

**K. K. Wagh Institute of Engineering Education and Research,
Nashik**

(Autonomous wef AY 2022-23)



Structure and Syllabus of S.Y. B. Tech (Chemical Engineering)

**Pattern: 2023
(wef AY 2023-24)**



K. K. Wagh Institute of Engineering Education and Research, Nashik

(Autonomous from Academic Year 2022-23)

S.Y. B. Tech Chemical Engineering															
(wef AY 2024-25)															
SEM-III															
Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	IN SEM	END SEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
2300201B	BSC	Applied Mathematics and Numerical Methods	3	-	-	20	60	20			100	3	-	-	3
2307202	PCC	Mechanical Operations	3	-	-	20	60	20			100	3	-	-	3
2307203	PCC	Chemical Reactions and Synthesis I	3	-	-	20	60	20			100	3	-	-	3
2307204	PCC	Lab work in Mechanical Operations	-	-	2	-	-	-	25	25	50	-	-	1	1
2307205	PCC	Lab work in Chemical Reactions and Synthesis I	-	-	4				50	50	100	-	-	2	2
2307206	MDM	Heat Transfer Processes	3	-	-	20	60	20	-	-	100	3	-	-	3
2307207	MDM	Lab Work in Heat Transfer Processes	-	-	2	-	-	-	25	25	50	-	-	1	1
2307208	OE	Industrial Management	2	-	-	-	-	50	-	-	50	2	-	-	2
2307209	VEC	Universal Human Values	-	2	-	-	-	50	-	-	50	-	2	-	2
2307210	VSEC	Problem Solving using Scilab		1	2	-	-	-	TUT-25 TW-25	-	50	-	1	1	2
Total Marks/Credits/hours			14	03	10	80	240	180	150	100	750	14	3	5	22



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S.Y. B. Tech. Chemical Engineering															
(wef AY 2024-25)															
SEM-IV															
Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	IN SEM	END SEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU	PR	TOTAL
2307211	PCC	Process Calculations	3	-	-	20	60	20			100	3	-	-	3
2307212	PCC	Chemical Reactions and Synthesis II	3	-	-	20	60	20			100	3	-	-	3
2307213	PCC	Thermodynamics	3	-	-	20	60	20			100	3	-	-	3
2307214	PCC	Lab Work in Process Calculations	-	-	2	-	-	-	25	25	50	-	-	1	1
2307215	PCC	Lab Work in Chemical Reactions and Synthesis II	-	-	4				50	50	100	-	-	2	2
2307216	MDM	Fluid Mechanics	3	-	-	20	60	20	-	-	100	3	-	-	3
2307217	MDM	Lab Work in Fluid Mechanics	-	-	2	-	-	-	25	25	50	-	-	1	1
2307218	OE	Environmental Economics	2	-	-	-	-	50	-	-	50	2	-	-	2
2307219	VEC	Democracy, Election and Governance	-	2	-	-	-	50	-	-	050	-	2	-	2
2307220	AEC	Technical Writing	-	1	2	-	-	-	TUT-25 TW-25	-	050	-	1	1	2
Total Marks/Credits/hours			14	03	10	80	240	180	150	100	750	14	3	5	22



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Exit Courses at S.Y. B. Tech (To award Diploma)															
Course Code	Course Type	Title of Course	Teaching Scheme			Evaluation Scheme and Marks						Credits			
			TH	TU	PR	INSEM	ENDSEM	CCE	TUT /TW	PR /OR	TOTAL	TH	TU /TW	PR	TOTAL
2307221	EXIT	Internship	0	0	0	0	0	0	100	0	100	0	2	0	2
2307222	EXIT	Chemical Process Industries	2	0	2	20	30	0	50	0	100	2	1	0	3
2307223	EXIT	Chemical Process Safety	2	0	2	20	30	0	50	0	100	2	1	0	3
Total Marks/Credits/hours			4	0	4	40	60	0	200	0	300	4	4	0	8



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Semester III (SY - B. Tech.) Chemical Engineering			
2300201B: Applied Mathematics & Numerical Methods			
Teaching Scheme: Theory: 3 hrs/week	Credit Scheme:3	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks	
Prerequisite: Linear Algebra, Vector algebra, Differential calculus and Integral calculus.			
Course Objectives: 1. Find General solution of higher-order linear differential equation with constant & variable coefficient using different Methods. 2. Find Laplace transform of functions using definition & properties & solve Ordinary D.E. using L.T. 3. Recognize nature of vector fields, use different vector differential operators & able to evaluate Line, surface & Volume integrals & its application 4. Solve boundary value problems for Numerical Methods, Laplace's equation, heat equation, the wave equation by separation of variables.			
	Course Outcomes		Bloom's Level
CO1	Define & understand basic concept of L.D.E, Transforms, Numerical techniques and Vector Calculus.		2- Understanding
CO2	Solve the problems on LDE, PDE, transforms using appropriate method.		3- Apply
CO3	Apply numerical methods and vector calculus to solve real life problems		3- Apply
CO4	Analyze complex engineering problems by using concepts of differential calculus and numerical techniques.		4- Analyze
CO5	Evaluate the real life problems by using concepts of differential calculus and numerical techniques.		5 -Evaluate
Course Contents:			
Unit 1	Linear Differential Equations with Constant Coefficient	(L08)	COs Mapped -CO1, CO2, CO4,CO5
LDE of nth order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE.			
Unit 2	Applications of Linear Differential Equations & Partial Differential Equations	(L07)	COs Mapped - CO1, CO2, CO4,CO5
Applications of LDE to chemical engineering problems and mass spring system. Basic concepts, modeling of Vibrating string, Wave equation, one and two dimensional Heat flow equations, method of separation of variables, use of Fourier series. Applications of PDE to problems of Chemical and allied engineering.			



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Unit 3	Transforms	(L07)	COs Mapped- CO1, CO2, CO4, CO5
Laplace Transform (LT): Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Dirac delta Unit Impulse, Bessel's function. Applications of LT for solving Linear differential equations. Fourier Transform (FT): Fourier transform, Fourier Sine & Cosine transform, Inverse Fourier Transforms.			
Unit 4	Numerical Methods	(L07)	COs Mapped -CO1, CO3, CO4, CO5
Numerical Solution of Algebraic and Transcendental equation: Bisection, Secant, Regula-Falsi, Newton-Raphson and Successive Approximation Methods, Numerical Solution of System of linear equations: Gauss elimination, Gauss-Jordon Elimination LU Decomposition, Cholesky, Jacobi and Gauss-Seidel Methods.			
Unit 5	Vector Calculus	(L07)	COs Mapped –CO1, CO3, CO4, CO5
Vector differentiation, Gradient, Divergence & Curl, Directional derivative, Solenoid, Irrotational and Conservative fields, Scalar potential, Vector identities. Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem.			
Text Books			
1. Higher Engineering Mathematics, B.V. Ramana, Tata McGraw-Hill. 2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication, Delhi. 3. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Ltd.			
Reference Books			
1. Advanced Engineering Mathematics, 7e, Peter V. O'Neil (Thomson Learning) 2. Applied Mathematics" (Volumes I and II), P. N. Wartikar and J. N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune. 3. Advanced Engineering Mathematics, 2e, M. D. Greenberg (Pearson Education). 4. Advanced Engineering Mathematics with MATLAB, 2e, Thomas L. Harman, James Dabney and Norman Richert (Brooks/Cole, Thomson Learning).			
Guidelines for Continuous Comprehensive Evaluation of Theory Course			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Tests on each unit using LMS (Each test for 15 M and total will be converted out of 05 M)	05	
2	Problem solving through Computational Software	05	
3	Tutorial (1 tutorial on each unit for 15 marks and total will be converted out of 05 M)	05	
4	Group Presentation on real life problem	05	
	Total	20	



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Topics for Tutorial		
Sr. No.	Title	CO Mapped
1	Examples on LDE of nth order with constant coefficients.	CO1, CO2, CO3, CO5
2	Examples on Applications of LDE to chemical engineering problems and mass spring system.	CO1, CO2, CO3, CO5
3	Examples on transforms.	CO1, CO2, CO3, CO5
4	Examples on Numerical Methods	CO1, CO2, CO4, CO5
5	Examples on Vector calculus.	CO1, CO2, CO4, CO5



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Semester III (SY - B. Tech.) Chemical Engineering 2307202: Mechanical Operations			
Teaching Scheme: Theory: 3 hrs/week		Credit Scheme:3	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks
Prerequisite: Courses of Engineering Mathematics, Physics and Chemistry			
Course Objectives: 1. To study properties of solids, separation and size reduction of solids. 2. To understand fluid solid separation using sedimentation operation, Fluidization. 3. To study mixing, agitation and Filtration Operations.			
Course Outcomes: on completion of course learner will be able to-			
Sr. No.	Course Outcomes		Bloom's Level
CO1	Classify the type of screening and size reduction equipment for different particle sizes		3- Apply
CO2	Understand different types solid-liquid, solid-gas separation operation.		2- Understand
CO3	Explain fluidization applications in Chemical industries and able to select a suitable type of conveyor for transportation of various types of solids.		3- Apply
CO4	Calculate the mixing index and select a suitable type of mixing equipment for solids-solid and solid-liquid etc.		3- Apply
CO5	Apply the concepts of Filtration operations for the selection of suitable type of filtration equipment.		3- Apply
Course Outcomes: on completion of course learner will be able to- 1. Classify the type of screening and size reduction equipment for different particle sizes 2. Understand different types solid-liquid, solid-gas separation operation. 3. Explain fluidization applications in Chemical industries and able to select a suitable type of conveyor for transportation of various types of solids. 4. Calculate the mixing index and select a suitable type of mixing equipment for solids-solid and solid-liquid etc. 5. Apply the concepts of Filtration operations for the selection of suitable type of filtration equipment.			
Course Contents:			
Unit 1	Size Reduction and Screening Operations	(L07)	COs Mapped - CO1
Particle size and shape, specific surface area; measurement of surface area, necessity of size reduction, different size reduction equipment's, crushing efficiency, wet grinding, open circuit and closed circuit grinding, industrial screening equipment and its types, screen analysis.			
Unit 2	Sedimentation and Separation Methods	(L07)	COs Mapped – CO2
Sedimentation, Kynch theory of sedimentation equipment and its types, classifiers, centrifugal			



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equipment, forth-flotation cell, magnetic separator, cyclone separator, liquid cyclone, electrostatic separator, precipitator, mineral jig.			
Unit 3	Fluidization and Transportation of solids	(L08)	COs Mapped – CO3
Concept of fluidization, fluidized bed systems, determination of minimum fluidization velocity, flow through packed bed, applications of fluidized bed. Spouted bed and fixed bed. Conveyors: principle, construction and working. Advantages, disadvantages and design calculations of belt conveyors, screw conveyors, chain & flight conveyors, bucket elevators and pneumatic conveyors.			
Unit 4	Mixing Operation	(L07)	COs Mapped – CO4
Necessity of mixing and agitation in chemical industries, axial flow and radial flow agitators and its types agitation vessel, un-baffled and baffled tanks, draft tube, power requirement in mixing calculations, performance of mixers, mixing index, types of mixing equipment's sigma mixer, Static mixer, ribbon blender, bunbury mixer, pug mill.			
Unit 5	Filtration	(L07)	COs Mapped – CO5
Filtration theory: constant pressure, constant rate, and variable pressure-variable rate filtration, classification of filtration and filters, filtration equipment, selection, sizing filter media and filter aids, classification of filtration, pressure drop through filter cake, filter medium resistance, specific cake resistance, types of filters – plate and frame, rotary vacuum filter, horizontal pressure leaf filters. Centrifugal filters.			
Text Books			
1. Unit operation in Chemical Engineering, R.S. Hiremath and A.P. Kulkarni, Everest publication.			
Reference Books			
1. Unit Operations in Chemical Engineering McCabe W. L. & Smith J.C., McGraw Hill Publications.			
2. Coulson & Richardson's Chemical Engineering, Volume 2, John Metcalfe Coulson, John Francis Richardson, John Hadlett Harker, J. R. Backhurst, Elsevier Science.			
3. "Introduction to Chemical Engineering", Badger W. L and Banchero J.T. McGraw Hill Publications.			
4. Perry's Hand book- 4 th edition McGraw Hill Publications.			
Guidelines for Continuous Comprehensive Evaluation of Theory Course			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Three Assignments on unit-1, Unit-2, Unit-3 & 4	10	
2	Group Presentation on Unit-5	05	
3	LMS Test on Each Unit	05	
	Total	20	



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Semester III (SY - B. Tech.) Chemical Engineering 2307203: Chemical Reactions and Synthesis I			
Teaching Scheme: Theory: 3 hrs/week		Credit Scheme: Scheme:3	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks
Prerequisite: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.			
Course Objectives: 1. To impart the basic concepts of organic chemistry 2. To develop understanding about concepts of organic reactions for analysis of unit 3. To study the different analytical instrumentation techniques			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes		Bloom's Level
CO1	Analyse the type of forces and synthesize the materials based on their properties		2 Understand
CO2	Estimate the kinetics of reaction and analyze the factors controlling the rate of reactions.		3 Apply
CO3	Analyze the given chemical substance by different Instrumentation techniques.		3 Apply
CO4	Estimate the quantity of solute and synthesize the solution based on the properties.		3 Apply
CO5	Evaluate the mechanism of reactions and apply proper factor for increasing the yield of the desired product.		4 Analyze
Course Contents:			
Unit 1	Bonding and Reactivity	(L07)	COs Mapped – CO1
Covalent Bonding- Introduction to VBT, Molecular orbital theory, MO structures of s-s, s-p , p-p overlaps , molecular orbital structure of butadiene, benzene, MO energy diagrams for diatomic molecules N2, O2 , CO. Aromaticity-conditions necessary for delocalization of electrons, resonance structures stability rules, resonance in phenol, aniline, ,benzaldehyde ,nitrobenzene molecules, Inductive effect and Resonance effect on pKa and pKb values of acids and bases.			
Unit 2	Reaction Dynamics &Photochemistry	(L08)	COs Mapped – CO2
Kinetics: Rate of reaction, rate constant, order of reaction, kinetics of first and second order reactions, numerical on above, Activated complex theory of reaction rates kinetics of complex reactions. Photochemistry: Introduction and importance, Stark-Einstein law, photochemical rate law, examples of photochemical reactions kinetics of i) H ₂ , Cl ₂ reaction ii) Dimerisation of anthracene. Types of Photochemical Organic reactions, Laws of photochemistry and quantum yields-problems. Photosensitized reactions.			



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Unit 3	Instrumental methods of Analysis	(L07)	COs Mapped – CO3
Chromatography: Adsorption and partition principles, Study of TLC, column, HPLC, Gas Chromatography and their applications. b) Optical methods: UV, Lambert-Beer law, IR spectroscopy-introduction, instrumentation, applications. Flame photometry- principle, instrumentation and applications.			
Unit 4	Solution	(L07)	COs Mapped – CO4
Solution:- definition, solution of gas in gas, gases in liquid, Henry's law, the ideal solution, Raoult's law of ideal solution, solutions of liquids in liquids, theory of dilute solution. Colligative properties, osmosis, osmotic pressure, Colligative properties of dilute solution-lowering of vapor pressure, elevation of boiling point and thermodynamic derivation, depression in freezing point and thermodynamic derivation. Abnormal behavior of solutions of electrolytes, Van't Hoff factor. Numerical on all above.			
Unit 5	Reaction Mechanisms	(L07)	COs Mapped – CO5
Substitution at saturated carbon (SN ¹ , SN ²) - mechanism, kinetics, stereochemistry, factors favoring it. Electrophilic aromatic substitution in benzene and mono substituted benzenes, activating and deactivating groups, nitration, Friedel-Craft reactions, sulphonation, and diazotization. Nucleophilic substitution on carbonyl carbon. Addition of HX on C=C, 1, 2 Eliminations- E1 mechanism, E2, (Saytzeff, Hoffman products), factors favoring it. Rearrangements- Beckmann, Claisen, Favorskii.			
Text Books			
1. Concise Inorganic Chemistry J.D. Lee, Wiley India Pvt Ltd. 5 th edition 2. Advanced Inorganic Chemistry Cotton, Wilkinson, Murillo, Bochmann, 6 th edition 3. Physical chemistry, P L Soni, Sultan Chand & Sons, 4. Physical Chemistry, Peter Atkins, Julio de Paula, James Keeler, International Eleventh			
Reference Books			
1. Fundamentals of Analytical Chemistry- Skooge and West, Cengage Learning EMEA, 9 th edition 2. Advanced Organic Chemistry, Jerry March, Wiley, 4 th edition 3. Organic Chemistry, Morrison Boyd & Bhattacharjee Pearson Education India, 7 th edition 4. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt and J.A. Dean & F.A. Settle, CBS Publishers, 7 th Edition			
Guidelines for Continuous Comprehensive Evaluation of Theory Course			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Four Assignments on unit-1, Unit-2, Unit-3 & 4	10	
2	Group Presentation on Unit-5	05	
3	LMS Test on Each Unit	05	
Total			20



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Semester III (SY - B. Tech.) Chemical Engineering 2307204: Lab work in Mechanical Operations		
Teaching Scheme: Practical: 2Hrs. /Week	Credit Scheme:1	Examination scheme: TW: 25 marks Practical: 25 marks Total: 50 Marks
Prerequisite: Courses of Engineering Mathematics, Physics and Chemistry		
Course Objectives: 1. To study properties of solids, separation and size reduction of solids. 2. To understand fluid solid separation using sedimentation operation, Fluidization. 3. To study mixing, agitation and filtration operations.		
Course Outcomes:		
Sr. No.	Course Outcomes	Bloom's Level
CO1	Evaluate the separation methods for solid & fluids.	3-Apply
CO2	Apply the principles of size reduction equipment's for solids.	3-Apply
CO3	Determine mixing Index and apply the knowledge on mixing principles for solid-solid / solid-liquid mixing.	3-Apply
CO4	Evaluate the filter medium & specific cake resistance.	3-Apply
CO5	Understand the various solid transportation techniques.	2- Understand
List of Laboratory Experiments (conduct at least 8 experiments from the below list)		
Sr. No.	Laboratory Experiments	CO Mapped
1.	To determine effectiveness of given set of standard screen	CO1
2.	To find efficiency of cyclone separator.	CO1
3.	To study batch sedimentation operation.	CO1
4.	To determine separation efficiency by using magnetic separator.	CO1
5.	To determine energy consumption and crushing law constants for jaw crusher	CO2
6.	To determine Critical speed of Ball mill & Average particle size of the product obtained in ball mill	CO2
7.	To determine mixing Index in Sigma Mixer	CO3
8.	To study Static Mixer.	CO3
9.	To determine filter medium resistance and specific cake resistance by using Plate & frame filter Press.	CO4
10.	To study various conveyor systems.	CO5
Guidelines for Laboratory Conduction		
• Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment. • Apparatus and equipments required for the allotted experiment will be provided by the lab		



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assistants using SOP.

- Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant.
- After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher.
- Students will then complete the experimental write up.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.

Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.
2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.



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Semester III (SY - B. Tech.) Chemical Engineering 2307205: Lab work in Chemical Reactions and Synthesis I		
Teaching Scheme: Practical: 4 Hrs. /Week	Credit Scheme: 2	Examination scheme: TW: 50 marks Practical: 50 marks Total: 100 Marks
Prerequisite: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.		
Course Objectives: 1. To impart the basic concepts of organic, inorganic and physical chemistry 2. To develop understanding about concepts of organic reactions for analysis of unit Processes 3. To study the different analytical instrumentation techniques and their applications		
Course Outcomes: On completion of the course, students will be able to–		
Sr. No.	Course Outcomes	Bloom's Level
CO1	Analyze the strength of forces and evaluate the size and molecular weight of the molecule.	2-Understand
CO2	Estimate the kinetics of reaction and analyze the factors controlling the rate of reactions.	3-Apply
CO3	Analyze the given chemical substance by different Instrumentation techniques.	3-Apply
CO4	Prepare and analyze the quality of organic compounds by different kinds of test.	3-Apply
List of Laboratory Experiments		
Sr. No.	Laboratory Experiments	CO Mapped
1	To determine diameter of solute molecule by viscosity measurements.	CO1
2	To determine rate constant of first order reaction of acid catalyzed hydrolysis of ester	CO2
3	Preparation of benzoic acid from benzamide, crystallization and purity checking by TLC.	CO4
4	To find molecular wt. of solute by depression in freezing point of solvent	CO1
5	Estimation of Cu^{++} ions by spectrophotometer	CO3
6	Identification of given organic compound (Acid)	CO4
7	Identification of given organic compound (Base)	CO4
8	Identification of given organic compound (Phenol)	CO4
9	Identification of given organic compound (Neutral)	CO4
10	To determine molecular weight of solid by Elevation in B.P	CO4
Text Books		
1. Laboratory manual on general and applied chemistry, Dr. S. K .Bhasin, Dhanpatrai publication. 2. Laboratory manual on engineering chemistry, Dr. S. K. Bhasin, Dhanpatrai publication. 3. Instrumental methods of chemical analysis, Chatwal Anand publication		
Reference Books		
1. Instrumental Methods of Analysis, H. H. Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7 th Edition, 1988 2. Vogel's analytical chemistry, J. Mendham, Pearson Education, 6 th Edition		



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Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment.
- Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.
- Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant.
- After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher.
- Students will then complete the experimental write up.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.

Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.
2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.



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Semester III (SY - B. Tech.) Chemical Engineering 2307206: Heat Transfer Processes			
Teaching Scheme: Theory: 3 hrs/week	Credit Scheme: 3	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks	
Prerequisite: Applied Mathematics, Thermodynamics			
Course Objectives: 1. To use heat transfer principles to understand the behavior of thermal systems. 2. To provide the basic knowledge in thermal system design and to enlighten heat transfer applications. 3. To classify and design of the various heat exchangers and evaporators used in chemical industries.			
Course Outcomes: on completion of course, learner will be able to-			
Sr. No.	Course Outcomes	Bloom's Level	
CO1	Acquire the fundamental knowledge of the modes of heat transfer and study its application.	2-Understand	
CO2	Demonstrate the concepts of convective heat transfer with empirical equations and examples.	3-Apply	
CO3	Acquire the basic concepts of thermal radiation.	2-Understand	
CO4	Identify and design of heat exchanger for specific applications in chemical industry.	5-Evaluate	
CO5	Classify and design of evaporation system based on the industrial applications.	4-Analyze	
Course Contents:			
Unit 1	Introduction	(L07)	COs Mapped - CO1
Modes of heat transfer- radiation, conduction and convection, Thermal conductivity, dimensional analysis. Steady state heat conduction through a plane slab, composite slab, hollow cylinder, composite cylinder and hollow sphere. Contact resistance, heat transfer between surfaces and surrounding, Thermal Insulation, Hot and cold insulating materials, critical thickness of insulation. Heat transfer through extended surfaces (fins). Introduction to transient/unsteady state heat conduction.			
Unit 2	Convection	(L07)	COs Mapped - CO1, CO2, CO4
Natural and forced convection, Equations for convective heat transfer through annulus and over a flat plate. Condensation: Modes and features, Nusselt's equation, condensation on vertical and horizontal plate Boiling: Pool boiling and nucleate boiling			
Unit 3	Radiation	(L07)	COs Mapped - CO3
Thermal radiation, black body radiation, properties of radiation, laws of radiation. Various cases of radiation between two surfaces, radiation shields			
Unit 4	Heat Exchangers	(L08)	COs Mapped – CO4
Basic types of heat exchangers, overall heat transfer coefficient, fouling factor, Double pipe heat exchanger design by LMTD, correction to mean temperature difference due to cross flow, multi-pass exchangers. and effectiveness-NTU methods (calculations of overall heat			



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transfer coefficient and area), Tubular Heat Exchanger: Shell and tube heat exchangers, Compact Type Heat Exchangers : Plate type heat exchange, Spiral type Heat Exchangers			
Unit 5	Evaporation	(L07)	COs Mapped – CO5
Introduction, types of evaporators, material and energy balance, boiling point elevation, capacity and economy, multiple effect evaporators			
Text Books			
1. Fundamentals of Engineering Heat and Mass Transfer (SI Units), R.C. Sachdeva, New Age International Publishers, 5th edition			
2. Heat and Mass Transfer, P K Nag, McGraw-Hill publications, 3rd Edition			
Reference Books			
1. Process Heat Transfer, D. Q. Kern, Tata McGraw Hill Publication, New Delhi, 11 th Edition.			
2. Heat Transfer, J P Holman, Tata McGraw Hill Publications, New Delhi, 9 th Edition.			
3. A Textbook on Heat Transfer, S. P. Sukhatme, Universities Press (India), 4 th Edition			
4. Transport phenomena, Bird R.B., Stewart W.E., Lightfoot E.N, Wiley Publications, 2 nd Edition			
5. Heat and Mass Transfer, Yunus A. Cengel,, McGraw Hill Publications, New Delhi, 3 rd Edition			
Guidelines for Continuous Comprehensive Evaluation of Theory Course			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Three Assignments on unit-1, Unit-2, Unit-3 & 4	10	
2	Group Presentation on Unit-5	05	
3	LMS Test on Each Unit	05	
	Total	20	



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Semester III (SY - B. Tech.) Chemical Engineering 2307207: Lab work in Heat Transfer Processes		
Teaching Scheme: Practical: 2Hrs. /Week	Credit Scheme: 1	Examination scheme: TW: 25 marks Practical: 25 marks Total: 50 Marks
Prerequisite: Engineering Mathematics, Thermodynamics		
Course Objectives: 1. To use heat transfer principles to understand the behavior of thermal systems. 2. To provide the basic knowledge in thermal system design and to enlighten heat transfer applications. 3. To classify and design of the various heat exchangers and evaporators used in chemical industries.		
Course Outcomes: on completion of course, learner will be able to-		
Sr. No.	Course Outcomes	Bloom's Level
CO1	Acquire the fundamental knowledge of the modes of heat transfer and study its application.	2-Understand
CO2	Demonstrate the concepts of convective heat transfer with empirical equations and examples.	3-Apply
CO3	Acquire the basic concepts of thermal radiation.	2-Understand
CO4	Identify and design of heat exchanger for specific applications in chemical industry.	5-Evaluate
CO5	Classify and design of evaporation system based on the industrial applications.	4-Analyze
List of Laboratory Experiments		
Sr. No.	Laboratory Experiments	CO Mapped
1.	Determination of thermal conductivity of composite wall	CO1
2.	Determination of thermal conductivity of insulation powder	CO1
3.	Calculation of heat transfer coefficient using natural convection	CO2
4.	Calculation of heat transfer coefficient using forced convection	CO2
5.	Determination of Stephan Boltzmann constant	CO3
6.	Determination of emissivity using thermal radiation	CO3
7.	Determination of heat transfer coefficient of Double pipe heat exchanger	CO4
8.	Determination of heat transfer coefficient of shell and tube heat exchanger	CO4
9.	Heat Transfer in agitated vessels	CO4
10.	Material balance and energy balance of Single effect evaporator	CO5
Text Books		
1. Fundamentals of Engineering Heat and Mass Transfer (SI Units), R.C. Sachdeva, New Age International Publishers, 5th edition 2. Heat and Mass Transfer, P K Nag, McGraw-Hill publications, 3rd Edition		
Reference Books		



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1. Process Heat Transfer, D. Q. Kern, Tata McGraw Hill Publication, New Delhi, 11th Edition.
2. Heat Transfer, J P Holman, Tata McGraw Hill Publications, New Delhi, 9th Edition.
3. A Textbook on Heat Transfer, S. P. Sukhatme, Universities Press (India), 4th Edition
4. Transport phenomena, Bird R.B., Stewart W.E., Lightfoot E.N, Wiley Publications, 2nd Edition
5. Heat and Mass Transfer, Yunus A. Cengel,., McGraw Hill Publications, New Delhi, 3rd Edition

Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment.
- Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.
- Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant.
- After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher.
- Students will then complete the experimental write up.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.

Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.
2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.



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Semester III (SY - B. Tech.) Chemical Engineering 2307208: Industrial Management			
Teaching Scheme: Theory: 2 hrs/week	Credit Scheme: 2	Examination scheme: Continuous Comprehensive Evaluation: 50 marks Total: 50 Marks	
Prerequisite: Basic management terms			
Course Objectives: 1. To introduce the fundamental concepts of Industrial Management. 2. To study the various organization structures and their working. 3. To interpret the production management concept in professional life. 4. To introduce quality objectives during the manufacturing/ production applications.			
Course Outcomes: on completion of course learner will be able to-			
Sr. No.	Course Outcomes	Bloom's Level	
CO1	Apply the fundamental concepts of Industrial Management.	3-Apply	
CO2	Apply the production management concept in professional career.	3-Apply	
CO3	Apply material planning, store keeping procedure and analyze importance of inventory control	3-Apply	
CO4	Apply quality objectives during the manufacturing/ production process.	3-Apply	
Course Contents:			
Unit 1	Fundamentals of Management	(L06)	COs Mapped - CO1
Administration Definition – Henry Fayol's principles of management Business Functions of Management – Planning Definition Functions Organisation Definition types of organisation –Line Functional Line & staff advantages and disadvantages Leadership Types –Quality of good leader. Motivation, Hierarchy of needs Communication – Process of Communication – Barriers for effective communication. Introduction and Meaning of Organization, Organization as a process, Span of Control, Authority, Responsibility and Accountability, Delegation of authority, Decentralization of authority.			
Unit 2	Production Management	(L06)	COs Mapped – CO2
Production Management – Modern Approach, Manufacturing systems, Interface management. Manufacturing / Operations Strategy – Principles & concept. Investment strategy, Capacity strategy, Quality strategy, Technology strategy, Customer focus strategy, Facility location strategy, Product flexibility strategy, Short delivery process strategy, Quick time delivery strategy, Concepts of Productivity, Measurement & Improvement, Lean Manufacturing, Value Engineering, Business Process Re-engineering. World Class Manufacturing (WCM)			
Unit 3	Material management	(L06)	COs Mapped – CO3
Definition, functions- Purchase - Objectives, different methods of purchasing -Purchase procedure-Comparative statement-purchase order-Tender-Types of tender- Storekeeping-classification of stores - Functions of store keeper. Store management Material Issue			



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Requisition- Material Returned Note- Store ledgers -Codification of stores-Inventory Management- Definition - functions of Inventory Control- concept, features and applications.- Material Requirement Planning (MRP)-concept, applications			
Unit 4	Quality Management	(L06)	COs Mapped – CO4
Concept - Quality control- Definition - Factors affecting quality- Advantages of quality control –Inspection - Different types of inspection. Total Quality Management-Meaning- Principles of total quality management-PDCA cycles Quality Circles-definition-Function. Modern approach to Quality Management, Acceptance sampling and statistical quality control, Deming's 14 points of QM, TQM Principles & implementation, ISO 9000–2000, ISO 14000 (Environment) & ISO 50000 (Energy) quality standards			
Text Books			
1. Industrial Engineering and Management, O.P. Khanna, Dhanpat Rai Publications 2. Business Organization and management- M. C. Shulka, S Chand & Co Ltd			
Reference Books			
1. Indian Economy, Agarwal, A. N., Vikas Publishing House Pvt. Ltd., New Delhi. 2. Principles of management- Knoots and O. Donnell, McGraw Hill Publishing company 3. The Practice of Management, Peter F. Drucker, Allied publishers pvt. ltd., Bombay. 4. Production management & Control, Barat & Nikhil, Academic Publishers, Calcutta. 5. Financial Management: An- Analytical & Conceptual Approach, Kuchhal, S. C. Chaitanya Publishing House, Allahabad. 6. Marketing Management: Analysis, Planning & Control, Kotler, Philip, Prentice –Hall of India Pvt. Ltd., New Delhi 7. Marketing and Salesmanship, Sinha, J. C., S. Chand & Co., Delhi			
Guidelines for Continuous Comprehensive Evaluation of Theory Course			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Three Assignments on unit-1, Unit-2, Unit-3 & 4	30	
2	Group Presentation on Unit-4	10	
3	LMS Test on Each Unit	10	
	Total	50	



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Semester III (SY - B. Tech.) Chemical Engineering 2307209: Universal Human Values			
Teaching Scheme: Tutorial: 2 hrs/week	Credit Scheme: 2	Examination scheme: Continuous Comprehensive Evaluation: 50 marks Total: 50 Marks	
Prerequisite: NA			
Course Objectives: 1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings. 2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way. 3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature. Thus, this course is intended to provide a much-needed orientation input in value education to the young enquiring minds.			
Course Outcomes: on completion of course learner will be able to-			
Sr. No	Course Outcomes	Bloom's Level	
1.	Evaluate the significance of value inputs in formal education and start applying them in their life and profession	5-Evaluate	
2.	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.	3-Apply	
3.	Analyze the value of harmonious relationship based on trust and respect in their life and profession	4-Analyze	
4.	Examine the role of a human being in ensuring harmony in society and nature.	4-Analyze	
5.	Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.	3-Apply	
Course Contents:			
Unit 1	Introduction-Basic Human Aspiration, its fulfilment through All-encompassing Resolution	(L05)	COs Mapped - CO1
The basic human aspirations and their fulfilment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All- encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.			
Unit 2	Right Understanding (Knowing)- Knower, Known & the Process	(L05)	COs Mapped – CO2



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The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).			
Unit 3	Understanding Human Being	(L05)	COs Mapped – CO3
Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self			
Unit 4	Understanding Nature and Existence	(L05)	COs Mapped – CO4
A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self-awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).			
Unit 5	Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living	(L05)	COs Mapped – CO5
Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire existence.			
Text Books			
1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana and G P Bagaria, Excel Books Publication New Delhi, 2nd Revised Edition.			
Reference Books			
1. Energy & Equity, D. Ivan Illich, The Trinity Press, Worcester, and Harper Collins, USA. 2. Small is Beautiful: a study of economics as if people mattered, E.F. Schumacher, Blond & Briggs, Britain. 3. How the Other Half Dies, Sussan George, Penguin Press. New Edition. 4. Limitsto Growth – Club of Rome’s report, Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, Universe Books. 5. Jeevan Vidya EkParichay, A Nagraj, Divya Path Sansthan, Amarkantak. 6. Science and Humanism, P L Dhar, RR Gaur, Commonwealth Publishers. 7. Human Values, A N Tripathy , New Age International Publishers. 8. How to practice Natural Farming, Subhas Palekar, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati. 9. Fundamentals of Ethics for Scientists & Engineers, E G Seebauer & Robert L. Berry, Oxford University Press 10. Engineering Ethics (including Human Values), M Govindrajan, S Natrajan & V.S. Senthil Kumar, Eastern Economy Edition, Prentice Hall of India Ltd. 11. Foundations of Ethics and Management, B P Banerjee, Excel Books Publications. 12. Indian Ethos and Modern Management, B L Bajpai, New Royal Book Company.			



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Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit 1, Unit 2, Unit 3	30
2	Group Presentations on Unit 4 and Unit 5	20
	Total	50



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Semester III (SY - B. Tech.) Chemical Engineering 2307210: Problem Solving using Scilab		
Teaching Scheme: Tutorial: 01 hrs/week Practical: 02 hrs/week	Credit Scheme: TUT: 1 TW: 1	Examination scheme: Tutorial: 25 Marks Term Work: 25 Marks Total : 50 marks
Prerequisite: NA		
Course Objectives: 1. To understand the basics of Scilab, its importance, relevance, and applications in chemical engineering 2. To perform basic calculations, Vector, Matrix Operations, Conditional Branching, Iteration, Scripts and Functions, Plotting, File Handling, User defined Input and Output, Integration, Solving Non-linear Equations, Linear Equations Gaussian Methods, Linear equations Iterative Methods, Interpolation, ODE Euler Methods, ODE Applications, Optimization Using Karmarkar Function		
Course Outcomes: On completion of the course, students will be able to–		
Sr. No.	Course Outcomes	Bloom's Level
CO1	Identify the fundamental concepts of Scilab, its significance, and its applications in chemical engineering	1-Knowledge
CO2	Explain how to perform basic calculations, vector & matrix operations, and utilize Scilab functionalities for plotting, file handling, and problem-solving	2-Understand
CO3	Implement Scilab for various tasks, including solving linear & non-linear equations, integration, ODE simulations, and optimization using provided functions.	3-Apply
Course Contents:		
Module I		(L03)
Vector, Matrix Operations, Conditional Branching		COs Mapped: CO1
Module II		(L03)
Iteration, Scripts and Functions, Plotting, File Handling		COs Mapped: CO2
Module III		(L03)
User defined Input and Output, Integration, Solving Non-linear Equations, Linear Equations Gaussian Methods, Linear equations		COs Mapped: CO3
Module IV		(L03)
Iterative Methods, Interpolation, ODE Euler Methods, ODE Applications, Optimization Using Karmarkar Function		COs Mapped: CO3
Text Books		
1. Introduction to Scilab for Engineers and Scientists, Sandeep Nagar, First Edition, Apress publisher (2017).		
2. Advanced Programming in Scilab, Chetan Jain, First Edition, Alpha Science International		



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Ltd (2020).

Reference Books

1. Introduction to Scilab, Michael Baudin, First Edition, DigitE publisher

Guidelines for Laboratory Conduction

1. Teacher will brief the given problem statement to students, its objectives and outcome.
2. Students will solve the allotted problem in a group or individually using simulator.
3. After solving problem, students will check their simulated results from the teacher.
4. Students will then complete the write up.

Guidelines for Student's Lab Journal

Write-up should include title, Software used, Concept utilized, Course Usage and Problem Statement, conclusion. Simulation steps, simulated results if any.

Guidelines for Term work Assessment

1. Each experiment from lab journal is assessed for thirty marks based on three rubrics.
2. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.



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Semester IV (SY - B. Tech.) Chemical Engineering 2307211: Process Calculations			
Teaching Scheme: Theory:03 hrs/week	Credit Scheme: 03	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks	
Prerequisite: Courses of Engineering Mathematics, Physics and Chemistry.			
Course Objectives: 1. To learn the various unit operations and unit processes performed in a chemical industry. 2. To impart knowledge on concepts of Material balance for unit operations and unit process. 3. To enable students to learn the application of the general energy balance equation and precisely to calculate the energy requirements for unit operations. 4. To study basic concepts of Humidification operation. 5. To study different types of fuels and understand the combustion calculations.			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes	Bloom's Level	
CO1	Determine the composition of the materials and apply the various laws governing solid, liquid and gas phases	3-Apply	
CO2	Calculate the amount of materials required to carry out the suitable unit operation and process.	3-Apply	
CO3	Determine the Conversion and Yield of the reactions.	3-Apply	
CO4	Evaluate the energy requirement for various unit operations and processes in chemical industries.	3-Apply	
CO5	Understand the basics of Humidification and Combustion Process.	2-Understand	
Course Contents:			
Unit 1	Units and Basic Chemical Principle	(L07)	COs Mapped: CO1
Introduction to unit operations, Units and dimensions: fundamental and derived units, conversions, ideal and real gas laws. Mole fractions and partial pressures, Average molecular weight, application of Dalton's, Amagat's, concept of vapor pressure, Raoult's law and its applications, gas & gaseous mixture.			
Unit 2	Material Balance without Chemical Reactions	(L08)	COs Mapped: CO2
Basic Concepts and Introduction to first law of thermodynamics, material balance calculations for Evaporation, Distillation, Filtration, Extraction, Mixing, crystallization. Bypass and Recycling operations.			
Unit 3	Material Balance with chemical reactions	(L07)	COs Mapped: CO3



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Concept of limiting and excess reactants, percentage conversion, yield and selectivity. Material balance of unsteady state processes involving chemical reaction.			
Unit 4	Energy Balance	(L07)	COs Mapped: CO4
Basic Concept, Sensible Heat, latent heats of Phase change, energy balances, heat capacity of pure substances and mixtures, enthalpy of pure substances and mixtures, Hess's law, Standard Heat of Formation and combustion, Heat of reaction, adiabatic reactions, adiabatic flame temperature calculations.			
Unit 5	Humidification and Combustion	(L07)	COs Mapped: CO5
Humidity and saturation: Molal humidity, absolute molal humidity, relative humidity, saturation humidity, psychrometric chart. Types of Fuel, Calorific values, Orsat Analysis, combustion calculations.			
Reference Books			
1. Stoichiometry and Process Calculations, K. V. Narayanan. and B. Lakshmikutty, Prentice Hall India Pvt., Limited, 2 nd edition. 2. Basic Principles and Calculations in Chemical Engineering David M. Himmelblau, James B Riggs,, Prentice Hall India Pvt., Limited, 8 th edition. 3. Stoichiometry, B.I. Bhatt. And S .M Vora., Tata McGraw Hill. 4 th edition. 4. Elementary Principles of Chemical Processes, Richard M. Felder, Ronald W. Rousseau, Lisa G. Bullard, 4 th edition.			
Sr. No.	Components for Continuous Comprehensive Evaluation		Marks Allotted
1	Three Assignments on unit-1, Unit-2, Unit-3 & 4		10
2	Group Presentation on Unit-5		05
3	LMS Test on Each Unit		05
	Total		20



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Semester IV (SY - B. Tech.) Chemical Engineering 2307212: Chemical Reactions and Synthesis II			
Teaching Scheme: Theory:03 hrs/week		Credit Scheme: 03	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks
Prerequisite: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.			
Course Objectives: 1. To impart the basic concepts of organic chemistry 2. To develop understanding about concepts of organic reactions for analysis of unit Processes 3. To study the different analytical instrumentation techniques			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes		Bloom's Level
CO1	Apply the concept of naturally occurring polymer and synthesize the new polymers		2-Understand
CO2	Apply the theory of synthesis of complex and evaluate their properties		3-Apply
CO3	Analyze the given chemical substance by different Instrumentation techniques.		3-Apply
CO4	Understand catalyst and its mechanism and apply it in the synthesis of compounds.		3-Apply
CO5	Understand concept of isomerism and analyze different isomers and their properties.		4-Analyze
Course Contents:			
Unit 1	Green Chemistry	(L07)	COs Mapped: CO1
Definition, goals of green chemistry, efficiency parameters, need of green chemistry, Major applications, traditional and green path way of adipic acid, polycarbonate, indigo dye, ibuprofen, carbaryl Carbohydrate: Cyclic structure of glucose, cellulose, starches. Starch based products, Cellulose acetate, nitrate, ether. catalytic site of enzyme, factors affecting enzyme activity.			
Unit 2	Transition metals and Co-ordination chemistry	(L07)	COs Mapped: CO2
Electronic configuration of first series transition metals shapes of d- orbital characteristics (variable oxidation states, magnetic property, color of transition metal compounds). Ligands, C.N. and geometry, nomenclature of complexes, chelates. Theories of co-ordination- i) Werner ii) EAN iii) VBT for tetrahedral and octahedral complexes iv) CFT (including crystal field splitting in octahedral field and tetrahedral field, CFSE for octahedral complexes.			



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applications of CFT)			
Unit 3	Volumetric Analysis	(L07)	COs Mapped: CO3
Standard solutions and their preparations, Concentration terms, small scale units of concentration, types of titrations-neutralization (with titration curves), complexometric, redox and precipitation with examples. Theory of indicators in above titrations. Numericals on all above			
Unit 4	Surface Chemistry	(L08)	COs Mapped: CO4
(a) Adsorption: Introduction to Freundlich and Langmuir theories of adsorption, adsorption from solution, B.E.T. Theory of adsorption of gases, Application of adsorption, numerical on above. (b) Applications characteristics, types, adsorption theory of catalysis, promoters, poisons, industrial applications of catalysts; Zeolites- structure, properties, applications as catalyst for reactions (amination of alcohol. NOX pollution control, alkylation, cracking conversion of methanol), Hydroformylation using catalyst, functionalized polymer,			
Unit 5	Stereochemistry and Unit processes in organic synthesis	(L07)	COs Mapped: CO5
Basic concepts, conformation isomerism of ethane, propane, butane, cyclohexane, mono-substituted cyclohexane, optical isomerism with 1 and 2 chiral centers, Mechanism, thermodynamics and kinetics of nitration, halogenations, sulphonation, preparation of nitrobenzene, chloral and vinyl chloride, dodecylbenzene sulphonate, lauryl alcohol.			
Text Books			
1. Concise Inorganic Chemistry J.D. Lee, Wiley India Pvt Ltd. 5 th edition 2. Advanced Inorganic Chemistry Cotton, Wilkinson, Murillo, Bochmann, 6 th edition 3. Physical Chemistry, P L Soni, Sultan Chand & Sons 4. Physical Chemistry, Peter Atkins, Julio de Paula, James Keeler, International Eleventh 5. Stereochemistry of Organic Compounds, Ernest L. Eliel, Samuel H. Wilen, Wiley 6. Unit Processes in Organic Synthesis, P. H. Groggins., Tata McGraw-Hill, 5 th edition			
Reference Books			
1. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7 th Edition. 2. Vogel's analytical chemistry, J. Mendham, Pearson Education, 6 th Edition.			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Four Assignments on unit-1, Unit-2, Unit-3 & 4	10	
2	Group Presentation on Unit-5	05	
3	LMS Test on Each Unit	05	
	Total	20	



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Semester III (SY - B. Tech.) Chemical Engineering 2307213: Thermodynamics			
Teaching Scheme: Theory:03 hrs/week	Credit Scheme: 03	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks	
Prerequisite: Courses in Engineering Mathematics, Physics and Chemistry.			
Course Objectives: 1. To introduce basic concepts of thermodynamics, and their applications. 2. To formulate and apply the laws of thermodynamics in order to solve a given problem using a particular thermodynamic process. 3. To understand different methods for performing phase and chemical reaction equilibrium calculations.			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes	Bloom's Level	
CO1	Understand basic concepts of thermodynamics and their applications and limitations in Chemical Engineering	2-Understand	
CO2	Formulate the relationship between different thermodynamic parameters for different processes and apply the thermodynamic laws to the given process in order to solve the problem	3-Apply	
CO3	Compare ideal gas/solution models to reflect behavior of real mixtures based on the concepts of chemical potential, fugacity, and excess free energy	3-Apply	
CO4	Evaluate the various methods and assumptions for performing phase equilibrium calculations	3-Apply	
CO5	Determine the equilibrium products and their concentration in equilibrium when dealing with systems involving chemical reactions	2-Understand	
Course Contents:			
Unit 1	Introduction and Basic Concept	(L07)	COs Mapped: CO1
Introduction and Fundamentals of Thermodynamics, Systems and variables, state and path function, work, heat, reversible and irreversible processes, internal energy, Zeroth law of thermodynamics, First law of thermodynamics for non-flow process and flow process, equilibrium state, phase rule, heat capacity.			
Unit 2	P-V-T Behavior and law of thermodynamics	(L07)	COs Mapped: CO2
P.V.T. behavior of pure fluids, Equation of state and concept of ideal gas, Processes involving ideal gas: constant volume process, constant pressure process, constant			



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temperature process, adiabatic process and polytropic process; Equation of state for real gases, second law of thermodynamics: Spontaneous process, heat reservoir, heat pump, heat engine, Kelvin Plank statement, Clausius statement, entropy.			
Unit 3	Thermodynamic Properties of Fluids	(L07)	COs Mapped: CO3
Fundamental property relations for closed systems, Maxwell relationships, Clausius-Clapeyron equation, Partial molar properties, chemical potential, Ideal and non-ideal mixtures/Solutions, fugacity and fugacity coefficient for pure components and for mixture of gases and liquids. Lewis Randall rule, Henry's law, activity co-efficient, Gibbs-Duhem equation, Excess properties of mixtures.			
Unit 4	Phase equilibrium	(L07)	COs Mapped: CO4
Criteria of equilibrium, phase equilibrium criteria, the phase rule, Duhem's theorem, vapor-liquid equilibrium of ideal and non-ideal solution at low to moderate pressures, Raoult's Law and Modified Raoult's Law, dew point and bubble point calculations, thermodynamic consistency test.			
Unit 5	Chemical reaction equilibrium	(L08)	COs Mapped: CO5
The reaction coordinates, Application of the criteria for equilibrium to chemical reactions, the standard Gibbs free energy change and the equilibrium constant, effect of temperature on equilibrium constant, evaluation of the equilibrium constant, relation of equilibrium constant to composition, calculation of equilibrium conversion for single reactions, the phase rule and Duhem's theorem for reacting systems			
Text Books			
1. Chemical Engineering Thermodynamics, K. V. Narayanan, Prentice Hall of India, 2 nd Edition. 2. Chemical Engineering Thermo Dynamics, Y.V.C. Rao, University press (INDIA) Ltd. 3. Introduction to Chemical Engineering Thermodynamics, J. M. Smith, H. C. Van Ness and M. M. Abbott, McGraw Hill Education, 7 th Edition.			
Reference Books			
1. An Introduction to Statistical Thermodynamics, Terrell L. Hill, Dover Publications Inc. 2. Chemical, Biochemical and Engineering Thermodynamics, S. I. Sandler, John Wiley & Sons, 4 th Edition.			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Three Assignments on unit-1, Unit-2, Unit-3 & 4	10	
2	Group Presentation on Unit-5	05	
3	LMS Test on Each Unit	05	
	Total	20	



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Semester IV (SY - B. Tech.) Chemical Engineering 2307214: Lab Work in Process Calculations		
Teaching Scheme: Practical: 2Hrs. /Week	Credit Scheme:1	Examination scheme: TW: 25 marks Practical: 25 marks Total: 50 Marks
Prerequisite: Courses of Engineering Mathematics, Physics and Chemistry		
Course Objectives: 1. To learn the various unit operations and unit processes performed in a chemical industry. 2. To impart knowledge on concepts of Material balance for unit operations and unit process. 3. To enable students to learn the application of the general energy balance equation and precisely to calculate the energy requirements for unit operations. 4. To study basic concepts of Humidification operation. 5. To study different types of fuels and understand the combustion calculations.		
Course Outcomes: On completion of the course, students will be able to–		
	Course Outcomes	Bloom's Level
CO1	To understand various chemical Engineering Software	2-Understand
CO2	To calculate equivalent weight, molecular weight and mole fraction using MS-EXCEL.	2-Understand
CO3	To determine the composition of the materials by using MATLAB.	3-Apply
CO4	To apply the knowledge of the software like UNISIM to find out composition of Binary Distillation/ Absorption/extraction/mixing operations.	3-Apply
CO5	To apply the knowledge of the software DWSIM to find the % conversion for the reaction.	3-Apply
List of Laboratory Experiments (Minimum seven experiments)		
Sr. No.	Laboratory Experiments	CO Mapped
1	To understand different software application like MS-EXCEL, MATLAB, DWSIM and UNISIM in process calculations.	CO1
2	To evaluate the equivalent weight, molecular weight and mole fraction using MS-EXCEL for various chemical compounds.	CO2
3	To determine the composition of the input stream for mixing operation by using MATLAB.	CO3
4	To calculate the material and energy balance for batch reactors using MATLAB.	CO3
5	To find the condenser duty and re-boiler load for binary distillation using UNISIM.	CO4
6	To find the composition of absorption/mixing by using UNISIM.	CO4



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7	To find the %Yield and %Conversion for reaction by using DWSIM.	CO5
8	To simulate the extraction operation using DWSIM.	CO5
Reference Books		
1. Stoichiometry and Process Calculations, Narayanan. K. V. and Lakshmikutty. B, PHI Publication. 2. Basic Principles and Calculations in Chemical Engineering, David M. Himmelblau Pearson Publication 3. Stoichiometry, Bhatt B.I. and Vora S.M., Tata McGraw Hill. 4. Elementary Principles of Chemical Processes, Richard M.Felder, Ronald W.Rousseau, John Wiley & Sons.		
Guidelines for Laboratory Conduction		
• Teacher will brief the given problem statement to students, its objectives and outcome. • Students will solve the allotted problem in a group or individually using simulator. • After solving problem, students will check their simulated results from the teacher. • Students will then complete the write up.		
Guidelines for Student's Lab Journal		
Write-up should include title, Software used, Concept utilized, Course Usage and Problem Statement, conclusion. Simulation steps, simulated results if any.		
Guidelines for Termwork Assessment		
1. Each experiment from lab journal is assessed for 30 marks based on three rubrics. 2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.		



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Semester IV (SY - B. Tech.) Chemical Engineering 2307215: Lab Work in Chemical Reactions and Synthesis II		
Teaching Scheme: Practical: 4Hrs. /Week	Credit Scheme:2	Examination scheme: TW: 50 marks Practical: 50 marks Total: 100 Marks
Prerequisite: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.		
Course Objectives: 1. To impart the basic concepts of organic, inorganic and physical chemistry 2. To develop understanding about concepts of organic reactions for analysis of unit Processes 3. To study the different analytical instrumentation techniques and their applications		
Course Outcomes: On completion of the course, students will be able to		
	Course Outcomes	Bloom's Level
CO1	Estimate the purity and quantity of substance present by traditional methods	3-Apply
CO2	Apply the theory of synthesis of complex and evaluate their properties	3-Apply
CO3	Understand catalyst and its mechanism and apply it in adsorption of organic compound.	2-Understand
CO4	Analyze the compounds purity and apply the purification techniques for it.	3-Apply
List of Laboratory Experiments		
Sr. No.	Laboratory Experiments	CO Mapped
1	Adsorption of acetic acid on charcoal to verify Freundlich isotherm	CO3
2	Determination of purity of sod. Carbonate by titration method	CO1
3	Preparation of tris ethylene diammine nickel (II) thiosulphate	CO2
4	Preparation of tetramine copper (II) sulphate	CO2
5	Preparation of osazone derivative of glucose	CO2
6	Estimation of glucose/acetone in solution	CO1
7	Purification of organic compounds by crystallization	CO4
8	Purification of organic compounds by sublimation	CO4
9	Determination of chloride content by Mohr's method	CO4



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10	To determine integral and differential heat of solution of a salt	CO1
11	Photo catalyst based chemical reaction	CO1
Text Books		
1. Laboratory manual on general and applied chemistry, Dr. S.K. Bhasin, Dhanpatrai publication.		
2. Laboratory manual on engineering chemistry, Dr. S.K. Bhasin, Dhanpatrai publication.		
Reference Books		
1. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7 th Edition.		
2. Vogel's analytical chemistry, J. Mendham, Pearson Education, 6 th Edition		
Guidelines for Laboratory Conduction		
• Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment. • Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP. • Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant. • After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher. • Students will then complete the experimental write up.		
Guidelines for Student's Lab Journal		
Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.		
Guidelines for Termwork Assessment		
1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.		
2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.		



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Semester IV (SY - B. Tech.) Chemical Engineering 2307216: Fluid Mechanics			
Teaching Scheme: Theory:03 hrs/week		Credit Scheme: 03	Examination scheme: In Semester Exam: 20 marks End Semesters Exam: 60 marks Continuous Comprehensive Evaluation: 20 marks Total: 100 Marks
Prerequisite: Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry.			
Course Objectives: 1. To introduce basic concepts of fluid mechanics, fluid properties, types of fluids and classification of flows. 2. To understand fluid statics, basic equations of fluid flow and applications to determine losses occurring through pipelines. 3. To develop relationships among process or system variables using dimensional analysis and fluidization and applications of different valves and pumps.			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes		Bloom's Level
CO1	Explain different fluid properties, types of fluids and flows.		1-Knowledge
CO2	Understand fluid statics and its applications related to pressure measuring devices in chemical industry.		2-Understand
CO3	Apply basic equations of fluid flow and determine fluid flow rate by different devices.		3-Apply
CO4	Apply theorems to form mathematical equations and determine energy losses for flow of fluid through different system.		3-Apply
CO5	Understand concepts of boundary layer and fluidization and applications of different valves and pumps for transportation of fluid through pipelines		3-Apply
Course Contents:			
Unit 1	Introduction	(L07)	COs Mapped: CO1
Fluid, branches of fluid mechanics, properties of fluid, classification of fluids, different types of viscometers, Newton’s law of viscosity, numericals, non-Newtonian fluids, types of flow, lines to describe the flow			
Unit 2	Fluid Pressure and Measurement	(L07)	COs Mapped: CO2
Pascal’s law, Hydrostatic law, concept of atmospheric, gauge, vacuum and absolute pressure, manometers, and pressure measurement by simple and differential manometer, Numericals based on manometers			
Unit 3	Basic Equations of Fluid Flow and Flow	(L07)	COs Mapped:



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	Measuring Devices		CO3
Basic equations of fluid flow: continuity equation and equation of motion, flow measurement using venturimeter, orifice meter, pitot tube, rotameter, Mass flowmeters, Numericals based on different flow measuring devices			
Unit 4	Fluid flow through pipelines and dimensional analysis	(L07)	COs Mapped: CO4
Laminar flow through circular pipe: Hagen Poiseuille equation, major and minor losses, Darcy-Weisbach equation, Numericals, dimensionless numbers in fluid mechanics, dimensional homogeneity, types of similarities, model and prototype, dimensional analysis by Rayleigh's method and Buckingham's method			
Unit 5	Boundary Layer and fluid transportation	(L08)	COs Mapped: CO5
Concept of hydrodynamic boundary layer, growth over a flat plate, different thickness of boundary layer, numerical based on boundary layer, types of fluidization, different types of valves and pumps, centrifugal pump working and characteristics, numericals based on centrifugal pump			
Text Books			
1. Hydraulics and Fluid Mechanics, Modi, L.P., Seth, S.M., Standard Book House, New Delhi. 2. A Textbook of Fluid Mechanics and Hydraulic Machines, Bansal R. K., Laxmi Publications.			
Reference Books			
1. Unit Operations of Chemical Engineering, W. L. McCabe, J. C. Smith, P. Harriot, McGraw-Hill International, 7 th Edition. 2. Fluid Mechanics for Chemical Engineers, Noel de Nevers; McGraw Hill, 3 rd Edition. Chemical Engineering, Volume-1, J R Backhurst, J H Harker, J.F. Richardson, J.M. Coulson, Butterworth-Heinemann, 6 th Edition.			
Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted	
1	Three Assignments on unit-1, Unit-2, Unit-3 & 4	10	
2	Group Presentation on Unit-5	05	
3	LMS Test on Each Unit	05	
	Total	20	



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Semester IV (SY - B. Tech.) Chemical Engineering 2307217: Lab Work in Fluid Mechanics		
Teaching Scheme: Practical: 2Hrs. /Week	Credit Scheme:1	Examination scheme: TW: 25 marks Practical 25 marks Total: 50 Marks
Prerequisite Courses, if any: - Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry		
Course Objectives: 1. To get knowledge of viscosity measuring device. 2. To get knowledge of pressure measuring devices. 3. To apply basic equations of fluid flow to determine fluid flow rate by different devices.		
Course Outcomes: On completion of the course, students will be able to–		
Sr. No.	Course Outcomes	Bloom's Level
CO1	Determine viscosity of fluid using viscometer and predict its variation.	2-Understand
CO2	Identify type of flow through pipeline.	1-Knowledge
CO3	Describe different pressure measuring devices.	1-Knowledge
CO4	Apply basic equations of fluid flow to determine fluid flow rate using different devices and energy losses.	3-Apply
CO5	Explain different centrifugal pump characteristics.	1-Knowledge
List of Laboratory Experiments (Minimum 8 experiments out of the following list should be performed)		
Sr. No.	Laboratory Experiments	CO Mapped
1	Determination of viscosity of fluid using viscometer	CO1
2	Determination of type of flow using Reynolds Apparatus	CO2
3	Verification of Bernoulli's theorem	CO3, CO4
4	Determination of coefficient of discharge of venturimeter	CO4
5	Determination of coefficient of discharge of orifice meter	CO4
6	Determination of coefficient of discharge of rotameter	CO4
7	Determination of friction factor (Major losses)	CO4
8	Determination of minor losses	CO4
9	Determination of centrifugal pump characteristics.	CO5
Text Books		
1. Hydraulics and Fluid Mechanics, Modi, L.P., Seth, S.M., Standard Book House, New Delhi. 2. A Textbook of Fluid Mechanics and Hydraulic Machines, Bansal R. K., Laxmi Publications.		
Reference Books		
1. Unit Operations of Chemical Engineering, W. L. McCabe, J. C. Smith, P. Harriot, McGraw-		



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Hill International, 7th Edition.

2. Fluid Mechanics for Chemical Engineers, Noel de Nevers; McGraw Hill, 3rd Edition.
3. Chemical Engineering, Volume-1, J R Backhurst, J H Harker, J.F. Richardson, J.M. Coulson, Butterworth-Heinemann, 6th Edition.

Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment.
- Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.
- Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant.
- After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher.
- Students will then complete the experimental write up.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.

Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.
2. Rubric R-1 is for timely completion, R-2 for understanding and R-3 for presentation/journal. Each rubric carries 10 marks.



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Semester IV (SY - B. Tech.) Chemical Engineering 2307218: Environmental Economics			
Teaching Scheme: Theory:02 hrs/week		Credit Scheme: 02	Examination scheme: Continuous Comprehensive Evaluation: 50 marks Total: 50 Marks
Prerequisite Courses, if any: -Economics for Sustainability			
Course Objectives: 1. To expose the students to environmental problems and concept of sustainable development 2. To explain the concepts of carbon footprint and its calculations. 3. To train the students to analyze environmental damage 4. To help students internalize the tools needed for the evaluation of projects such as cost-benefit analysis, and environmental impact			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes		Bloom's Level
CO1	Study of local and global environmental issues and limitations of applying economic principles to the environment.		2-Understand
CO2	Demonstrate carbon footprint and develop broader understanding of economics of climate change.		3-Apply
CO3	Illustrate the environment policy issues like environmental damage.		4- Analyze
CO4	Analyze environmental policy for local environmental problems and understand and the implementation of international environment policy		4- Analyze
Course Contents:			
Unit 1	Introduction to Sustainable development , Environmental Issues	(L08)	COs Mapped: CO1
Introduction to Sustainable development, concepts, sustainable development goals, Overview of environmental problems in the world. Climate change, International agreements, Overview of environmental problems of India, Carbon footprint			
Unit 2	Externalities, Environmental policies	(L08)	COs Mapped: CO2
The theory of externalities: Pareto optimality and market failure in the presence of externalities; property rights and the Coase theorem, The design and implementation of environmental policy: overview; Pigouvian taxes and effluent fees; tradable permits; choice between taxes and quotas under uncertainty; implementation of environmental policy			
Unit 3	Measuring Environmental Impacts	(L08)	COs Mapped: CO3
International environmental problems: trans-boundary environmental problems; economics of climate change; trade and environment. Measuring the benefits of environmental improvements: non-market values and measurement methods; risk assessment and perception			
Text Books			



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1. Kolstad, C. (2010). Intermediate environmental economics, 2nd ed. Oxford University Press.
2. Stephen Smith (2011) Environmental Economics: A Very Short Introduction, Oxford University Press

Reference Books

1. This Changes Everything: Capitalism vs. the Climate by Naomi Klein
2. Cropper, M., Oates, W. (1992). Environmental economics: A survey, Journal of Economic Literature, 30, 675-740.
3. Heal, G. (2012). Reflections – defining and measuring sustainability. Review of Environmental Economics and Policy, 6, 147-163.
4. Newell, R., Pizer, W., Raimi, D. (2013). Carbon markets 15 years after Kyoto: Lessons learned, new challenges. Journal of Economic Perspectives, 27, 123- 46.
5. Perman, R., Ma, Y., McGilvray, J., Common, M. (2011). Natural resource and environmental economics, 3rd ed. Pearson Education/Addison Wesley.
6. Stavins, R. (ed.) (2012). Economics of the environment: Selected readings, 5th ed. W. W. Norton.

Sr. No.	Components for Continuous Comprehensive Evaluation	Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3	30
2	Group Presentation on any two units (Unit-1, Unit-2, Unit-3)	20
	Total	50



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Semester III (SY - B. Tech.) Chemical Engineering 2307219: Democracy, Election and Governance			
Teaching Scheme: Tutorial: 02hrs/week		Credit Scheme: 02	Examination Scheme: Continuous Comprehensive Evaluation: 50 Marks
Prerequisite Courses, if any: NA			
Course Objectives: 1. To introduce the students meaning of democracy and the role of the governance 2. To help them understand the various approaches to the study of democracy and governance			
Course Outcomes: On completion of the course, students will be able to–			
	Course Outcomes		Bloom’s Level
CO1	Understand the and inculcate key principles of Democracy		2-Understand
CO2	Identify how different rights are protected in Democratic systems		2-Understand
CO3	Understand various approaches for Governance		2-Understand
CO4	Reflect on the various threats and challenges to Democracy		3-Apply
COURSE CONTENTS			
Unit I	Democracy- Foundation and Dimensions	(L08)	COs Mapped – CO1, CO2,CO4
Constitution of India, Evolution of Democracy- Different Models, Dimensions of Democracy- Social, Economic, and Political			
Unit II	Decentralization	(L08)	COs Mapped – CO1, CO2, CO3, CO4
Indian tradition of decentralization, History of Panchayat Raj institution in the lost independence period 73 rd and 74 th amendments, Challenges of caste, gender, class, democracy and ethnicity			
Unit III	Governance	(L08)	COs Mapped – CO2, CO3, CO4
Meaning and concepts, Government and governance, Inclusion and exclusion			
Text Books			
1. Basu, D. D. (1982), “Introduction to the Constitution of India”, Prentice Hall of India. 2. Chandra, B. (1999), “Essays on contemporary India”, Har-Anand Publications.			
Sr. No.	Components for Continuous Comprehensive Evaluation		Marks Allotted
1	Three Assignments on Unit-1, Unit-2, Unit-3		30
2	Group Presentation on any two units Unit-1, Unit-2, Unit-3		20
	Total		50



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Semester IV (SY - B. Tech.) Chemical Engineering 2307220: Technical Writing			
Teaching Scheme: Tutorial: 01 hrs/week Practical: 02 hrs/week		Credit Scheme: TUT: 1 TW: 1	Examination scheme: Tutorial:25 Marks TermWork: 25 Marks Total :50 marks
Prerequisite Courses, if any: - English with Grammar			
Course Objectives: To make the student aware of the importance of writing skills and the significance of documentation related to the works carried by any engineering professional.			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes		Bloom’s Level
CO1	Discuss the various components of thesis		2-Understand
CO2	Describe significance of word processors in technical writing		2-Understand
CO3	Use word processors for academic and research writing		3- Apply
Course Contents:			
Unit 1	Academic writing	(L06)	COs Mapped: CO1, CO2
Importance of report writing in academics and research; Different types of academic and research activities; Necessity of report writing for achievement of academic and research goals; Different types of reports / presentations; Characteristics of academic and research reports / presentations. Structure of a thesis; Scope of the work; Literature review; Experimental / computational details; Preliminary studies; Results and Discussions; Figures and Tables preparation; Conclusions and future works; Bibliography; Appendices			
Unit 2	Tools and techniques for research writing	(L06)	COs Mapped - CO2, CO3
Types of research papers; Structure of research papers; Research paper formats; Abstract writing; Methodology; Results and discussions; Different formats for referencing; Ways of communicating a research paper, Handling MS Word and Latex processors; Developing effective power point presentation; Plagiarism; its handing through plagiarism detection tools			
Text Books			
1. C P Ravikumar, “On Writing a Thesis”, IETE Journal of Education, 2000. 2. K. V. Laan, J. T. Hackos, “The Insider's Guide to Technical Writing”, 2 nd Edition, 2022. 3. J. Cox, J. Lambert, “Microsoft Word 2010 Step by Step", Microsoft Press, 1 st Edition, 2010. Available (online) 4. H. Kopka, P. W. Daly, “A guide to LATEX: and Electronic Publishing”, Addison-Wesley Longman Limited 2004, 4 th Edition, 2004. Available (online).			
Reference Books			
1. M. D. Desai, “Technical communication”. Available (online).			



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2. SWAYAM course on “Academic & Research Report Writing” by Dr. Samir Roy, NITTTR Kolkata.

3. S. K. Singh, “Technical Writing”, Vayu Education of India.

Guidelines for Laboratory conduction/assignment

- Teacher will brief about various types of academic and research activities.
- Teacher will brief the types of research thesis/ papers, content of the thesis/ research papers and structure of the research thesis/ papers.
- Students will study the case study of research thesis/paper and prepare power point presentation for scope of the work.
- Groups of students will study review paper and based on it, students will prepare Literature review.
- Students will check the case studies, literature review and power of point presentation from the teacher.

Guidelines for Student's Lab Journal

Write-up should include the guidelines for writing the research paper / thesis. Importance of Literature review and Bibliography. Write-up should include type of research paper, topic of research paper/ thesis, concept utilized, Developing effective power point presentation, conclusion, etc.

Guidelines for Term work Assessment

1. Each assignment carries 30 marks,
2. Evaluation is based on three rubrics. Rubric R-1 for timely completion, R-2 for understanding and R-3 for presentation/journal writing where each rubric carries ten marks.



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S. Y. B. Tech Chemical Engineering Department Specific Exit Courses (To award Diploma) 2307221: Internship		
Teaching Scheme: Theory: NA	Credit Scheme: 02	Examination Scheme: Term work: 100 Marks
Course Objectives: The objectives of the course are to 1. Encourage and provide opportunities for the students to acquire professional learning experiences. 2. Provide exposure to handling and using various tools, measuring instruments, and technologies used in industries. 3. Enable students to develop professional and employability skills and expand their professional network.		
Course Outcomes: On completion of the course, students will be able to–		
	Course Outcomes	Bloom's Level
CO1	Operate various measuring instruments, and tools used in industry efficiently and develop technical competence.	1-Remember 2-Understand
CO2	Understand the working culture and environment of the Industry and get familiar with various departments and practices in the industry.	4-Analyze 5-Evaluate
CO3	Apply internship learning in engineering project work, i.e. topic finalization, project planning, prototype development, result interpretations, report writing, etc.	3-Apply
CO4	Create a professional network and learn about ethical, safety measures, and legal practices.	1-Remember 2-Understand
Internship Guidelines for the Students		
A. Before Joining the Internship		
1. Search for internships in the industries provided by the department. 2. The internship duration should be of 4 weeks. 3. Ask for the internship request letter from the respective class / Internship coordinator. Concerned coordinator will appoint a guide for you. 4. Mentoring of the internship activity will be done through your Guide/Internship coordinator. 5. You are informed to report to concerned from time to time.		
B. During Internship		



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1. Keep the internship record book with you.
2. Note down all the details date-wise in the internship record book. Take the signature of your industry mentor daily.
3. The internship record book will help you to write your final internship report. Simultaneously you can start writing internship reports.
4. Maintain an institutional culture while working in the industry.

C. After Internship

1. Submit the Internship Record book and Internship report. Both are in hard copy.
2. Submit all your details within 15 days of completion of the Internship.
3. After the internship, the presentation schedule will be displayed.
4. The internship course will be assumed to be completed only after the final presentation. The date of presentation will be declared at least 10-15 days before the actual date.

Evaluation and Assessment of Internship			
Sr. No.	Evaluation Parameter	Marks	Remarks
1	Internship Record Book	25	Maintain all the records. This should be handwritten and submitted in hard copy. It will be evaluated based on 1. Proper and timely documented entries 2. Adequacy and quality of information 3. Data, observations, and discussions recorded 4. Thought process and recording techniques used 5. Organization of the information
2	Internship Report	25	Submit your report as per the guidelines. It should have 1. Starting pages: Certificates, declaration, abstract, table of contents, figures, tables, etc. 2. Chapter 1: Introduction: Brief about the company, industry or organization, objectives, motivation, and organization of the report 3. Chapter 2: Problem Identification/Problem statement/objectives and scope/expected outcomes 4. Chapter 3: Methodological details 5. Chapter 4: Results / Analysis /inferences and conclusion 6. Chapter 5: Suggestions/Recommendations for improvement to the industry, if any 7. End Pages: Acknowledgement and references
3	Post-Internship Evaluation	50	Evaluation will be done by both industry and department mentors, based on the presentation criteria given below 1. Internship Identification and Selection 2. The Problem Studied with objectives and expected outcomes 3. Consideration of environmental/ Social /Ethical/ Safety measures/Legal aspects. 4. Methodology/System/Procedure Q&A 5. Block diagram, flow-chart, algorithm, system description 6. Final results, discussions, suggestions, comments, etc. Q&A



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		7. Presentation and Communication
Total Marks	100	Timely completion of activities is essential for all above

S. Y. B. Tech Chemical Engineering Department Specific Exit Courses (To award Diploma) 2307222: Chemical Process Industries		
Teaching Scheme: Theory: 02 hrs/week Practical: 02 hrs/week	Credit Scheme: 03 Theory: 02 TW: 01	Examination scheme: In SemExam: 20Marks End SemExam: 30Marks Term work: 50 Marks Total: 100 marks
Prerequisites: Basic Knowledge of Chemical compound, Introduction of unit processes and unit operations		
Course Objectives: 1. To study introduction of chemical engineering and study of glass, coal and chlor-alkali industries 2. To study Natural chemical industry. 3. To study nitro-phosphorus, sulfur industry. 4. To study Petroleum and Polymer industry. 5. To study Petrochemical Industry.		
Course Outcomes: On completion of the course, students will be able to–		
CO	Course Outcomes	Bloom's Level
CO1	Understand basic concepts and explain glass, coal and chlor-alkali industry.	2-Understand
CO2	Understand and describe about natural chemical industry.	2- Understand
CO3	Understand and explain about nitro-phosphorus, sulfur industry	2- Understand
CO4	Understand and describe about Petroleum and Polymer industry.	2- Understand
CO5	Understand and describe about petrochemical industry	2- Understand
Course Contents:		
Unit 1	Basic Concepts (L05)	COs Mapped :CO1
Introduction: Chemical industries-facts and figures, MSDS, Unit operation and unit process concepts, Chemical processing and role of chemical engineers, process flow diagrams, the anatomy of a chemical manufacturing process, major engineering problems Glass Industries: Method of manufacture, manufacture of special glasses Coal Chemicals: Destructive distillation of coal, Types of carbonization, Coke oven–construction, working and applications Chlor-Alkali Industry: Production of Soda ash, Production of Chlorine and caustic soda.		
Unit 2	Natural Chemical Industry (L05)	COs Mapped :CO2
i. Sugar and starch industry ii. Oil, Fat and waxes iii. Pulp and Paper industry iv. Food and food- by product processing		
Unit 3	Nitrogen, Phosphorus and sulfur Industry (L05)	COs Mapped :CO3
i. Nitrogen Industry: Production of Ammonia, Nitric acid, Urea, Ammonium Nitrate.		



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ii. Phosphorous Industry: Production of Phosphoric acid, single and triple Super Phosphate, Ammonium Phosphate		
iii. Sulphur Industry: Production of Sulphur, Sulphuric acid, Ammonium sulphate.		
Unit 4	Petroleum and Polymer Industry (L05)	COs Mapped :CO4
i. Petroleum Industry: History of production of crude petroleum, characteristics of refineries-refinery operations,		
ii. Introduction to Polymer, Classification of Polymerization, Production:polyolefins: polyethylene, poly propylene and polystyrene, styrene copolymers, polyvinyl chloride, polycarbonate, nylon 6,nylon 66,urea formaldehyde, styrene butadiene rubber (SBR) etc		
Unit 5	Petrochemical Industry (L05)	COs Mapped :CO5
i. C1 Compounds: Production of Methanol, Formaldehyde, and Halogenated Hydrocarbons.		
ii. C2 Compounds: Production of Ethylene and Acetylene- Steam Cracking of Hydrocarbons, Ethylene Dichloride, Vinyl Chloride.		
iii. C3 Compounds: Production of Propylene by Indirect Hydration, Acetone, Cumene		
iv. Aromatic Compounds: Production of Phenol, Phthalic Anhydride and Styrene.		
REFERENCE BOOKS:		
1. Dryden's Outlines of Chemical Technology, M Gopal Rao, Marshal Sittig, East-west press 3 rd Edition.		
2. Shreve's Chemical Process Industries, George T Austin, Tata McGRAW Hill, 5 th Edition.		
3. Unit Processes in Organic Synthesis, P. H. Groggins., Tata McGRAW-Hill, 5 th Edition.		
4. Chemical Process Technology Jacob A. Moulijn, Michiel Makkee, Annelies E. van Diepe, Wiley		
5. Industrial Chemicals, Feith – Keys and Clerk		
6. Chemical Technology- Venkateshwaralu, Vol. I, II, III, IV Chemical Engg. IIT Madras		

Suggested List of Laboratory Assignments:		
Any eight practical's to be performed out of the following:		
Sr. No.	Laboratory Experiments	CO Mapped
1.	Lab scale product synthesis.	CO1
2.	Mass balance calculations of any two processes using process calculation approach.	CO1,CO2
3.	Heat balance calculations of any two processes using process calculation approach.	CO1, CO2
4.	Calculations based on recycle operations.	CO1, CO2
5.	Process flow sheets drawing of any two processes using CAD.	CO1, CO3
6.	Simple mass & energy balance using process simulators	CO1, CO3
7.	Process flow sheets drawing of any two processes using Simulation Software	CO1, CO3
8.	Mass Balance using Simulation approach	CO1, CO3
9.	Energy Balance using simulation approach	CO1, CO3



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Guidelines for Laboratory Conduction

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- Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant.
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Guidelines for Termwork Assessment

1. Each experiment from lab journal is assessed for 30 marks based on three rubrics.
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(Autonomous from Academic Year 2022-23)

S. Y. B. Tech Chemical Engineering Department Specific Exit Courses (To award Diploma) 2307223: Chemical Process Safety			
Teaching Scheme: Theory:02 hrs/week Practical:02 hrs/week		Credit Scheme: Theory: 02 TW: 01	
Examination scheme: In Sem Exam: 20Marks End Sem Exam: 30Marks Term work: 50 Marks Total Marks: 100 Marks			
Prerequisite Courses, if any: - Basic Chemical Engineering courses			
Course Objectives: 1. To introduce basic concepts of Industrial safety and their applications in Chemical Engineering. 2. To create manpower related to Industrial Safety. 3. To develop study, analyze and develop safety techniques to avoid the accidents.			
Course Outcomes: On completion of the course, students will be able to–			
Sr. No.	Course Outcomes		Bloom's Level
CO1	Recognize and analyses safety program and Create safety culture.		3-Apply
CO2	Get acquainted and interpret the exact causes behind different accidents in chemical history and apply the knowledge of Industrial hygiene for safety purpose.		2- Interpret
CO3	Evaluate cause of fire and explosion along its types and also create the prevention strategy.		3-Apply
CO4	Create different designs for preventing incidents and hazard management.		3-Apply
CO5	Evaluate HAZOP and risk assessment and plan for emergency.		3-Apply
Course Contents:			
Unit 1	Introduction to Process Safety	(L05)	COs Mapped: CO1
Importance of process safety with examples of major accidents; which might cover chemical, petroleum & petroleum chemical Industrial. Safety culture, storage of dangerous materials, plant layout safety systems, OSHA incidence rate, FAR, FR, The accident process: Initiation, propagation, and termination, toxicology: ingestion, inhalation, injection, dermal absorption, dose versus response curves, relative toxicity, threshold limit values.			
Unit 2	Industrial hygiene	(L05)	COs Mapped - CO2
Government regulations, identification, evaluation: evaluating exposures to volatile toxicants by monitoring, evaluating worker exposures to dusts, evaluating worker exposures to noise, estimating worker exposures to toxic vapors. Control of toxic chemicals, Storage and handling of flammable and toxic chemical, Runway reactions. Relief system risk and hazards management.			



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Unit 3	Fire, Explosion and Prevention	(L05)	COs Mapped – CO3
Technology and process selection, scale of disaster, fire triangle, distinction between fires and explosion, definitions of ignition, auto-ignition temperature, fire point, flammability limits, mechanical explosion deflagration and detonation, confined explosion, unconfined explosion, vapour cloud explosions, boiling liquid expanding vapour explosion (BLEVE), dust explosion, shock wave, flammability characteristics of liquids and vapours, minimum oxygen concentration (MOC). Design to prevent Fires and Explosions: Inerting, static Electricity, Explosion proof equipment and Instrument, Ventilation, sprinkler systems and Miscellaneous Design for preventing Fires and Explosion.			
Unit 4	Hazard Analysis	(L05)	COs Mapped – CO4
Identification process, checklists, hazard surveys, HAZOP studies, safety reviews. Risk assessment: review of probability theory, interaction between process units, revealed and unrevealed failure, probability of coincidence, event trees and fault trees.			
Unit 5	Emergency Preparedness and Planning	(L05)	COs Mapped – CO5
Typical emergency Plan, On-Site and Off Site Plans, Emergency Control Programme, Emergency shutdown systems, Individual responsibility during emergency. Role of computers in safety, Tackling of disasters, Technology and process selection for emergency. Prevention of hazard human element			
Reference Books			
1. Daniel A. Crawl and Joseph F. Louvar, Chemical Process Safety: Fundamentals with applications, Prentice Hall, Inc, 1990. 33 2. P. P. Leos, Loss prevention in process Industries, Vol 1 and 2 Butterworth, 1983 3. R. W. King and J. Magid, Industrial Hazards and Safety Handbook, Butterworth, 1982 4. Khulman, Introduction of Safety Science, TUV Rheinland, 1986 5. W. E. Baker, Explosion, hazards and Evaluation, Elsevier, Amsterdam, 1983 6. O. P. Kharbanda and E. A. Stallworthy, Management of Disasters and How to Prevent Them. Grower 1986			

Suggested List of Laboratory Assignments/ case study:		
Sr. No.	Assignments/ case study	CO Mapped
1.	Case study on most significance accidents.	CO1
2.	Study of MSDS of the chemicals used in the practical's.	CO1, CO2
3.	Study of different types of Fire extinguishers.	CO1, CO2
4.	Determination of Threshold limit value for chemicals by dose response curve	CO1, CO2
5.	Evaluation techniques used to find workers exposure to toxicants.	CO1, CO3
6.	Study of different types of ventilation systems.	CO1, CO3
7.	Study of different types of sprinkler systems.	CO1, CO3



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8.	Case study on HAZOP study on one of the unit operations	CO1, CO3
Guidelines for Laboratory Conduction		
• Teacher will brief the given experiment to students with its procedure, observations, calculation, and outcome of the experiment. • Apparatus, software and equipment's required for the allotted experiment will be provided by the lab assistants using SOP. • In study practical students will collect suitable material from various sources such reference books, journals and will arrange in proper format. • Students will perform the allotted experiment in a group under the supervision of faculty and lab assistant. • After performing the experiment, students will perform calculations based on the obtained readings and get it verified from the teacher. • Students will then complete the experimental write up.		
Guidelines for Student's Lab Journal		
Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, results, conclusions, etc.		
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