat transfer coefficient; Critical insulation thickness, Dimensional analysis: Forced Convection, Natural Convection: Dimensionless numbers in heat transfer and their significance.														
Unit: 3 10(Hours)														
Introduction to thermal boundary layer, Analogy between heat and momentum transfer: Reynolds's, Prandtl and Colburn analogies. 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:4 10 (Hours)														
Heat Exchanges : Types of heat exchangers, LMTD derivation. Overall heat transfer Coefficients, Heat Exchanger effectiveness. Fouling factors, Double Pipe Heat Exchanger and description of Shell and Tube heat exchanger. Types of single effect evaporator, capacity and economy, Boiling point elevation and Duhring's rule, Theory of multi-effect evaporator														
Unit:5 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, concentric cylinders and spheres. Combined heat transfer by conduction, convection and radiation														
Teaching Method (s): Chalk & Board/PPT/Video Lectures														
Ref. 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														
3: Kern D. Q., Process Heat Transfer														
4. R.K Rajput Heat and mass transfer, S. Chand publication														

Subject code	Course Title											L	T	P	C
23BCHPC23002	Fluid Mechanics											3	0	0	3
Pre-Requisites (If any)-Mathematics, Mechanics															
Course Educational Objective															
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.															
CEO2: To describe about the flow behavior of fluid in different devices.															
Course Outcome															
CO1	Rephrase the basic principles of fluid mechanics														
CO2	Evaluate pressure measuring devices and decanters using the principles of fluid statics.														
CO3	Analyze fluid flow problems with the application of the momentum and energy equations														
CO4	Describe dimensionless groups using dimensional analysis.														
CO5	Explain the pipe flows, mixing processes & fluid machinery														
CO6	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	1	2	3
	CO1	3	2	-	-	2	-	-	-	-	-	-	3		
	CO2	2	3	-	-	3	-	-	-	-	-	-	2		
	CO3	2	3	2	-	2	-	-	-	-	-	-	1		
	CO4	2	3	1	-	2	-	-	-	-	-	-	2		
	CO5	2	3	-	-	3	-	-	-	-	-	-	2		
	CO6	3	2	2	-	2	-	-	-	-	-	-	3		
Unit: 1 10 (Hours) Classification of fluid, Fluid statics – basic equation, equilibrium of fluid element – Hydrostatic Pressure, Pressure measuring Devices. Rheological properties of Fluid, Flow in boundary layers. Its formation & growth in tubes & plates.															
Unit: 2 10 (Hours) Fluid flow: Continuity equation, Continuity equation in 3D, velocity potential and stream function. Momentum & Bernoulli's equation. Flow measuring devices; Venturi, Orifice, Pitot tube & Rotameter.															
Unit: 3 10 (Hours) Flow of incompressible fluid in pipes, Relation between skin friction & wall shear. Laminar flow in pipes, Hagen-Poiseuille equation, Friction factor, Friction from changes in velocity or direction,															
Unit: 4 10 (Hours) Flow of compressible fluids: Basic equations. Flow past immersed bodies, Drag Co-efficient. Motion of particles through fluids, terminal Velocity. Dimensional analysis. Energy losses in pipe, Hydraulic gradient line, total energy line.															
Unit: 5 10 (Hours) Mechanism of fluidization, Application of fluidization. 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 Dreviers															
Ref. Books 1: A Text book of Fluid Mechanics & Hydraulic Machines by R. K. Bansal 2: Transport processes and unit operations by Christie J. Geankopolis, PHI															

Subject code	Course Title	L	T	P	C										
23BCHPC23003	Chemical Process Calculations	3	0	0	3										
Course Outcome															
Pre-Requisites (If any)-Mathematics, Chemistry, Thermodynamics															
Course Educational Objective															
CEO1: To teach fundamentals of calculation and its application to solution of solid, liquid and gaseous system CEO2: To teach fundamentals of calculation and its application to mass and energy balance for non-reactive system CEO3: To teach fundamentals of calculation and its application to mass and energy balance for reactive system															
Course Outcome															
CO1	Convert physico-chemical quantities from one system of units to another														
CO2	Calculations in solution and humidification														
CO3	Calculate mass balances on non-reactive systems														
CO4	Carry out mass balances on reactive systems														
CO5	Perform mass and energy balances in processes involving phase changes														
CO6	Analyze the mass and energy balances for combustion and reactive processes														
	COs	PROGRAMME OUTCOMES											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
	CO1	3	2	-	-	-	-	-	-	-	-	-	2		
	CO2	3	2	-	-	-	-	-	-	-	-	-	1		
	CO3	2	2	-	-	-	-	-	-	-	-	-	1		
	CO4	1	0	-	-	-	-	-	-	-	-	-	2		
	CO5	2	1	-	-	-	-	-	-	-	-	-	1		
	CO6	1	2	-	-	-	-	-	-	-	-	-	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		10 (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, Enthalpy-concentration charts															
Unit:3		10 (Hours)													
Fundamentals of material balances: Process classification; Balances; Material balance calculations – flow charts, basis of calculation, balancing a process, degrees of freedom analysis, general procedure for single unit process material balance calculations, examples including – Evaporation, Crystallization, Absorption, Distillation, Drying, Extraction, etc.; Balances on multiple unit processes – Recycle and bypass															
Unit:4		10 (Hours)													
Chemical Reaction stoichiometry: Stoichiometry, limiting and excess reactants, fractional conversion, extent of reaction, multiple reactions - yield and selectivity; Balances on reactive processes – molecular species balances, atomic species balances, product separation and recycle, Purging; Combustion reactions – Orsat analysis, theoretical and excess air, material balances on combustion reactions															
Unit: 5		12(Hours)													
Energy balances: Elements of energy balance calculations – reference states, process paths, procedure for energy balance; Sensible heat and heat capacities, estimation of heat capacities as function of temperature, Energy balances on single phase systems; Phase change operations – latent heats and their estimation, energy balances on process involving phase changes, Energy balances on reactive processes: Heats of reaction; Hess law; Heats of formation; Heats of combustion; Energy balances with reactions – general procedure, processes with known heat inputs: adiabatic reactors, Fuels and combustion – adiabatic flame temperature															
Ref. 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															
3.Chemical process principles- Hoejen, Watson, John Wiley & Asia pub.															
4.Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata Mc Graw Hill publishing company Ltd. New Delhi (1996)															

Subject code	Course Title											L	T	P	C
23BCHPC23101	Heat Transfer Lab													2	1
Course Educational Objective															
CEO1: To enable the students to understand various types of heat transfer phenomena															
CEO2: To enable the students to handle combined mode heat transfer equipments															
CEO3: To enable the students to develop a sound working knowledge on evaporator															
Course Educational Objective															
CO1	Determine thermal conductivity of solids and fluids														
CO2	Calculate efficiency of fins														
CO3	Study of free and forced convection heat transfer														
CO4	Determine efficiency of Double Pipe Heat exchangers														
CO5	Comparative study of vertical and horizontal Condenser														
CO6	Evaporator handling														
	COs	PROGRAMME OUTCOMES										PSOs			
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
	CO1	2			2	-	-		-	-	-	-	2		
	CO2	2			1	-	-	-	-	-	-	-	2		
	CO3	2			2	-	-	-	-	-	-	-	1		
	CO4	1			-1	-	-	-	-	-	-	-	1		
	CO5	1			1	-	-	-	-	-	-	-	2		
	CO6	1			2	-	-	-	-	-	-	-	1		
LIST OF EXPERIMENTS:															
<ol style="list-style-type: none"> 1. Study of Composite Wall 2. Determination of Thermal Conductivity of Liquid 3. Study of Bare and Fin Tube heat exchanger 4. Study of Free convection phenomena 5. Study of Forced convection phenomena 6. Study of parallel flow heat exchanger 7. Study of counter flow heat exchanger 8. Study of Horizontal condenser 9. Study of Vertical condenser 10. Study of Film wise and Drop wise condensation apparatus 11. Study of Calendria type evaporator 12. Determine the Stefan's Boltzmann Constant for Radiation Heat Transfer 															

Subject code	Course Title											L	T	P	C
23BCHPC23102	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.														
CO5	Calculate pressure drop across pipe.														
CO6	Determine the characteristics of flow meters, packed & fluidized beds and centrifugal pumps.														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	3	-	-	2	-	-	-	-	-	-	-	1			
CO2	2	-	-	3	-	-	-	-	-	-	-	1			
CO3	2	-	-	3	-	-	-	-	-	-	-	1			
CO4	3	-	-	2	-	-	-	-	-	-	-	2			
CO5	2	-	-	3	-	-	-	-	-	-	-	1			
CO6	2	-	-	3	-	-	-	-	-	-	-	2			
List of experiment:															
<ol style="list-style-type: none"> 1. Reynolds's Apparatus – Flow pattern characterization using Reynolds's Apparatus. 2. Bernoulli's Apparatus – To verify the Bernoulli's Equation using Bernoulli's apparatus. 3. Venturi Meter – Determination of flow rate of fluid flowing inside a pipe. 4. Orifice Meter – Determination of flow rate of fluid flowing inside a pipe. 5. Pitot tube – Determination of point velocity of fluid by using Pitot tube. 6. Determination of frictional losses in flow through pipes. 7. Determination of pressure drops in flow through non-circular pipes. 8. 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. 															

IV Semester [Second Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	ES	23BCSES24001	Data Base Management System	3	0	0	3	40	60
2	PC	23BCHPC24001	Chemical Engineering Thermodynamics	3	0	0	3	40	60
3	PC	23BCHPC24002	Mass Transfer-I	3	0	0	3	40	60
4	PC	23BCHPC24003	Mechanical Operations	3	0	0	3	40	60
5	PC	23BCHPC24004	Numerical Methods in Chemical Engineering	3	0	0	3	40	60
6	HS	23BBSHS24001	Advanced Communication Skills and Professional Ethics	2	0	0	1	40	60
PRACTICAL / SESSIONAL								240	360
7	PC	23BCHPC24101	Thermo-physical Lab	0	0	2	1	100	0
8	PC	23BCHPC24102	Mass Transfer-I Lab	0	0	2	1	100	0
9	PC	23BCHPC24103	Mechanical Operations Lab	0	0	2	1	100	0
10	HS	23BBSHS24101	Advanced Communication Skills and Professional Ethics Lab	0	0	2	1	100	0
11	PSI	23BCHPW24101	Project	0	0	2	1	100	0
12	MC	23BBSMC24401	Environmental Sciences	0	0	2	0	0	0
				17	0	12	21	500	
Total Credits:							21	740	360

Subject code	Course Title	L	T	P	C									
23BCHPC24001	CHEMICAL ENGINEERING THERMODYNAMICS	3	0	0	3									
Pre-Requisites (If any)-														
CEO1: To apply the fundamentals of chemical engineering thermodynamics CEO2: To apply the application of thermodynamics to various processes. CEO3: Calculation of thermodynamic properties for chemical reaction in industrial applications														
Course Outcome														
CO1	Apply the first and second laws of thermodynamics to chemical processes.													
CO2	Compute the properties of ideal and real gas mixtures													
CO3	Estimate thermodynamic properties of substances in gas and liquid states													
CO4	Estimate heat and work requirements for industrial processes													
CO5	Explain the vapor-liquid equilibrium for a system													
CO6	Explain the chemical reaction equilibrium for a system													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	0	0	-	-	-	-	-	-	-		3	
CO2	3	3	0	0	-	-	-	-	-	-	-		2	
CO3	2	2	2	1	-	-	-	-	-	-	-		1	
CO4	1	0	0	0	-	-	-	-	-	-	-		2	
CO5	2	1	0	0	-	-	-	-	-	-	-		2	
CO6	1	3	0	2	-	-	-	-	-	-	-		2	
Unit:1						10 (Hours)								
Introduction & First Law of Thermodynamics: First Law of Thermodynamics Energy Balance for Closed Systems, Equilibrium, The Phase Rule, The Reversible Process, Internal energy, Enthalpy, Heat Capacity, Mass and Energy balances for Open Systems. Volumetric Properties of Pure Fluids: General P-V-T Behavior of Pure Substances, Virial Equations of State, The Ideal Gas, Application of the Virial Equations, Cubic Equations of State, The Second Law of Thermodynamics: Statements of the Second Law, Heat Engines, Entropy, Entropy Changes of an Ideal Gas, Mathematical Statement of the Second Law, Entropy Balance for Open Systems, Calculation of Ideal Work, Lost Work, The Third Law of Thermodynamics.														
Unit:2						10 (Hours)								
Phase Equilibria: The nature of equilibrium, Criteria of equilibrium, The phase rule, Duhem's theorem, Raoult's law, Henry's law, Modified Raoult's law, Dew point and bubble point calculations, Relative volatility, 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														
Unit:4						10 (Hours)								
Solution Thermodynamics: Applications- Liquid phase properties from VLE data, Activity coefficient, Excess Gibbs Energy, Models for the excess Gibbs energy, Property changes of mixing, Heat effects of mixing process.														
Unit 5:						10 (Hours)								
The reaction coordinate, Equilibrium criteria to chemical reactions, Gibbs free energy change, Equilibrium constant, Effect of temperature on equilibrium constant, Evaluation of equilibrium constants, Relation of equilibrium constant to composition, Equilibrium conversions for single reactions, Phase rule and Duhem's theorem for reacting systems, Multireaction equilibria.														
Ref. Books														
<ol style="list-style-type: none"> Introduction to Chemical Engg. Thermodynamics by Smith and H.C. Vannes and M. Abbot (7th edition) Tata McGraw Hill, 2009 S.Sandler, "Chemical, Biochemical and Engineering Thermodynamics", 4th edition, Wiley, India. Chemical Engg. Thermodynamics by Y.V.C. Rao – University Press Chemical Engg. Thermodynamics by K.V.Narayan, PHI, 2000 Engineering and Chemical Thermodynamics by Milo D. Koretsky- 2nd Edition, Wiley publication 														

Subject Code	Course Title	L	T	P	C									
23BCHPC24002	MASS TRANSFER-I	3	0	0	3									
Course Outcome														
Pre-Requisites (If any)- CPC, CET														
Course Educational Objective														
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.														
CEO3: To understand the mechanism of distillation, absorption and humidification.														
Course Outcome														
CO1	To demonstrate about the diffusion process.													
CO2	Determine diffusivity coefficient in gases, liquids and solids.													
CO3	Familiar with special distillation techniques such as steam distillation and azeotropic distillation.													
CO4	Distinguish the mechanism of absorption, distillation and humidification.													
CO5	Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems.													
CO6	Design equipment for gas-liquid mass transfer operations.													
Cos	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	1	0	2	2						2		1	
CO2	2	2	1	1	2		3				2		1	
CO3	2	2	1	3	1	-	-	-	-	-	1		2	
CO4	1	0	0	2	2	-	-	-	-	-	1		1	
CO5	2	2	1	0	1	-	-	-	-	-	-		1	
CO6	1	0	0	2	2	-	-	-	-	-	-		2	
Unit:1 (10 Hours)														
Diffusion: Introduction to Mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolar counter current diffusion, Stefan-Maxwell equation, diffusivity of gases and liquids, application of molecular diffusion.														
Unit:2 (10 Hours)														
Concept of mass transfer coefficient and driving force, Concept of Sherwood number, Sherwood number correlations for various geometries and flow regimes: The Route to Correlations, Theories of mass transfer coefficient for gas to turbulent liquid flow, Two film resistance theory; Analogies between heat, mass and momentum transfer.														
Unit:3 (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:4 (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, Tray efficiencies, introduction to multi component distillation.														
Unit:5 (10 Hours)														
Humidification operations: Definition of fundamental terms, Psychrometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, Gas liquid contact, Dehumidification, Adiabatic Humidification. Equipments: Natural Circulation, Natural draft, Mechanical draft. Humidity Measurement: Direct chemical method, Hygrometer method, Sling Psychrometer, Dew point method, Mirror method.														
Ref. 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.														
3. Principles of Mass Transfer and Separation Processes by B K Dutta, PHI.														
4. Mass Transfer Operations by A Suryanarayana, New Age International.														

Subject code	Course Title											L	T	P	C
23BCHPC24003	Mechanical Operation											3	0	0	3
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.														
CO5	Demonstrate agitation and mixing processes														
CO6	Describe different conveyors and transportation devices for handling of materials.														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	3	3	2	-	1	1	-	-	-	-	-	3		-	
CO2	3	3	2	-	1	1	-	-	-	-	-	1		-	
CO3	3	3	2	-	1	1	-	-	-	-	-	1		-	
CO4	3	3	2	-	1	1	-	-	-	-	-	2		-	
CO5	3	3	2	-	1	1	-	-	-	-	-	-		-	
CO6	3	3	2	-	1	1	-	-	-	-	-	-		-	
Unit:1 10 (Hours) Properties and storage of solids: Characteristics of solid particles and solids in bulk. Size Reduction: Objectives, Methods, and Principles of size reduction, Size reduction equipment: Coarse, Intermediate, and Fine Crushers and Ultra-fine grinders, Open & closed circuit grinding.															
Unit:2 10 (Hours) Solid-solid separation: Screening, Electrical separation, Classification, Gravity concentration, and Flootation and their latest equipment.															
Unit:3 10 (Hours) Solid-liquid separation: Motion of particles through fluid, drag Coefficient, Free and hindered setting, Sedimentation and equipments, Thickeners, Cyclones, Classifications: Sink & float method, Jigging, Tabling, Forth flotation															
Unit:4 08 (Hours) Solid-liquid separation Filtration, Theory, plats & frame filter Press, Leaf filter, Rotary filter, Mixing & Agitation, Power consumption of Mixer, Liquid Mixing, Solid Mixing, Mixing equipment.															
Unit:5 08 (Hours) Gas-solid separation: Principle and equipment. Transportation of solids: Conveyors and elevators.															
Teaching Method(s): Chalk & Board/PPT/Video Lectures															
Reference Books:															
<ol style="list-style-type: none"> 1. Mc Cabe & Smith, Unit operations of Chemical engineering, Mc Graw lim 2. Coulson & Richabol Vol-2 Chemical Engineering pergammic Press. 3. Mechanical Operation for chemical engineers, Narayan and Bhattacharjee 4. Mechanical Operation by Swain. Publisher, Tata McGraw-Hill Education, 2011 															

Subject code	Course Title											L	T	P	C
23BCHPC24004	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 .														
CO5	Understand the concepts of probability and statistics														
CO6	Perform testing of hypothesis														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	3	2	-	-		-	-	-	-	2	2	2			
CO2	2	2	-	1		-	-	-	-	2	1	2			
CO3	2	1	-	-		-	-	-	-	-	1	1			
CO4	1	2	-	2	-	-	-	-	-	1	2	2			
CO5	1	1	-	2	-	-	-	-	-	2	2	1			
CO6	2	1	-	1	-	-	-	-	-	1	1	2			
Unit:1 SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS 10 Hours 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 INTERPOLATION 10 Hours Newton’s Forward and Backward Difference Interpolation, Newton Divided Difference interpolation formula, Lagrange’s interpolation Piecewise Linear Interpolation Piecewise Quadratic Interpolation, Piecewise Cubic Hermite Interpolation. cubic spline interpolation.															
Unit-3 NUMERICAL DIFFERENTIATION AND INTEGRATION 10 Hours Numerical Differentiation: First Derivative, Partial Derivatives, Richardson’s Extrapolation. Numerical integration: The trapezoidal rule, The Simpsons (1/3rd, 3/8th) rules, Romberg algorithm for numerical integration Chemical engineering problems where the above mentioned numerical schemes will be illustrated in details.															
Unit-4 ORDINARYDIFFERENTIALEQUATIONS 10 Hours Ordinary Differential Equations: Euler’s method, improved Euler’s method, Runge-Kutta method. Multistep methods; Adams-Bash forth Methods, Adams-Moulton Methods, Adams Predictor-Corrector methods, (Simpson’s method and Milne’s method). Application in chemical and bio.															
Unit-5 PARTIAL DIFFERENTIAL EQUATION 10 Hours Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method. Hyperbolic Partial Differential Equation.															

Subject Code	Course Title	L	T	P	C
23BCHPC24101	Thermo physical Lab			2	1

Pre -Requisite: Thermodynamics ,Process calculation, Chemistry

Course Educational Objective

CEO1: To apply the fundamentals knowledge for applying equation of state for industrial application

CEO2: To evaluate thermodynamic property during mixing.

CEO3: To calculate the properties in phase equilibrium

CO1	Verification of Equation of state for gaseous system
CO2	To evaluate and analyse of thermodynamic property changes in mixing results in mixing
CO3	Make use of knowledge in real time.
CO4	To gain practical knowledge during vapour-liquid equilibrium
CO5	Evaluating and analysing the result in Liquid-liquid equilibrium
CO6	Evaluating and analysing the result in Solid-liquid equilibrium

COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	-	1	-	-	-	-	-	-	-	1		
CO2	2	3	-	2	-	-	-	-	-	-	-	1		
CO3	2	3	-	1	-	-	-	-	-	-	-	1		
CO4	3	2	-	2	-	-	-	-	-	-	-	2		
CO5	2	3	-	1	-	-	-	-	-	-	-	-	1	
CO6	2	2	-	1	-	-	-	-	-	-	-	-	1	

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

Subject code	Course Title	L	T	P	C
23BCHPC24102	Mass Transfer-I Lab			2	1

Course Title

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

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.

CEO3: To understand the mechanism of distillation, absorption and humidification.

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

CO1	To demonstrate about the diffusion process.
CO2	Determine diffusivity coefficient in gases, liquids and solids.
CO3	Familiar with special distillation techniques such as steam distillation and azeotropic distillation.
CO4	Distinguish the mechanism of absorption, distillation and humidification.
CO5	Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems.
CO6	Design equipment for gas-liquid mass transfer operations.

COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	2		0	1		1						-	2		
CO2	2		1	2		3	-						2		
CO3	2		1	2	-	1	-	-	-	-	-	-	1		
CO4	1		0	0	-	0	-	-	-	-	-	-	2		
CO5	2		1	2	-	2	-	-	-	-	-	-	1		
CO6	1		0	0	-	0	-	-	-	-	-	-	2		

LIST OF EXPERIMENTS:

- Determination of diffusion coefficient for carbon tetrachloride -air system by using vapour-air diffusion apparatus.
- Study of vapor -liquid equilibrium curve for methanol-water system.
- Verification of Rayleigh's equation through simple distillation for binary mixture of water and ethanol.
- Determination of vaporization and thermal efficiencies in steam distillation of the given organic liquid i.e. nitrobenzene or aniline.
- Study of lab scale bubble cap distillation column at different reflux ratios.
- 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.
- Determination of number of plates of packed bed distillation column at varying reflux ratios for a binary mixture of methanol and water using McCabe Thiele diagram.

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 construction 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.														
CO5	Demonstrate agitation and mixing processes														
CO6	Describe different conveyors and transportation devices for handling of materials.														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	2	2	-	2	-	-	-	-	-	-	-	1			
CO2	3	2	-	1	-	-	-	-	-	-	-	2			
CO3	3	2	-	2	-	-	-	-	-	-	-	1			
CO4	3	2	-	1	-	-	-	-	-	-	-	2			
CO5	3	2	-	-	-	-	-	-	-	-	-	2			
CO6	2	2	-	-	-	-	-	-	-	-	-	1			
List of experiment:															
<ol style="list-style-type: none"> 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. 															

V Semester [Third Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	PC	23BCHPC35001	Chemical Process Technology	3	0	0	3	40	60
2	PC	23BCHPC35002	Chemical Reaction Engineering- I	3	0	0	3	40	60
3	PC	23BCHPC35003	Mass Transfer-II	3	0	0	3	40	60
5	PE	23BCHPE35001	Computational Fluid Dynamics	3	0	0	3	40	60
			Biochemical Engineering						
			Process Utility and Industrial Safety						
			Multicomponent Distillation						
6	OE	23BCHOE35001	Open Elective – 1(MS)	3	0	0	3	40	60
7	MS	23BCHHS35001	Organizational Behavior	2	0	0	2	40	60
			Engineering Economics and Costing						
PRACTICAL / SESSIONAL								240	360
7	PC	23BCHPC35101	Chemical Process Technology Lab	0	0	2	1	50	0
8	PC	23BCHPC35102	Chemical Reaction Engineering- I Lab	0	0	2	1	50	0
9	PC	23BCHPC35103	Mass Transfer-II Lab	0	0	2	1	50	0
10	PSI	23BCHPW35101	Summer Industry Internship	0	0	2	1	50	0
11	PSI	23BCHPW35102	Minor Project-I	0	0	2	2	50	0
				18	0	12	23	250	
Total Credits:							23	490	360

Subject code	Course Title											L	T	P	C
23BCHPC35001	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.														
CO5	Understanding of production methods and various problems and troubleshooting of the process associated with process industries.														
CO6	Evaluate the effect of process conditions on conversion and economics of the plant, various problems and troubleshooting of the process														
	COs	PROGRAMME OUTCOMES											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
	CO1	3	-	0	-	1	0	-	-	-	-	1		2	
	CO2	2	-	1	-	2	0	-	-	-	-	2		1	
	CO3	2	-	1	-	2	1	-	-	-	-	3		2	
	CO4	1	-	0	-	0	0	-	-	-	-	0		1	
	CO5	2	-	1	-	2	1	-	-	-	-	2		2	
	CO6	1	-	0	-	0	0	-	-	-	-	2			
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														11(Hours)	
Natural Products: -Edible and essential oils, Extraction and Refining of Oil, hydrogenation of Oil, soaps and detergents, pulp and paper industry, manufacture of sugar, starch and its derivatives, Industrial & absolute alcohol, paints and varnishes, Natural dyes.															
Unit:3														11 (Hours)	
Glass: composition of glass, raw materials, manufacturing method of glass- pot furnace and tank furnace, annealing of glass. Ceramic Ceramic: Basic raw materials, white-wares, manufacturing process of porcelain and their forming operations.															
Unit:4														9 (Hours)	
Polymers: Fundamentals, polyethylene, PVC, polypropylene, Polystyrene, Phenol formaldehyde, Urea formaldehyde, Poly vinyl acetate, Polylactic acid, Nylon															
Unit-5														4 (Hours)	
Cement: Definition, Types of Chemical composition of Portland cement, raw materials, dry and wet process for manufacturing cement clinker, setting and hardening of cement.															
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
23BCHPC35002	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 conditions															
Course Outcome															
Pre-Requisites (If any)-Mass Transfer-I, Heat Transfer, Chemical Process Calculations															
CO1	Understand principles of chemical kinetics and rate laws based on concentration and temperature dependence.														
CO2	Analyze batch reactor data using integral and differential methods for various reaction orders.														
CO3	Design and compare ideal isothermal reactors for single reactions and multiple reactor configurations.														
CO4	Predict product distribution and selectivity in parallel reactions for effective reactor design.														
CO5	Analyze series and series-parallel reactions involving zero and first-order kinetics.														
CO6	Apply collision, transition state, and Arrhenius theories to estimate and interpret reaction kinetics.														
		PROGRAMME OUTCOMES											PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	3	1	0	2	2	-	-	-	-	-	-				
CO2	1	3	2	0	1	2	-	-	-	-	-				
CO3	2	1	3	2	1	2	-	-	-	-	-				
CO4	0	1	0	3	2	1	-	-	-	-	-				
CO5	1	1	2	1	2	-	-	-	-	-	-				
CO6	2	2	1	1		-	-	-	-	-	-				
Unit:1 Kinetics of Homogeneous Reactions 10 (Hours)															
Introduction and overview of the subject, kinetics of homogeneous reactions, elementary and non-elementary reactions, Concentration dependent term of a rate equation and temperature dependent term of a rate equation, Collision theory, Transition state theory and Arrhenius theory.															
Unit:2 Interpretation of batch reactor data 10 (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, Autocatalytic reactions.															
Unit:4 Design for Multiple Reactions 7(Hours)															
Design of parallel reactions: Introduction to multiple reactions, Qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size, Selectivity, side entry reactor,															
Unit:5 Design for Multiple Reactions 8 (Hours)															
Design of Reactions in series: Irreversible first order reactions in series; qualitative and quantitative discussion about product distribution, First order followed by zero order reaction, Zero order followed by first order reaction, Irreversible series –parallel reactions.															
Teaching Method (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															
Online resources: http://umich.edu/~elements/5e/															

Subject code	Course Title	L	T	P	C									
23BCHPC35003	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 an adsorber and calculations involved in liquid-liquid extraction and solid liquid extraction.														
CEO2:At the end of the study students will come to know the uses of drying & the design of dryers.														
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 the idea of design processes for cooling tower, fixed-bed adsorption.													
CO4	Building foundation for process intensification and innovations for novel systems of mass transfer.													
CO5	Understand the uses and application of leaching.													
CO6	Know about the fundamental of Crystallization.													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1	0								2		2	1	
CO2	2	1	1			3						2	2	
CO3	2	1	-	-	-	-	-	-	-	-	-	2	1	
CO4	2	2	-	-	-	-	-	-	-	-	-	1	2	
CO5	3	2		2									2	1
CO6	2	2	-	-	-	-	-	-	-	-	-	2	1	
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 10 (Hours)														
Adsorption: Theory of adsorption, Industrial adsorbents, adsorption equilibrium, Adsorption isotherms, single and multistage operations.														
Unit:4 10 (Hours)														
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:5 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.														
Teaching Method(s): Chalk & Board/PPT/Video Lectures														
Text Books 1: Treybal R. E., Mass Transfer 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
23BCHPE35001	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 equipment.															
CO1	Interpret the usage of water as utility across various applications in an industry.														
CO2	Calculate the requirements of water and air and their applications as utilities.														
CO3	Interpret the Knowledge of utilization of air and various form of air utilization in industry.														
CO4	Understanding of application and means of generation of steam in industry														
CO5	Evaluate and apply the various risk assessment methods in industries														
CO6	Do the hazard analysis for different industries using HAZOP.														
		PROGRAMME OUTCOMES											PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	1	-	-	-	-	2	3	-	-	-	-	-	2		
CO2	2	-	-	-	-	3	2	-	-	-	-	-	2		
CO3	2	-	-	-	-	2	2	-	-	-	-	-	1		
CO4	0	-	-	-	-	1	0	-	-	-	-	-	2		
CO5	2	-	-	-	-	2	2	-	-	-	-	-	1		
CO6	1	-	-	-	-	2	3	-	-	-	-	-	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 11 (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, Steam nozzles, Condensate utilization, Steam traps and Accessories, Flash tank analysis, Safety valves, Pressure reduction valves.															
Unit:3 12 (Hours)															
Air compressors, Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Impeller Blade Shape, Vacuum pumps, Air receivers, Different types of ejectors, Air dryers.															
Unit: 4 6 (Hours)															
Hazards: Classifications and assessment of various types of hazards, Risk assessment methods, General principles of industrial safety, Hazards due to fire, explosions, toxicity and radiations, hazards control, Case studies of hazardous incidents in industries using HAZOP.															
Unit-5 6 (Hours)															
Safety: Introduction and its importance of safety, Principle of industrial safety, Definition - Accident, Incident, Explosion, Contamination, Fire, Protection & Housekeeping, Safety training & Education, Safety Management- Unsafe condition in factories, Basic safety programmes, Rules & Regulation of safety department, Safeguarding the public.															
Teaching Method (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
BPCCH5110	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 principles of manufacturing for key inorganic and organic chemicals.																
CO2	Determine key physicochemical properties of raw materials and products through standardized procedures.																
CO3	Interpret process flow diagrams and operating parameters for chemical processes.																
CO4	Analyze experimental data to identify issues and optimize production conditions.																
CO5	Design basic chemical process layouts and plan unit operations for production.																
CO6	Demonstrate skills in handling chemical manufacturing processes with a focus on safety, sustainability, and quality.																
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			
CO5	2	2	1	1	-	-	-	-	-	-	-	-	2	1			
CO6	1	-	2	2	-	-	-	-	-	-	-	-	1	1			
LIST OF EXPERIMENTS:																	
<ol style="list-style-type: none"> 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								
BPCCH5120	Chemical Reaction Engineering-I LAB			2	1									
Pre -Requisite:														
Course Outcome: At the end of the course, the students will be able to														
CO1	Calculate the rate constant for various types of chemical reactors (batch, plug flow, CSTR).													
CO2	Determine the order of chemical reactions through experimental analysis.													
CO3	Interpret reaction kinetics data to assess reactor performance.													
CO4	Design basic equipment for separation processes such as distillation, extraction, or crystallization.													
CO5	Develop functional models or prototypes for feed separation applications.													
CO6	Demonstrate technical skills in operating, measuring, and analyzing unit operations equipment safely.													
		PROGRAMME OUTCOMES											PSOs	
COs	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	
CO5	2	2											2	
CO6	1		3	1										1
<ol style="list-style-type: none"> 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
BPCCH5140	Mass Transfer-II Lab														2	1	
Pre -Requisite:																	
Course Educational Objective																	
CEO1:To learn analytical experimental methods using sophisticate instruments an interpretation of Experimental data.																	
Course Outcome: At the end of the course, the students will be able to																	
CO1	Explain the principles and mechanisms involved in separation by adsorption.																
CO2	Describe liquid-liquid extraction and leaching operations with practical relevance.																
CO3	Design equipment for the separation of multicomponent feed solutions.																
CO4	Develop a working model for extraction of oil from mustard cake.																
CO5	Evaluate mass transfer equipment performance through experimental analysis.																
CO6	Demonstrate hands-on skills in operating drying, adsorption, crystallization, and mass transfer setups.																
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				
CO5	2	2	1											1			
CO6	1		2	2									3				
<p>1. Extraction of oil from a sample of mustard cake.</p> <p>2. Study of drying characteristics of wet solids in a tray dryer under forced draft condition.</p> <p>3. Drying of solids in a rotary dryer.</p> <p>4. Adsorption isotherm & efficiency determination.</p> <p>5. To study the performance of a Swenson-Walker crystallizer and to determine the crystal yield and the efficiency of crystallizer.</p> <p>6. To determine that mass transfer coefficients for the given system using the experimental setup.</p>																	

VI Semester [Third Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	PC	23BCHPC36001	Process Equipment Design	3	0	0	3	40	60
2	PC	23BCHPC36002	Process Control	3	0	0	3	40	60
3	PC	23BCHPC36003	Chemical Reaction Engineering- II	3	0	0	3	40	60
4	PE	23BCHPE36001	Fluidization Engineering	3	0	0	3	40	60
			Mineral Process Engineering						
			Fuel and Energy Technology						
			Fertilizer Technology						
			Polymer Technology						
5	OE	23BCHOE36001	Open Elective – 2(OE)	3	0	0	3	40	60
6	MS	23BCHHS36001	Organizational Behavior	2	0	0	2	40	60
			Engineering Economics and Costing						
PRACTICAL / SESSIONAL								180	420
7	PC	23BCHPC36101	Process Equipment Design Lab	0	0	2	1	100	0
8	PC	23BCHPC36102	Process Control Lab	0	0	2	1	100	0
9	PSI	23BCHPW36101	Minor Project-II	0	0	2	2	100	0
				17	0	6	21	300	0
Total Credits:							21	480	420

Subject Code	Course Title	L	T	P	C									
23BCHPC36001	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 and classify the equipment and processes in chemical process flow diagrams.													
CO2	Develop process models using standard flow diagrams for chemical engineering systems.													
CO3	Explain instrumentation diagrams and interpret different process control strategies.													
CO4	Design and scale-up fabrication diagrams for chemical process equipment.													
CO5	Analyze the working principles and design aspects of separation and heat exchange equipment.													
CO6	Apply mechanical design principles to reactors, pressure vessels, and storage tanks.													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	2	0	1	0	0	0	1	0	0	3	2	0
CO2	3	2	3	0	2	0	0	0	1	0	0	3	2	0
CO3	2	3	2	3	3	0	0	0	1	0	0	2	3	0
CO4	3	2	3	3	3	0	0	0	1	0	0	2	3	0
CO5	3	3	2	2	2	0	0	0	1	0	0	3	2	0
CO6	2	2	3	0	3	0	0	0	1	0	0	2	2	3
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, Pressure vessels – calculation of thickness of cylindrical and spherical shells subjected to internal pressure, heads or covers. Storage vessels – storage of nonvolatile liquids, storage of volatile liquids, storage of gases. Supports for vessels – bracket or lug supports, leg supports, skirt supports, saddle supports.														
Unit:5 10 (Hours)														
Types of reactors, process design of batch reactor and continuous flow reactors, selection of reactors, mechanical features of reactor design.														
Teaching Method (s): Chalk & Board/PPT/Video Lectures														
Text Books 1.: R. E. Treybal, Mass Transfer Operations 2.: D. Q. Kern, Process Heat Transfer.														
<ol style="list-style-type: none"> 1. Ref. Books Levenspiel 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									
23BCHPC36002	PROCESS CONTROL	3	0	0	3									
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	Apply Laplace transforms and develop mathematical models for dynamic systems like first- and second-order processes.													
CO2	Analyze the behavior of open-loop and closed-loop control systems using block diagrams and transfer functions.													
CO3	Evaluate control system performance using frequency response tools such as Bode plots and Root Locus.													
CO4	Select and implement advanced control strategies like cascade, feedforward, and ratio control for industrial applications.													
CO5	Design and analyze sampled data control systems using Z-transforms and apply them to chemical process control.													
CO6	Develop mathematical models and simulations for chemical engineering systems using appropriate tools and techniques.													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	2	2	2	0	0	0	1	1	0	3	2	0
CO2	3	3	3	2	3	0	0	0	1	1	0	3	2	0
CO3	3	3	3	3	3	0	0	0	1	1	0	3	3	1
CO4	2	2	3	2	3	1	0	0	1	1	0	3	3	2
CO5	3	3	3	3	3	0	0	0	1	1	0	3	3	2
CO6	3	3	3	3	3	0	0	0	1	2	1	3	3	3
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, principles of pneumatic and electronic controllers, Closed loop transfer functions, transient response of simple control systems.														
Unit:3 10 (Hours)														
Block diagram of a Chemical Reactor Control system, Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, Stability, Root locus.														
Unit:4 10 (Hours)														
Advanced control strategies- Cascade control, feed forward control, ratio control, Dead time compensation, internal model control, controller tuning and process identification, control valves, Air Fuel Ratio Control for Drum Boilers. Level Control in Drum Boiler, Shrinking and Swelling, Inverse response of Drum Boiler.														
Unit:5 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.														
Teaching Method (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.														
1. <i>Industrial Instrumentation and Control, 3rd ed. by S K Singh, McGraw-Hill.</i>														
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
23BCHPC36003	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 the concept of residence time distribution (RTD) and interpret E, F, and C curves for non-ideal flow reactors.														
CO2	Analyze and model non-ideal reactors using segregation, mixedness, tanks-in-series, and dispersion models.														
CO3	Describe the kinetics and mechanisms of heterogeneous reactions including adsorption, surface reactions, and rate control.														
CO4	Evaluate the impact of pore diffusion and surface kinetics on catalytic reactions, and determine effectiveness factors.														
CO5	Determine the rate equations and performance of reactors containing porous catalyst particles, including deactivation effects.														
CO6	Apply shrinking core models for fluid-particle reactions and identify the rate controlling steps in solid-fluid systems.														
	COs	PROGRAMME OUTCOMES										PSOs			
		1	2	3	4	5	6	7	8	9	10	11	1	2	3
	CO1	3	1	0	0	1	1	-	-	-	-	-		2	
	CO2	1	3	2	0	3	3	-	-	-	-	-		2	
	CO3	2	1	3	0	1	1	-	-	-	-	-		1	
	CO4	0	1	0	3	1	1	-	-	-	-	-		2	
	CO5	2	1	3	2	1	1	-	-	-	-	-		2	
	CO6	1	2	1	2	3	3	-	-	-	-	-		1	
Unit: I Basics of Non-Ideal Flow 8 (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															
Unit: II Conversion & Modeling Non-ideal reactors 10 (Hours)															
Conversion in non-ideal flow reactors, Diagnosing reactor ills. Modeling non-ideal reactors; Combination of two ideal reactors- PFR and CSTR in series, Predicting conversion in real reactors- segregation model and mixedness model, Tanks-in-series model, Dispersion model															
Unit: III Heterogeneous Reactions and Solid Catalysis 12 (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: IV Solid Catalyzed Reactions 10 (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: V 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 Method (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,	Mc Graw Hill, 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									
23BCHPE36001	FUEL AND ENERGY TECHNOLOGY	3	0	0	3									
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	Explain the origin, classification, and properties of solid fuels like coal and coke.													
CO2	Describe the composition, refining processes, and products of crude oil and liquid fuels.													
CO3	Analyze the types, production methods, and applications of gaseous and synthetic fuels													
CO4	Understand the basics of nuclear fuels, reactors, moderators, and structural materials.													
CO5	Perform combustion calculations including air requirements and fuel analysis.													
CO6	Evaluate fuel properties and combustion efficiency based on industrial and environmental needs.													
	PROGRAMME OUTCOMES											PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2		1	-	-	1	-	-	-	-	-	-	2	
CO2	2	2	2	-	-	3	-	-	-	-	-	-	1	
CO3	1		1	-	-	2	2	-	-	-	-	-	2	
CO4	1		2	-	-	0		-	-	-	-	-	1	
CO5	2	2	1										1	
CO6	1	2										3		
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, Petrographic 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, Coal tar 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, Carbureted water gas. Synthetic Fuels : Hydrogenation of coal, Fischer – Tropsch synthesis														
Unit:4 10 (Hours)														
Nuclear fuels and nuclear reactors, moderators and structural materials.														
Unit:5 10 (Hours)														
Combustion: Combustion of solids fuels, Pulverized coal. Calculation of volumes and weights of air necessary for combustion of fuels, gas analysis.														
Teaching Method (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
BPCCH6110	Process Equipment and Design Lab													2	1	
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	Design and analyze double pipe and 1-2 shell and tube heat exchangers.															
CO2	Design single effect horizontal and vertical tube evaporators based on process requirements.															
CO3	Design packed absorption columns considering mass transfer and column dimensions.															
CO4	Design continuous plate-type distillation columns using stage-wise calculations.															
CO5	Design fixed roof storage tanks based on volume, fluid type, and safety norms.															
CO6	Apply design standards and simulation tools for process equipment design and drawing preparation.															
COs	PROGRAMME OUTCOMES											PSOs				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3		
CO1	2	1	0	1				-	-	-	1	1	2			
CO2	1	2	1	1			3	-	-	-			2			
CO3	1	2	1	2	-	-	-	-	-	-	-	-	1			
CO4	1	0	0		-	-	-	-	-	-	-	-	2			
CO5	2	1	3	1								1		2		
CO6	1	2	1	3									3			
<ol style="list-style-type: none"> 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
BPCCH6120	Process control Lab			2	1	

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	Analyze the dynamic response and determine the time constant of single and multi-tank systems.
CO2	Evaluate the transient behavior of interacting and non-interacting systems with step input changes.
CO3	Examine the performance of ON-OFF controllers in temperature and pressure control systems.
CO4	Assess the effect of PD, PI, and PID controllers on temperature and pressure trainer setups
CO5	Investigate system stability for temperature and pressure control trainers under various conditions.
CO6	Apply open loop tuning methods for temperature and pressure control systems.

COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	2					1					2	2	
CO2		2					1						1	
CO3	1		3											3
CO4	1	2												3
CO5	3							2			1		2	
CO6	3	2									1	1	2	

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.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
THEORY									
1	PC	23BCHPC47001	Transport Phenomenon	3	0	0	3	40	60
2	PC	23BCHPC47002	Process Modeling and Simulation	3	0	0	3	40	60
3	PC	23BCHPC47003	Petroleum Refinery Engineering	3	0	0	3	40	60
4	PE	23BCHPE47001	Interfacial Engineering	3	0	0	3	40	60
			Process Instrumentation						
			Plant Safety and Risk Analysis						
			Sustainability Engineering						
			Modern Separation Technique						
5	OE	23BCHOE47001	Open Elective – 3(IE)	3	0	0	3	40	60
PRACTICAL / SESSIONAL								150	350
6	PSI	23BCHPW47103	Technical Seminar	0	0	2	1	100	0
7	PSI	23BCHPW47101	Summer Industry Internship	0	0	0	1	100	0
8	PSI	23BCHPW47102	Major Project Work-I	0	0	6	3	100	0
				15	0	6	20	300	0
Total Credits:							20	450	350

Subject code	Course Title	L	T	P	C									
23BCHPC47001	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.													
CO5	Ability to develop laminar flow behavior													
CO6	Ability to develop turbulent flow behavior													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	1	0	3	-	3	-	-	-	-	2		2	
CO2	2	3		2	2	1	-	-	-	-	1		2	
CO3	2	2	3	2	1	2	-	-	-	-	2		1	
CO4	1	2	-	-	1	2	-	-	-	-	2		2	
CO5	1	1	3		2	1					1		2	
CO6	1		2	2	1	2					2		1	
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.														
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.														
Unit:4 10 (Hours)														
Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, Energy equations, use of equations of change, The equation of continuity, summary of equations of change and fluxes, use of equations of change, time-smoothed equation of change, empirical expressions.														
Unit:5 10 (Hours)														
Dimensional analysis of equations of change, comparison of laminar and turbulent flows, Inter phase transport in isothermal systems, temperature distribution for turbulent flow in tubes, jets, empirical expressions for turbulent mass flux.														
Teaching Method (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									
23BCHPC47002	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	Explain the mathematical model of reactors													
CO5	Explain the mathematical model of mass & heat transfer equipments													
CO6	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	1	2	3
CO1	2	1	0	3	1	2	-	-	-	-	2		2	
CO2	2	2		2	2	1	-	-	-	-	2		2	
CO3	1	2	3	1	2	1	-	-	-	-	1		1	
CO4	2	1	2	2	3	2	-	-	-	-	2		2	
CO5	2	2	2	1	-	1	-	-	-	-	2		2	
CO6	2	1	3	2	1	1	-	-	-	-	1		1	
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 10 (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.														
Unit:5 10 (Hours)														
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									
23BCHPC47003	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.													
CO5	Understand the different steps of petroleum recovery process													
CO6	Identify the different products of petroleum													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	1		-	1			1	-	-	-		2	
CO2	2	2		-	3			2	-	-	-		1	
CO3	1	1		-	2		-	1	-	-	-		1	
CO4	1	2		-	0			2	-	-	-		2	
CO5	1	2		-	1			1	-	-	-		2	
CO6	2	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.														
Unit:3 10 (Hours)														
ASTM distillation, Octane number and Cetane number. Treatment of products, additives, blending of gasoline. Treatment of gasoline, kerosene, lubes and lubricating oils, waxes.														
Unit:4 10 (Hours)														
Treatment of products, additives, blending of gasoline. Treatment of gasoline, kerosene, lubes and lubricating oils, waxes.														
Unit:5 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									
23BCHPE47001	INTERFACIAL ENGINEERING	3	0	0	3									
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.													
CO5	Measurement of surface properties by using different tools													
CO6	Use of thermodynamics of micelle and mixed micellar formation and their applications													
Cos	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	-	-	3	-	-	1	-	-	-			2
CO2	-	-	-	-	2	-	-	1	-	-	-			2
CO3	-	-	-	-	3	-	-	2	-	-	-			1
CO4	-	-	-	-	1	-	-	3	-	-	-			2
CO5	-	-	-	-	-	-	-	2	-	-	-			1
CO6	-	-	-	-	1	-	-	2	-	-	--			1
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 (8 Hours)														
Intermolecular Forces, Van-der-waals forces (Kessom, Debye, and London Interactions). Potential energy curve, Brownian motion and Brownian Flocculation.														
UNIT: 3 (8 Hours)														
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:4 (8 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:5 (8 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
23BCHPE47001	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.														
CO5	Know about Osmotic and gel layer controlled filtration														
CO6	Know about advance membrane separation process for liquid and gas														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	-	-	-	-	3	-	-	3	-	-	-			2	
CO2	-	-	-	-	1	-	-	2	-	-	-			1	
CO3	-	-	-	-	2	-	-	2	-	-	-			1	
CO4	-	-	-	-	1	-	-	1	-	-	-			2	
CO5	-	-	-	-	2	-	-	2	-	-	-			1	
CO6	-	-	-	-	2	-	-	1	-	-	-			2	
Unit:1 8 (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 8 (Hours)															
Principles of membrane separation processes: Reverse osmosis, nano-filtration, ultra-filtration, micro-filtration,.															
UNIT:3 8 (Hours)															
Osmotic controlled filtration, gel layer controlled filtration. Basic principles and modeling of dialysis															
Unit:4 8 (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:5 8 (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: Separation 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
23BCHPE47001	Process Instrumentation											3	0	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 operations.														
CO5	Know about the level measuring instruments														
CO6	Know about the flow measuring instruments														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	1	1	2					-	-	-	3		2		
CO2	1	1	2	2			2	-	-	-	-	-	1		
CO3	2	1	2	-	-			-	-	-	-	-	1		
CO4	1	0	0	-	-			-	-	-	-	-	2		
CO5	1	2	0	-	-			-	-	-	-	-	2		
CO6	1	2	-	1	-	-	-	-	-	-	-	-	1		
UNIT:1 Temperature measuring instruments [8 Hours] 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,															
UNIT:2 Thermo-electric temperature measurements [8Hours] Thermoelectricity, Industrial thermocouple, Resistance thermometers - Thermal coefficient of resistance, Industrial resistance, Radiation receiving elements, Radiation, Photoelectric and Optical pyrometers															
UNIT:3 Pressure-measuring instruments [10 Hours] 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:4 Level measuring instruments [10 Hours] 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:5 Flow-measuring instruments [10 Hours] 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. <i>Industrial Instrumentation and Control, 3rd ed. by S K Singh, McGraw-Hill.</i>															
Ref. Books: 1. Patranabis, Principles of Industrial Instrumentation, 3rd ed., TMH, 2001 2. Johnson, C.D., “Process Control Instrumentation Technology”, Pearson Education, Inc.															

Subject Code	Course Title	L	T	P	C									
23BCHPE47001	SUSTAINABILITY ENGINEERING	3	0	0	3									
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 bio mimicking, green engineering, green building, sustainable habitat, sustainable urbanization													
CO5	Know about conventional and non-conventional energy													
CO6	Knowledge about management in industrial processes													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1	1	0	-	-			-	-	-	-		2	
CO2	2	2						-	-	-	-		2	
CO3	2	2	3				1	-	-	-	-	1	1	
CO4	1	1			1		2	-	-	-	-		1	
CO5	1		1				2	-	--	-	-		1	
CO6	1	1	-	-	-	-	2	-	-	-	-	1	1	
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 (8 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.														
UNIT :4 (8 Hours)														
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:5 (8 Hours)														
Green Engineering, Sustainable Urbanization, industrialization 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: 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.														

VIII Semester [Fourth Year]

Sl. No.	Course Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE
				L	T	P			
			THEORY						
1	PE	23BCHPE48001	Safety in Chemical Industries	3	0	0	3	40	60
			Pollution and its control						
			Physical and Analytical Chemistry						
			Water Conservation and Management						
2	PE	23BCHPE48002	Integrated Solid Waste Management	3	0	0	3	40	60
			Treatment of Industrial effluent						
			Green Technology						
			Coal processing technology						
3	OE	23BCHOE48001	Open Elective – 5(CPT)	3	0	0	3	40	60
PRACTICAL / SESSIONAL									
7	PSI	23BCHPW48101	Major Project Work-II & Dissertation	0	0	6	3	100	0
8	PSI	23BCHPW48102	Technical Seminar	0	0	2	1	100	0
				9	0	6	13	290	210
Total Credits:							13	290	210

Subject code	Title of the subject											L	T	P	C
23BCHPE48001	POLUTATION AND ITS CONTROL											3	0	0	3
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														
CO5	Development of methods to dispose hazardous waste														
CO6	Learn about the sustainability of industry and environment														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	-	-	-	-	-	-	1	2	-	-	-	2			
CO2	-	-	-	-	-	-	-	3	-	-	-	2			
CO3	-	-	-	-	-	-	2	1	-	-	-	1			
CO4	-	-	-	-	-	-	1	1	-	-	-	2			
CO5	-	-	-	-	-	-	-	2	-	-	-	1			
CO6	-	-	-	-	-	-	2	-	-	-	-	2			
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-															
Unit:5															
Sustainability Strategies- Barriers to Sustainability–Industrialization and sustainable development – Cleaner production in achieving sustainability- sustainable development															
Teaching Method (s):Chalk & Board/PPT/Video Lectures															
Text Books 1: Environmental Engineering, by Ruth F. Weiner and Robin Matthews – 4th Edition Elsevier, 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	Course Title											L	T	P	C
23BCHPE48001	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 behavior, 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														
CO5	Know about the isotherms used in adsorption														
CO6	Different instrument used in atomic spectroscopy														
Cos	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	3	3	0	0	-	-	-	-	-	-	-	3			
CO2	3	3	0	0	-	-	-	-	-	-	-	2			
CO3	2	2	2	1	-	-	-	-	-	-	-	1			
CO4	1	0	0	0	-	-	-	-	-	-	-	2			
CO5	1	2	-	-	-	-	-	-	-	-	-	1			
CO6	2	-	1	1	-	-	-	-	-	-	-	-			
Unit:1 10 (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 10 (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 10 (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,															
Unit:5 10 (Hours)															
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 Method (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, Jalandhar, 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
23BCHPE48001	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.														
CO5	Know about the functions of water resources														
CO6	Methods and techniques for water management														
Cos	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	2	1	0	0	-	-	-	-	-	-	-	-	3		
CO2	2	2	0	0	-	-	-	-	-	-	-	-	1		
CO3	2	2	2	1	-	-	-	-	-	-	-	-	1		
CO4	-	0	2	2	-	-	-	-	-	-	-	-	2		
CO5	1	2	-	-	-	-	-	-	-	-	-	-	2		
CO6	2	-	1	1	-	-	-	-	-	-	-	-	-	1	
Unit:1											10 (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											10 (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											8 (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.															
Unit:5											10 (Hours)				
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 <u>Libor Jansky</u> ,															
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															

Subject code	Course Title	L	T	P	C									
23BCHPE48002	GREEN TECHNOLOGY	3	0	0	3									
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.													
CO5	Impact of conventional fossil fuels on environment													
CO6	Knowledge about biomass energy and their utilization													
COs	PROGRAMME OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	1	0	-	-			-	-	-	-		2	
CO2	2	3						-	-	-	-		2	
CO3	2	3	3				1	-	-	-	-		2	
CO4	1	2			1			-	-	-	-		1	
CO5	1		1				2	-	--	-	-		2	
CO6	1	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, photo catalyst, PEG, Nano catalyst, and biocatalyst. Green solvents: Supercritical fluids, fluoruous 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,														
Unit:5						8(Hours)								
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. <i>Handbook of Green Chemistry, Vol. 1 to 9 by P T Anastas, Wiley VCH.</i>														
2. <i>Green Chemistry and Engineering: A Practical Design Approach by C J González and D J C Constable, Wiley.</i>														
3. <i>Green Chemistry and Engineering: A Pathway to Sustainability by A E Marteel Parrish and M A Abraham, Wiley.</i>														
4. <i>Pollution Prevention: Fundamentals and Practice' by Paul L Bishop (2000), McGraw Hill International.</i>														
Ref. Books														
1. <i>Green Chemistry for Environmental Sustainability by S K Sharma and AMudhoo, CRC Press.</i>														
2. <i>Handbook of Organic Waste Conversion' by Bewik M.W.M</i>														
3. <i>Non-conventional Energy Sources' by Rai G.D.</i>														

Subject Code	Course Title	L	T	P	C									
23BCHPE48002	TREATMENT OF INDUSTRIAL EFFLUENT	3	0	0	3									
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													
CO5	Different methods of disposing the solid waste and hazardous waste													
CO6	Pollution control in premier industries													
COs	PROGRAM OUTCOMES											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	2	-	-	2	1	-	-	-	-	-	2	
CO2	-	-	1	-	-	3	2	-	-	-	-	-	2	
CO3	-	-	1	-	-	2	2	-	-	-	-	-	1	
CO4	-	-	1	-	-	1	1	-	-	-	-	-	1	
CO5	-	-	2	-	-	-	2	-	-	-	-	-	2	
CO6	1		1	-	-	-	2	-	-	-	-	-	2	
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, secondary treatment: 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 ozonization)														
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.														
UNIT:4														
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 and venturi scrubbers), Gaseous emission control (Sox, Nox and organic vapor): absorption by liquids and adsorption by solids.														
UNIT:5 (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 and Thermal power plants.														
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCs														

<p>Text Books:</p> <ol style="list-style-type: none"> 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.
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Waste water treatment by M. Narayana Rao and A.K. Datta, 3rd Edition, Oxford and IHB, 2008. 2. Air Pollution 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	Title of The Subject											L	T	P	C
23BCHPE48002	INTEGRATED SOLID WASTE MANAGEMENT											3	0	0	3
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														
CO5	Regulatory processes for hazardous waste														
CO6	Know about the different methods of treatment of hazardous waste														
COs	PROGRAMME OUTCOMES											PSOs			
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	
CO1	-	-	2	-	-	2	1	-	-	-	-	-	1		
CO2	-	-	1	-	-	2	3	-	-	-	-	-	2		
CO3	-	-	1	-	-	2	2	-	-	-	-	-	1		
CO4	-	-	1	-	-	1	1	-	-	-	-	-	2		
CO5	1	-	1	-	-	-	2	-	-	-	-	-	1		
CO6	1	1	-	-	-	-	2	-	-	-	-	-	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, Waste processing, 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 8 (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 8 (Hours)															
Hazardous Waste Fundamentals, Definition, Classification, Generation, Regulatory process, Current Management Practices															
Unit:5 (7 Hours)															
Treatment and Disposal Methods, Physicochemical processes, Biological processes, Stabilization and solidification; Thermal methods; Land disposal, Remediation of Contaminated Sites.															
Teaching Method(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 Evans J.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															