K. K. Wagh Institute of Engineering Education and Research, Nasik (Autonomous w.e.f. A.Y.2022-23)
Pattern of Course Structure: Semester – III S.Y.B.Tech Chemical Engineering

Course Code	Course Type	Title of Course	Teaching Scheme Hrs./week			Evaluation Scheme and Marks								Credits			
			TH	TU	PR	In Sem	End Sem	CCE	TU	TW	PR	OR	Total	TH	TU	PR	Total
SMH222201	BSC	Applied Mathematics III	3	1	-	20	60	20	25		-	-	125	3	1	-	4
CHE222002	DCC	Chemistry I	3	-	-	20	60	20			-	-	100	3	-	-	3
CHE222003	DCC	Fluid Mechanics	3	-	-	20	60	20			-	-	100	3	-	-	3
CHE222004	ESC	Engineering Materials	3	-	-	20	60	20			-	-	100	3	-	-	3
CHE222005	DCC	Process Calculations	3	-	-	20	60	20			-	-	100	3	-	-	3
CHE222006	LHSM	Organizational Behavior	1	-	-	-	-	-		25	-	-	25	1*	-	-	1
CHE222007	DCC	Chemistry I Lab	-	-	4	-	-	-		25	50	-	75	-	-	2	2
CHE222008	DCC	Fluid Mechanics Lab	-	-	2	-	-	-		25		25	50	-	-	1	1
CHE222009	ESC	Engineering Materials Lab	-	-	2	-	-	-		25		25	50	-	-	1	1
CHE222010	PSI	Skill Development Course	-	-	2	-	-	-		25#	-	-	25	-	-	1	1
		Total	**16**	**1**	**10**	**100**	**300**	**100**	**25**	**125**	**50**	50	**750**	**16**	**1**	**5**	**22**

Assessment of 25 marks will be done considering consistent progress of work throughout the semester
Credit for 'PR' head are linked with 'TW' and 'OR' marks
*This Credit will be assessed as a TW.

K. K. Wagh Institute of Engineering Education and Research, Nasik (Autonomous w.e.f. A.Y.2022-23)
Pattern of Course Structure: Semester – IV S.Y.B.Tech Chemical Engineering

Course Code	Course Type	Title of Course	Teaching Scheme Hrs./week			Assessment Scheme of Marks							Credits			
			TH	TU	PR	In Sem	End Sem	CCE	TW	PR	OR	Total	TH	TU	PR	Total
CHE222011	DCC	Chemistry II	3	-	-	20	60	20		-	-	100	3	-	-	3
CHE222012	DCC	Heat Transfer	3	-	-	20	60	20		-	-	100	3	-	-	3
CHE222013	DCC	Mechanical Operations	3	-	-	20	60	20		-	-	100	3	-	-	3
CHE222014	DCC	Thermodynamics	3	-	-	20	60	20		-	-	100	3	-	-	3
CHE222015	LHSM	Soft Skills	3	-	-	20	60	20		-	-	100	3	-	-	3
CHE222016	ASM	Process Simulation using DWSIM	1	-	-	-	-	-		-	-	-	-	-	-	-
CHE222017	DCC	Chemistry II Lab	-	-	4	-	-	-	25	50	-	75	-	-	2	2
CHE222018	DCC	Heat Transfer Lab	-	-	2	-	-	-	25		25	50	-	-	1	1
CHE222019	DCC	Mechanical Operations Lab	-	-	2	-	-	-	25	25		50	-	-	1	1
CHE222020	PSI	Project Based Learning	-	-	2	-	-	-	25 #	-	-	25	-	-	1	1
		Total	**16**	**-**	**10**	**100**	**300**	**100**	**100**	**75**	25	**700**	**15**	**-**	**5**	**20**

Assessment of 25 marks will be done considering consistent progress of work throughout the semester.
Credit for ‘PR’ head are linked with ‘TW’ and ‘OR’ marks

K. K. Wagh Institute of Engineering Education and Research, Nasik (Autonomous w.e.f. A.Y.2022-23)
Details of Course Structure: S.Y. B.Tech Chemical Engineering

- **Summary of Credits and Total Marks for U.G. Programme:**

Semester	**S.Y. B.Tech Chemical Engineering**	
	Total Credits (TH+PR/OR/TU)	**Total Marks**
III	22	750
IV	20	700
Total	**42**	**1450**

- **Description of various Courses:**

Type of Course	**Description**	**Type of Course**	**Description**
ESC	Engineering Science Course - Workshop - Drawing- Fundamentals of different branches	DCC	Department Core Course
BSC	Basic Science Courses	DEC	Department Elective Course
LHSM	Liberal arts, Humanities, Social Sciences and Management courses	OEC	Open Elective Courses of other technical or emerging areas /Courses designed by Industry
PSI	Project work, Seminar, Internship, PBL	IMC	Induction and Mandatory Courses
NC/AC	Non Credit Courses /Audit Courses	ASM	Additional Specialized / MOOCs

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

SMH222201: Applied Mathematics III

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03hrs/week **Tutorial:01hr/week**	**03** **01**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks** **Tutorial / Termwork: 25Marks**

Prerequisite Courses: -Higher Secondary Mathematics

Course Objectives:

- Find general solution of higher-order linear differential equation with constant & Variable coefficient using different Methods.
- Find Laplace transform of functions using definition & properties & solve Ordinary D.E. using L.T.
- Recognize nature of vector fields ,use different vector differential operators& able to evaluate Line, surface &Volume integrals& its application
- Solve boundary value problems for Numerical Methods, Laplace's equation, heat equation, the wave equation by separation of variables.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Identify nature of vector field, understand basic concept of L.D.E., Numerical techniques, Laplace transform.	2-Understanding
CO2	Solve Laplace transform, Numerical Methods, Directional Derivative, Line Integral and solve L.D.E. using different Methods.	2-Understanding
CO3	Apply concept of Laplace transform & Differential equations, Numerical techniques in Fluid Mechanics, Continuity equations, Stream lines, Equations of motion, Bernoulli's equations, Heat Transfer.	3- Apply
CO4	Apply & Solve mass spring system, P.D.E. & Evaluate Surface, Volume Integral.	3- Apply
CO5	Apply Concept of Differential equations, Numerical techniques, Vector Calculus to various applications including real life problem.	3 – Apply

COURSE CONTENTS			
Unit I	**Linear Differential Equations with Constant Coefficient**	**(08hrs+ 2hrs Tutorial)**	**COs Mapped - CO1, CO2, CO3, 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 II	**Applications of Linear Differential Equations & Partial Differential Equations**	**(08hrs+ 2hrs Tutorial)**	**COs Mapped - CO3, 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.			
Unit III	**Laplace Transform (LT) and Applications**	**(08hrs + 2hrs Tutorial)**	**COs Mapped - CO1, CO2, CO3**
Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, **Dirac delta** Unit Impulse, Applications of LT for solving Linear differential equations.			
Unit IV	**Numerical Methods**	**(08hrs + 2hrs Tutorial)**	**COs Mapped - CO1, CO2, CO3, 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, Chelesky, Jacobi and Gauss-Seidel Methods.			
Unit V	**Vector Calculus**	**(08hrs+ 2hrs Tutorial)**	**COs Mapped –CO1, CO2, 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. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi. 3. Advanced Engineering Mathematics,7th Edition, by peter V. O'Neil(Thomson Learning)			

Reference Books
1. Erwin Kreyszig,"Advanced Engineering Mathematics", Wiley Eastern Ltd. 2. P. N. Wartikar and J. N. Wartikar, "Applied Mathematics" (Volumes I and II), Pune Vidyarthi Griha Prakashan, Pune. 3. Advanced Engineering Mathematics, M. D. Greenberg (Pearson Education).

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments (Total 3 Assignment, Unit I and II 20 marks, Unit III and IV 20 marks and Unit V 10 marks & 50 marks will be converted to 10 Marks)	10
2	Tests on each unit using LearniCo (Each test for 15 M and total will be converted out of 10 M)	10

List of Tutorial Assignments		
Sr. No.	**Title**	**CO Mapped**
1	Examples on LDE of nth order with constant coefficients.	CO1, CO2, CO3, CO5
2	Examples on Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous DE.	CO1, CO2, CO3, CO5
3	Examples on Applications of LDE to chemical engineering problems and mass spring system.	CO3, CO4,CO5
4	Examples on modeling of Vibrating string, Wave equation, one and two dimensional Heat flow equations.	CO3, CO4,CO5
5	Solve problems on matrices using MATLAB.	CO1, CO2, CO3
6	Solve system of equations using MATLAB.	CO1, CO2, CO3
7	Examples on Laplace transform properties and theorems.	CO1, CO2, CO3
8	Examples on Inverse Laplace transform properties and theorems.	CO1, CO2, CO3
9	Examples on Numerical Methods	CO1, CO2, CO3, CO5
10	Examples on Numerical Methods	CO1, CO2, CO3, CO5
11	Examples on Vector differentiation.	CO1, CO2,

		CO4, CO5
12	Examples on Vector Integration.	CO1, CO2, CO4, CO5

Guidelines for Tutorial / Termwork Assessment		
Sr. No.	**Components for Tutorial / Termwork Assessment**	**Marks Allotted**
1	Assignment on computational software	5
2	Tutorial (Each tutorial carries 15 marks)	15
3	Attendance (Above 95 % : 05 Marks, below 75% : 0 Marks)	5

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222002: Chemistry- I

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.

Course Objectives:

- To impart the basic concepts of organic chemistry
- To develop understanding about concepts of organic reactions for analysis of unit
- To study the different analytical instrumentation techniques

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Analyze 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 I	**Bonding and Reactivity**	**(08hrs)**	**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 N_2, O_2 , CO_2, H_2, CO. Aromaticity-conditions necessary for delocalization of electrons, resonance structures stability rules, resonance in benzene, phenol, aniline, benzaldehyde, nitrobenzene molecules, Inductive effect, steric effect and Resonance effect on pKa and pKb values of acids and bases.			
Unit II	**Reaction Dynamics &Photochemistry**	**(08hrs)**	**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.			
Unit III	**Instrumental methods of Analysis**	**(8hrs)**	**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 (FTIR), instrumentation, applications. Flame photometry- principle, instrumentation and applications.			
Unit IV	**Solution**	**(8hrs)**	**CO4**
Solution :-definition, solution of gas in gas, gases in liquid, Henry's law, the ideal solution, Raoult'1s 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 V	**Reaction Mechanisms**	**(8hrs)**	**CO5**
Substitution at saturated carbon (SN^1,SN^2) - mechanism, kinetics, stereochemistry, factors favoring it. Electrophonic 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, 2Eliminations- E1 mechanism, E2,			

(Saytzeff, Hoffman products), factors favoring it. Rearrangements- Beckmann, Claisen, Favorskii, Sonochemical reaction

Text Books

1. Inorganic chemistry - J.D. Lee
2. Inorganic chemistry - Cotton and Wilkinson's
3. Physical chemistry -P L Soni
4. Physical Chemistry- Atkins
5. Physical Chemistry - MaronPruton
6. Instrumental methods of chemical analysis Chatwal -Anand

Reference Books

1. Analytical chemistry- Skooge and West
2. Reaction mechanism - Jerry March
3. Organic Chemistry - Morrison and Boyd
4. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988

Guidelines for Continuous Assessment of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment on 1,2,3,4,Unit	**10**
2	Group presentations on Unit 5	**05**
3	Learnico test on each unit	**05**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222003: Fluid Mechanics

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry

Course Objectives:

- To introduce basic concepts of fluid mechanics, fluid properties, types of fluids and classification of flows.
- To understand fluid statics, basic equations of fluid flow and applications to determine losses occurring through pipelines.
- 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–

	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 to 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 I	Introduction	**(08hrs)**	**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 II	Fluid Pressure and Measurement	**(08hrs)**	**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 III	Basic Equations of Fluid Flow and Flow Measuring Devices	**(08hrs)**	**COs Mapped – 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 IV	Fluid flow through pipelines and dimensional analysis	**(08hrs)**	**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 V	Boundary Layer and fluid transportation	**(08hrs)**	**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. Modi, L.P., Seth, S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.
2. Bansal, R. K., "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications.

Reference Books

1. McCabe,W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition.
2. Noel de Nevers; Fluid Mechanics for Chemical Engineers, Third Edition; McGraw Hill.
3. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1, 6th ed., Butterworth-Heinemann.

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	LearniCo Test on Each Unit	05
	Total	**20**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222004: Engineering Materials

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: - Basics of Physics, Chemistry, Engineering Mathematics.

Course Objectives:

- To impart the basic concepts of material science.
- To develop understanding selection of engineering materials based on properties.
- To describe the applications of advance materials like nano materials.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	State the basic concepts of material science.	1-State
CO2	Select materials based on their properties for various applications.	2-Identify
CO3	Describe metals and their alloys and selection process and analyze them according to their properties.	3-Interpret
CO4	Describe and analyze nano materials and their properties.	3-Interpret
CO5	Identify electron microscope and their types.	2-Identify

COURSE CONTENTS

Unit I	Introduction	**(08hrs)**	**COs Mapped -CO1**

Introduction to materials and their principle properties; structure-property relationships in materials Non-Metals: Introduction to Ceramics and Glass: Classification, Properties (Physical, Chemical, and Mechanical Properties), and Applications. Introduction to the determination of mechanical properties of materials using ASTM methods.

Heat Treatments: Methods for Fabrication, Rolling, Bending, Central Punching, Riveting, and Welding.

Unit II	Materials Testing	**(08hrs)**	**COs Mapped - CO2**

Testing of materials, destructive and non destructive tests

Structure of the atom: crystal structures and their influence on material properties deformation and slip

processes.			
Unit III	Metals and their alloys	**(08hrs)**	**COs Mapped – CO3**
Introduction to Ferrous and nonferrous alloys. Ferrous Alloys: Iron–Carbon Diagram, Mild Steel, Special Steels, Stainless Steels. Nonferrous Alloys: Brass, Aluminum Alloys, and Titanium Alloys, Basics of corrosion and preventive measures. High- and Low-Temperature Materials, Insulators, Refractories.			
Unit IV	Nano materials	**(08hrs)**	**COs Mapped – CO4**
Classification, synthesis, characterization, and application of Nano materials. Fullerenes, Bucky balls, carbon nano tubes, fullerites. Nano particles – silver nano particles. Applications of Nano materials in Chemical Industry			
Unit V	Experimental techniques	**(08hrs)**	**COs Mapped – CO5**
Introduction to Electron Microscopes Study of Scanning electron microscopy SEM (Basics, Principal Elements, working), study of Transmission electron microscopy TEM (Basics, Principal Elements, working). Scanning probe microscopes: Study of scanning tunneling microscopy, atomic force microscopy, X-ray diffraction			

Textbooks

1. A textbook of machine design, Khurmi R.S. and Gupta J.K.
2. Material Science & Metallurgy for Engineers, Dr. V. D. Kodgire, Everest Publishing House

Reference Books

1. James F. Shacketford, introduction to material science, McMillan publishing company,
2. D.Z. Jestrazebaski, properties of Engg. Materials, 3rd Ed. Toppers. Co. Ltd
3. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978
4. Introduction to Nano Technology, John Wiley & Sons by Charles P Poole, Frank J Owens.
5. Nano materials, synthesis, properties and applications, Institute of physics publishing, Bristol and Philadelphia, by A.S. Edelstein and R.C. Kamarhati

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	LearniCo Test on Each Unit	05
	Total	**20**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222005: Process Calculations

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory:03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry.

Course Objectives:

- To learn the various unit operations and unit processes performed in a chemical industry.
- To impart knowledge on concepts of Material balance for unit operations and unit process.
- To enable students to learn the application of the general energy balance equation and precisely to calculate the energy requirements for unit operations.
- To study basic concepts of Humidification operation.
- 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	Determine the composition of the materials.	3-Apply
CO2	Apply the various laws governing solid, liquid and gas phases	3-Apply
CO3	Calculate the amount of materials required to carry out the suitable unit operation and process.	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 I	Units and Basic Chemical Principle	**(08hrs)**	**COs Mapped - CO1, CO2**

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 II	Material Balance without Chemical Reactions	**(08hrs)**	**COs Mapped - CO1, CO2, CO3**
Basic Concepts and Introduction to first law of thermodynamics, material balance calculations for distillation, Filtration, Extraction, Mixing, crystallization. Bypass and Recycling operations			
Unit III	Material Balance with chemical reactions	**(08hrs)**	**COs Mapped - CO1, CO2, CO3,**
Concept of limiting and excess reactants, percentage conversion, yield and selectivity. Material balance of unsteady state processes involving chemical reaction.			
Unit IV	Energy Balance	**(08hrs)**	**COs Mapped - CO1, CO2, 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 V	Humidification and Combustion	**(08hrs)**	**COs Mapped - CO1, CO5**
Humidity and saturation: Molal humidity, absolute molal humidity, relative humidity, saturation humidity, psychrometric chart. Types of Fuel, Calorific values, Orsat Analysis, combustion calculations.			

Text Books

1. Narayanan. K.V. and Lakshmikutty.B, "Stoichiometry and Process Calculations" PHI Publication.
2. David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", Pearson Publication.

Reference Books

1. Bhatt B.I. and Vora S.M., "Stoichiometry", Tata McGraw Hill.
2. Richard M. Felder, Ronald W. Rousseau, "Elementary Principles of Chemical Processes", John Wiley & Sons.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on unit-1, Unit-2, Unit-3 &Unit-4, 5	10
2	Group Presentation on Unit-5	05
3	LearniCo Test on Each Unit	05
	Total	**20**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222006: Organizational Behavior

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :01 hr/week	**01**	**Term work: 25 Marks**

Prerequisite Courses, if any: -

Course Objectives:

- To present a problem oriented in depth knowledge of behavior in organization.
- To address the underlying concepts, methods of organization.
- To give an idea about different areas of organizational behavior in Chemical Industries.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	To understand various methods and terms used different organizational behavior model	1-Knowledge
CO2	To understand Individual Behavior like attitude, perception, motivation, personality, misbehavior and emotions.	2-Understand
CO3	To understand group behavior, leadership and power	2-Understand
CO4	To understand dynamics of organizational behavior and managing change.	3-Apply

COURSE CONTENTS

	Module-1	**(03hrs)**	**COs Mapped - CO1**

Organizational Behavior (OB): Learning objectives, Definition & Meaning, Why to study OB, an OB model, New challenges for OB Manager , Learning: Nature of learning, How learning occurs, Learning & OB, Case Study Analysis

	Module-2	**(03hrs)**	**COs Mapped - CO2**

Personality: Meaning & Definition, Determinants of Personality, Personality Traits, Personality & OB

Perception: Meaning & Definition, Perceptual process, Importance of Perception in OB

Motivation: Nature & Importance, Herzberg's Two Factor theory, Maslow's Need Hierarchy theory, Alderfer's ERG theory

Case Study Analysis

	Module-3	**(03hrs)**	**COs Mapped – CO3**

Communication: Importance, Types, Barriers to communication, Communication as a tool for improving Interpersonal Effectiveness, Groups In Organization: Nature, Types, Why do people join groups, Group Cohesiveness & Group Decision Making- managerial Implications, Effective Team Building

Leadership: Leadership & management, Theories of leadership- Trait theory, Behavioral Theory, Contingency Theory, Leadership & Followership, How to be an Effective Leader

Conflict: Nature of Conflict & Conflict Resolution Transactional Analysis**:** An Introduction to Transactional Analysis, Case Study Analysis

	Module-4	**(03hrs)**	**COs Mapped – CO4**

Organizational Culture: Meaning & Definition, Culture & Organizational Effectiveness Human Resource Management: Introduction to HRM, Selection, Orientation, Training & Development, Performance Appraisal, and Incentives Organizational_Change: Importance of Change, Planned Change & OB Techniques International QB: An Introduction to Individual & Interpersonal Behavior in Global Perspectives, Case Study Analysis

Reference Books

1. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organizational Behavior, Pearson Education
2. Udai Pareek, Understanding Organizational Behaviour, Oxford Higher Education
3. Margi Parikh and Rajan Gupta, Organizational Behaviour, McGraw Hill Education
4. Fred Luthans, Organizational Behavior, McGraw Hill
5. Schermerhorn, Hunt and Osborn, Organizational behavior, John Wiley

Guidelines for Guidelines for Term work Assessment		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Two Assignments on Module-1, Module-2, Module-3	15
2	Group Presentation on Module-4	10
	Total	**25**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222007: Chemistry I Lab

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical: 04 hrs/week	02	Practical: 50 Marks TW: 25 Marks

Prerequisite Courses, if any: - Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.

Course Objectives:

- To impart the basic concepts of organic, inorganic and physical chemistry
- To develop understanding about concepts of organic reactions for analysis of unit Processes
- 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	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 inB.P	CO1

Text Books

1. Laboratory manual on general and applied chemistry by Dr. S. K. Bhasin, Dhanpatrai publication.
2. Laboratory manual on engineering chemistry by Dr. S. K. Bhasin, Dhanpatrai publication.
3. Instrumental methods of chemical analysis Chatwal -Anand

Reference Books

1. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988
2. Vogel's analytical chemistry

Guidelines for Laboratory Conduction

1. Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.
2. Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.
3. Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.
4. After performing the experiment students will check their readings, calculations from the teacher.
5. After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork 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.

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222008: Fluid Mechanics Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 02 hrs/week	**01**	**Oral: 25 Marks** **Term work: 25 Marks**

Prerequisite Courses, if any: - Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry

Course Objectives:

- To get knowledge of viscosity measuring device.
- To get knowledge pressure measuring devices.
- 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–

	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 and energy losses by different devices.	3-Apply
CO5	Explain different centrifugal pump characteristics.	1-Knowledge

List of Laboratory Experiments

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. Modi, L.P., Seth, S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.
2. Bansal, R. K., "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications.

Reference Books

1. McCabe,W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition.
2. Noel de Nevers; Fluid Mechanics for Chemical Engineers, Third Edition; McGraw Hill.
3. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1, 6th ed., Butterworth-Heinemann.

Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this 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 (two students in each group) under the supervision of faculty and lab assistant.
- After performing the experiment students will check their readings, calculations from the teacher.
- After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

- Each experiment from lab journal is assessed for thirty marks 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.

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222009: Engineering Materials Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 02 hrs/week	**01**	**TW: 25 Marks** **Oral: 25 Marks**

Prerequisite Courses, if any: - Basics of Physics, Chemistry, Engineering Mathematics.

Course Objectives:

- To get knowledge mechanical properties of engineering materials.
- To get analyze the quality of engineering materials.
- To synthesize and characterize the nano materials.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Determine hardness of engineering materials by various instruments.	2-Understand
CO2	Determine toughness of engineering materials.	2-Understand
CO3	Determine the defects present in the specimen by non-destructive testing.	2-Understand
CO4	Describe and analyze nano materials and their properties.	3-Interpret
CO5	Identify electron microscope and their types.	2-Identify

List of Laboratory Experiments

Sr. No.	**Laboratory Experiments**	**CO Mapped**
1	Determination of hardness of C.I, M.S, brass, aluminum specimen by Brinell's hardness test.	CO1
2	Determination of hardness of C.I, M.S, brass, aluminum specimen by Rockwell hardness test	CO2
3	Determination of toughness of M.S, brass, aluminum by impact test.	CO3, CO4
4	Study of Microstructure of ferrous material.	CO4
5	Study of Microstructure of non-ferrous material.	CO4

6	Determination of defects in material by dye penetration Test.	CO4
7	Determination of defects in material by magnetic particle test.	CO4
8	Synthesis of gold/silver (Au/Ag) nanoparticles and record the optical absorption spectra using simple absorption spectrometer.	CO4
9	Synthesis of Fe2O3 nanoparticles of different shapes and calculates the average size using scanning electron microscope SEM or TEM.	CO5

Text Books

1. A text book of machine design, Khurmi R.S. and Gupta J.K.
2. Material Science & Metallurgy for Engineers, Dr. V. D. Kodgire, Everest Publishing House.

Reference Books

1. James F. Shacketford, introduction to material science, McMillan publishing company,
2. D.Z. Jestrazebaski, properties of Engg. Materials, 3rd Ed. Toppers. Co. Ltd
3. J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978
4. Introduction to Nano Technology, John Wiley & Sons by Charles P Poole, Frank J Owens.
5. Nano materials, synthesis, properties and applications, Institute of physics publishing, Bristol and Philadelphia, by A.S. Edelstein and R.C. Kamarhati

Guidelines for Laboratory Conduction

1. Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment.
2. Apparatus and equipments required for the allotted experiment will be provided by the lab assistants using SOP.
3. Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.
4. After performing the experiment students will check their readings, calculations from the teacher.
5. After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork 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.

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: III

CHE222010: Skill Development Course

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 02 hrs/week	**01**	**Termwork: 25 Marks**

Prerequisite Courses, if any: -Basic Knowledge of computer, Communication and English

Course Objectives:

- To enhance ability of students to write technical reports without errors.
- To enable students to make effective power point slides in MS PowerPoint or equivalent software.
- To improve group working ability of students' group/ team work.
- To improve computational ability using Microsoft Excel.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Write grammatically correct technical reports in MS Words or equivalent software.	3-Apply
CO2	Prepare effective power point slides in MS PowerPoint or equivalent software.	3-Apply
CO3	Perform the group/ team Work/ task.	3-Apply
CO4	Apply MS Excel and it's features for solving problems.	3-Apply
CO5	Present, convince and persuade to be an effective and successful professional.	3-Apply

List of Assignments

Sr. No.	**Particulars**	**CO Mapped**
1	Development of communication skills in oral as well as writing.	CO1, CO3
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.	CO1, CO5

3	The oral communication skills should emphasize presentation skills.	CO2, CO5
4	Use of audio-visual facilities like working of LCD, powerpoint presentations required for making effective presentation.	CO2, CO5
5	Group Discussion	CO3, CO5
6	Group Task	CO3, CO5
7	Introduction to Microsoft Excel	CO4, CO5

Text Books

1. Kaul, Asha. Business Communication. Delhi: Prentice-Hall of India, 2006
2. Nitin Bhatnagar. Effective Communication and Soft Skills. Pearson Education India.

Reference Books

1. Eric Garner. Team Building.
2. Wendy Palmer and Janet Crawford. Leadership Embodiment.

Guidelines for Assignments

- Teacher will brief the given assignment to students its procedure, observations calculation, and outcome of this assignments.
- software required for the allotted assignments will be provided by the lab assistants using SOP.
- Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant.
- After performing the assignment students will check the same from faculty.
- After checking they have to prepare final copy of the assignment.

Guidelines for Student's Assignments

Printed assignments should include title, aim, diagram (if any), procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

- Each assignment from lab journal is assessed for thirty marks 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.

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering **Pattern 2022 Semester: IV** **CHE222011: Chemistry II**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.

Course Objectives:

- To impart the basic concepts of organic chemistry
- To develop understanding about concepts of organic reactions for analysis of unit
- To study the different analytical instrumentation techniques

Course Outcomes: On completion of the course, students will be able to–

	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 I	**Green Chemistry**	**(08hrs)**	**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. Ethanol based products, Cellulose acetate, nitrate, ether. catalytic site of enzyme, factors affecting enzyme activity

Unit II	Transition metals and Co-ordination chemistry	(08hrs)	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, applications of CFT)

Unit III	Volumetric Analysis	(8hrs)	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 IV	Surface Chemistry	(8hrs)	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 V	Stereochemistry and Unit processes in organic synthesis	(8hrs)	CO5

Basic concepts, conformation isomerism of ethane, propane, butane, cyclohexane, monosubstituted cyclohexane, optical isomerism with 1 and 2 chiral centres, Mechanism, thermodynamics and kinetics of nitration, halogenations, sulphonation, preparation of nitrobenzene, chloral (DDT) and vinyl chloride (PVC), dodecyl benzenesulphonate, alpha-olefin sulphonate, 2-ethyl hexanol

Text Books

1. Inorganic chemistry - J.D. Lee
2. Inorganic chemistry - Cotton and Wilkinson’s
3. Physical chemistry -P L Soni
4. Physical Chemistry- Atkins
5. Physical Chemistry – Maron Pruton
6. Instrumental methods of chemical analysis Chatwal –Anand

Reference Books
1. Analytical chemistry- Skooge and West 2. Reaction mechanism - Jerry March 3. Organic Chemistry - Morrison and Boyd 4. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean & F.A Settle, CBS Publishers, 7th Edition, 1988

Guidelines for Continuous Assessment of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignment on 1,2,3,4,Unit	**10**
2	Group presentations on Unit 5	**05**
3	Learnico test on each unit	**05**

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

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S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222012: Heat Transfer

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20 Marks** **InSem Exam: 20 Marks** **EndSem Exam: 60 Marks**

Prerequisite Courses, if any: -Engineering Mathematics I and II, Thermodynamics

Course Objectives:

- To use heat transfer principles to understand the behavior of thermal systems.
- To recognize the various modes of heat transfer i.e. conduction, convection and radiation.
- To provide the basic knowledge in thermal system design and to enlighten heat transfer applications.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Demonstrate knowledge of the fundamental concepts of conduction, radiation, and convection heat transfer	3-Apply
CO2	Calculate problem on conduction, convection and radiation.	3-Apply
CO3	Identify the type of heat transfer model that needs to be applied.	2-Understand
CO4	Identify, formulate and solve engineering problems based on heat exchanger.	3-Apply
CO5	Select evaporator for industrial applications.	2-Understand

COURSE CONTENTS

Unit I	Introduction	**(08hrs)**	**COs Mapped - CO1, CO2, CO3**

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, critical thickness of insulation. Heat transfer through extended surfaces (fins). Introduction to transient/unsteady state heat conduction.

Unit II	Convection	**(08hrs)**	**COs Mapped -**

			CO1, CO2, CO3
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 III	Radiation	**(08hrs)**	**COs Mapped – CO1, CO2, CO3**
Thermal radiation, black body radiation, properties of radiation, laws of radiation. Various cases of radiation between two surfaces, radiation shields			
Unit IV	Heat Exchangers	**(08hrs)**	**COs Mapped – CO4**
Basic types of heat exchangers, overall heat transfer coefficient, fouling factor, Double pipe heat exchanger design by LMTD and effectiveness-NTU methods (calculations of overall heat transfer coefficient and area), Shell and tube heat exchangers, Plate type heat exchange			
Unit V	Evaporation	**(08hrs)**	**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), New Age International Publishers.
2. Heat and Mass Transfer by P K Nag, McGraw-Hill publications

Reference Books

1. J P Holman, "Heat Transfer" 9th edition, Tata McGraw Hill Publications, New Delhi (2004)
2. S. P. Sukhatme, "A Textbook on Heat Transfer", 4th ed, Universities Press (India), 2005
3. D. Q. Kern, "Process Heat Transfer", 11th ed., Tata McGraw Hill Publication, New Delhi
4. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications,2002
5. Yunus A. Cengel "Heat and Mass Transfer" 3rd ed., Tata McGraw Hill Publications, New Delhi (2007)

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	3 Assignments on Units 1, 2, 3 and 4	10
2	Group Presentation on Unit 5	05
3	LearniCo Test on Each Unit	05
	Total	**20**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222013: Mechanical Operations

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry

Course Objectives:

- To study properties of solids, separation and size reduction of solids.
- To understand fluid solid separation using sedimentation operation, Fluidization.
- To study mixing, agitation and Filtration Operations.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Classify the type of screening and size reduction equipment for different particle sizes	2- Understand
CO2	To understand different types solid-liquid, solid-gas separation options	2-Understand
CO3	Explain fluidization applications in Industries and able select a suitable type of conveyor for transportation of different types of solids.	2-Understand
CO4	Calculate the mixing index and select a suitable type of mixing operation for various types of solids and liquids.	3-Apply
CO5	Use concepts Filtration operations select suitable type of filtration equipment.	3-Apply

COURSE CONTENTS

Unit I	Size Reduction and Screening Operations	**(08hrs)**	**COs Mapped - CO1, CO2**

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 II	Sedimentation and Separation Methods	**(06hrs)**	**COs Mapped -, CO2, CO3**

Sedimentation, kynch theory of sedimentation equipment and its types, classifiers, centrifugal equipment, forth-flotation cell, magnetic separator, cyclone separator, liquid cyclone, electrostatic separator, precipitator, mineral jig.

Unit III	Fluidization and transportation of solids	**(08hrs)**	**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 IV	Mixing Operation	**(08hrs)**	**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 V	Filtration	**(08hrs)**	**COs Mapped - CO5**
Filtration theory: constant pressure, constant rate, and variable pressure-variable rate filtration, incompressible and compressible cake 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, horizontal pressure leaf filters. Centrifugal filters-basket type.			

Text Books

1. R.S. Hiremath and A.P. Kulkarni, Unit operation in Chemical Engineering, Everest publication.
2. Kiran D. Patil, Mechanical operations: Fundamental Principles and Application, Nirali publication.

Reference Books

1. McCabe W. L. &Smith J.C. "Unit Operations in Chemical Engineering". McGraw Hill Publications.
2. Coulson J. M. and Richardson J.F. "Chemical Engineering, Vol. 2".
3. Badger W. L and Banchero J.T. "Introduction to Chemical Engineering", 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	LearniCo Test on Each Unit	05
	Total	**20**

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

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S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222014: Thermodynamics

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20Marks** **InSem Exam: 20Marks** **EndSem Exam: 60Marks**

Prerequisite Courses, if any: - Courses in Engineering Mathematics, Physics and Chemistry.

Course Objectives:

- To introduce basic concepts of thermodynamics, and their applications.
- To formulate and apply the laws of thermodynamics in order to solve a given problem using a particular thermodynamic process.
- To understand different methods for performing phase and chemical reaction equilibrium calculations.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Understand basic concepts of thermodynamics, as well as 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 I	Introduction and Basic Concept	**(08hrs)**	**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 II	P-V-T Behavior and law of thermodynamics	**(08hrs)**	**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 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, Carnot principle, third law of thermodynamics.

Unit III	Thermodynamic Properties of Fluids	**(08hrs)**	**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 IV	Phase equilibrium	**(08hrs)**	**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 V	Chemical reaction equilibrium	**(08hrs)**	**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. S.Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th edition, John Wiley, 2006.
2. Rao Y.V.C., Chemical Engineering Thermo Dynamics, University press (INDIA) Ltd.
3. Hill, T.L., An Introduction to Statistical Thermodynamics, Dover Publications, 1960.

Reference Books

1. J. M. Smith, H. C. Vanness, M. M. Abott, 2005, Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 7^{th} edition
2. K. V. Narayanan, 2011, Chemical Engineering Thermodynamics, Prentice Hall Of India, New 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	10
2	Group Presentation on Unit-5	05
3	LearniCo Test on Each Unit	05
	Total	**20**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222015: Soft Skills

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :03 hrs/week	**03**	**Continuous Comprehensive Evaluation: 20 Marks** **InSem Exam: 20 Marks** **EndSem Exam: 60 Marks**

Prerequisite Courses, if any: - English

Course Objectives:

- To encourage the students for the development of soft skills and communication skills through creative thinking.
- To make the students aware of critical thinking and problem-solving skills.
- To develop leadership skills and organizational skills through group activities.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Memorize various elements of effective communicative skills.	2-Understand
CO2	Apply critical thinking skills in problem solving.	3-Apply
CO3	Improve social and work-life skills as well as personal and emotional well-being.	2-Understand
CO4	Interpret people at the emotional level through emotional intelligence.	3-Apply
CO5	Identify the situation and take necessary decisions as a leader.	2-Understand

COURSE CONTENTS

Unit I	Soft Skills & Communication Skills	**(08hrs)**	**COs Mapped - CO1**
Introduction, meaning, significance of soft skills: definition, significance; types of communication skills: Intrapersonal & Inter-personal skills:Verbal and Non-verbal Communication.			
Unit II	Critical Thinking	**(08hrs)**	**COs Mapped - CO2**
Active Listening, Observation, Curiosity, Introspection, Analytical Thinking, Open-mindedness, Creative Thinking.			
Unit III	Problem Solving & Decision Making	**(08hrs)**	**COs Mapped – CO3**

Meaning & features of Problem Solving, Managing Conflict, Conflict resolution, Methods of decision making, Effective decision making in teams, Methods & Styles			
Unit IV	Emotional Intelligence & Stress Management	**(08hrs)**	**COs Mapped – CO4**
Managing Emotions, Thinking before Reacting, Empathy for Others, Self-awareness, Self-Regulation, Stress factors, Controlling Stress –Tips and Buckingham's method			
Unit V	Leadership Skills	**(08hrs)**	**COs Mapped – CO5**
Team-Building, Decision-Making, Accountability, Planning, Public Speaking, Motivation, Risk-Taking, -Team Building, Time Management			

Text Books

1. Personality Development and Soft Skills Publisher: Oxford University Press; Pap/Cdr edition (July 22, 2012)
2. Personality Development and Soft Skills: Preparing for Tomorrow, Dr Shikha Kapoor Publisher : I K International Publishing House; (February 28, 2018)

Reference Books

1. Soft skills: personality development for life success by Prashant Sharma, BPB publications 2018.
2. Soft Skills by Alex K. Published by S.Chand
3. Soft Skills: An Integrated Approach to Maximise Personality Gajendra Singh Chauhan, Sangeetha Sharma Published by Wiley.
4. Communication Skills and Soft Skills (Hardcover, A. Sharma) Publisher: Yking books
5. Soft Skills for a Big Impact (English, Paperback, RenuShorey) Publisher: Notion Press
6. Life Skills Paperback English Dr. Rajiv Kumar Jain, Dr. Usha Jain Publisher: Vayu Education of India.

Guidelines for Continuous Comprehensive Evaluation of Theory Course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Assignments on Each Unit	05
2	Group Presentation/Discussion on Each Unit	10
3	LearniCo Test on Each Unit	05
	Total	**20**

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222016:Process Simulation using DWSIM

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :01 hrs/week	**Spoken Tutorial Certification**	**Spoken Tutorial Online Exam**

Prerequisite Courses, if any: - Basics of unit operations, unit processes, reactors and Heat Exchangers

Course Objectives:

- To introduce different process simulation software
- To study unit operations via simulation approach
- To learn unit processes via simulation approach

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Understand basic concepts of process simulation.	2-Understand
CO2	Simulate unit operation problems by DWSIM software.	3-Apply
CO3	Solve different reactors and heat exchanger problems by DWSIM software.	3-Apply

COURSE CONTENTS

Module 1	**Basics of Chemical Process Simulation Software**	**(03hrs)**	**COs Mapped - CO1**

Defining Simulation Configuration Wizard window Selecting chemical compounds, Selecting property packages, Choosing the units, Adding a stream to the flowsheet, Defining mole fractions of a stream, Defining stream condition of a stream, Introduction to Property Editor Window, adding mixer to the flowsheet, Defining single phase and two phase streams Carrying out material balance calculations, Adding a flash vessel to the flowsheet, Repeating all of the above with flash vessel, Verifying the results of calculations, mixer problem

Module 2	**Simulation of Unit operations**	**(04hrs)**	**COs Mapped - CO1, CO2**

Defining default units for variables using System of Units, Adding shortcut distillation column to the flowsheet, Connecting feed, output, energy streams to the column, Specifying condenser type Specifying condenser and reboiler pressure, Specifying desired product composition through key

values, Specifying a guess value of reflux ratio, Simulate a shortcut distillation column, Minimum and actual number of stages, Minimum reflux ratio, Optimal Feed stage location, Absorption column

Module 3	**Simulation of different types of reactors, Heat Exchanger**	**(04hrs)**	**COs Mapped - CO1, CO2, CO3,**

- Selecting chemical components and thermodynamics, Adding material streams to the flowsheet, Defining the properties of the streams, adding reactors, specifying reactors, Verifying the results of calculations,
- Simulating heat exchanger- Adding heat exchanger to the flowsheet Connecting inlet and outlet streams to the exchanger, Defining calculation type and flow direction, Defining cold and hot fluid pressure drop, Changing the shell side configurations, Changing the tube side configurations, Using master property table, Defining object and heat exchanger properties

Module 4	**Simulation of heat exchanges, custom unit operations using Scilab, python**	**(03hrs)**	**COs Mapped - CO1, CO2, CO3**

- Introducing Scilab CAPE-OPEN Unit Operation, Defining molar flow rates of the compounds, Defining molar enthalpy of the compounds Defining pressures of the compounds Calculating outlet pressure of the product stream, Calculating molar flow rates of product stream, Calculating molar enthalpy of product stream
- Introducing Python script in the flowsheet Introducing GetProp and SetProp function Defining mass flow and mole flow of the compounds, Defining out, Property Package.DWCalc Equilibrium function, Defining Property Packages.FlashSpec function Calculating outlet pressure of the product stream, Calculating mass and molar flow rates of product stream, Calculating enthalpy of product stream

Text Books

1. A. K. Jana, "Process Simulation and Control Using ASPEN", PHI Learning Pvt. Ltd. Publications.

Reference Books

3. McCabe,W. L, J. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition, Seventh edition.
4. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1", 6th ed., Butterworth-Heinemann.
5. Ralph Schefflan, Teach Yourself the Basics of Aspen Plus, A John Wiley & Sons, inc., publication

Guidelines for online test

Step 1:

• Login to the Student Dashboard (http://spoken-tutorial.org/participant/login/),

Go to 'Ongoing Test' and click 'Enroll', The invigilator will mark the Attendance for you.

Step 2:

• Please refresh your browser screen after the invigilator marks your attendance, click 'Enter into Test' in the Ongoing test tab. It will take you to a new window (Spoken Tutorial Online Test Center).

Step 3:

• After you enter your Username and Password, you will see the Homepage where you will get the list of Tests available for various FOSS / Courses. Click on the Test which you want to give. (Note: Read the instructions which appear on the screen.)

Step 4:

• Click on “Attempt Quiz Now”. Then click on “Start Attempt”.

Step 5:

• At the end of the test, click on “Finish attempt” in the Quiz Navigation Panel. You will get to see “Summary of Attempts”. • It will also show if you missed any questions. You can click on “Return to attempts” or you can go back and attempt by clicking on the particular question number.

Step 6:

• Confirm by clicking on “Submit All and Finish” once you have completed the test. • You will get your test score on the spot.

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222017: Chemistry II Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 04 hrs/week	**02**	**Practical: 50 Marks** **TW: 25 Marks**

Prerequisite Courses, if any: - Knowledge of fundamental Chemistry up to XII standard and first year Engineering Chemistry.

Course Objectives:

- To impart the basic concepts of organic, inorganic and physical chemistry
- To develop understanding about concepts of organic reactions for analysis of unit Processes
- 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	2-Understand
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
CO5	Apply principles of ion exchange resin for treatment of hard water.	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 ofglucose	CO2
6	Estimation of glucose/acetone insolution	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
10	To determine integral and differential heat of solution of a salt	CO1
11	Demineralization of hard water using ion exchange resin.	CO5

Text Books

1. Laboratory manual on general and applied chemistry by Dr.S. K.Bhasin, Dhanpatrai publication.
2. Laboratory manual on engineering chemistry by 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, 7th Edition, 1988
2. Synthesis of organic compound-Vogel

Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this 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 (two students in each group) under the supervision of faculty and lab assistant.
- After performing the experiment students will check their readings, calculations from the teacher.
- After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

- Each experiment from lab journal is assessed for thirty marks 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.

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

(Autonomous from Academic Year 2022-23)

S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222018: Heat Transfer Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 02 hrs/week	**01**	**Oral: 25 Marks** **Termwork: 25 Marks**

Prerequisite Courses, if any: - Engineering Mathematics, Thermodynamics

Course Objectives:

- To understand the various modes of heat transfer i.e. conduction, convection and radiation.
- To get a knowledge of heat exchanger.
- To get a knowledge of evaporators.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Determine the thermal conductivity.	2-Understand
CO2	Calculate the heat transfer coefficient using convection.	2-Understand
CO3	Determine the emissivity using radiation.	2-Understand
CO4	Determine the heat transfer coefficient of heat exchanger	2-Understand
CO5	Understand evaporators characteristics.	2-Understand

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	CO4

	exchanger	
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), New Age International Publishers.
2. Heat and Mass Transfer by P K Nag, McGraw-Hill publications

Reference Books

1. J P Holman, "Heat Transfer" 9th edition, Tata McGraw Hill Publications, New Delhi (2004)
2. S. P. Sukhatme, "A Textbook on Heat Transfer", 4th ed, Universities Press (India), 2005
3. D. Q. Kern, "Process Heat Transfer", 11th ed., Tata McGraw Hill Publication, New Delhi
4. Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2ed., Wiley Publications,2002
5. Yunus A. Cengel "Heat and Mass Transfer" 3rd ed., Tata McGraw Hill Publications, New Delhi (2007)

Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this 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 (two students in each group) under the supervision of faculty and lab assistant.
- After performing the experiment students will check their readings, calculations from the teacher.
- After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

- Each experiment from lab journal is assessed for thirty marks 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

Pattern 2022 Semester: IV

CHE222019: Mechanical Operations Lab

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 02 hrs/week	**01**	**Teamwork: 25Marks** **Practical: 25 Marks**

Prerequisite Courses, if any: -Courses of Engineering Mathematics, Engineering Mechanics, Physics and Chemistry

Course Objectives:

- To study properties of solids, separation and size reduction of solids.
- To understand fluid solid separation using sedimentation operation, Fluidization.
- To study mixing, agitation and filtration operations.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Evaluate the separation methods for solid & fluids.	3-Apply
CO2	Apply the principles of size reduction equipments for solids.	3-Apply
CO3	Gain the knowledge on mixing principles for solid-solid / solid-liquid mixing.	2-Understand
CO4	Evaluate the filter medium & specific cake resistance.	3-Apply
CO5	Understand the various solid transportation techniques.	2- Understand

List of Laboratory Experiments

Sr. No.	**Laboratory Experiments**	**CO Mapped**
1	To determine effectiveness of given set of standard screen	**CO1**
2	To determine energy consumption and crushing law constants for jaw crusher	**CO1, CO2**
3	To determine Critical speed of Ball mill & Average particle size of the product obtained in ball mill	**CO1, CO2**
4	To determine mixing Index in Sigma Mixer	**CO3**
5	To find efficiency of cyclone separator.	**CO1**

6	To determine filter medium resistance and specific cake resistance by using Plate &frame filter Press	**CO4**
7	To determine area of batch thickener by conducting batch sedimentation test.	**CO2**
8	To determine separation efficiency by using magnetic separator.	**CO1, CO4**
9	To study various conveyor systems.	**CO5**

Text Books

1. R.S. Hiremath and A.P. Kulkarni, Unit operation in Chemical Engineering, Everest publication.
2. Kiran D. Patil, Mechanical operations: Fundamental Principles and Application, Nirali publication.

Reference Books

1. McCabe W. L. & Smith J. C. "Unit Operations in Chemical Engineering". McGraw Hill Publications.
2. Coulson J. M. and Richardson J. F. "Chemical Engineering, Vol. 2".
3. Badger W. L and Banchero J.T. "Introduction to Chemical Engineering", McGraw Hill Publications.

Guidelines for Laboratory Conduction

- Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this 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 (two students in each group) under the supervision of faculty and lab assistant.
- After performing the experiment students will check their readings, calculations from the teacher.
- After checking they have to write the conclusion of the final result.

Guidelines for Student's Lab Journal

Write-up should include title, aim, diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.

Guidelines for Termwork Assessment

- Each experiment from lab journal is assessed for thirty marks 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.

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

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S. Y. B. Tech. Chemical Engineering

Pattern 2022 Semester: IV

CHE222020: Project Based Learning

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory :02 hrs/week	**01**	**Continuous Comprehensive TW: 25 Marks**

Prerequisite Courses, if any: - Physics, Chemistry, Mathematics, Material balance, and Energy balance.

Course Objectives:

- To emphasize long-term autonomous learning and work: unstructured multidisciplinary problems that need research.
- To integrate knowledge and skills from various areas through more complex problem solving.
- To integrate knowledge and skills from various areas through more complex problem solving.
- To improve teamwork, prepare students for a social environment through self-evaluation and self-criticism, guard against self-complacency, and try to see beyond their own ideas and knowledge.

Course Outcomes: On completion of the course, students will be able to–

	Course Outcomes	**Bloom's Level**
CO1	Increase their capacity for learning through shared cognition.	2-Understand
CO2	Draw on lessons from several disciplines and apply them in a practical way.	3-Apply
CO3	Learn by performing, and PBL will promote long-term retention of material.	2-Understand
CO4	Replicate a skill, as well as improve teachers' and students' attitudes towards learning.	2-Understand
CO5	Identify the situation and take necessary decisions as a leader.	2-Understand

COURSE CONTENTS

Unit I	Selection of the relevant problem	**(08hrs)**	**CO1**

A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students' wondering within different disciplines and professional environments.

Unit II	Literature Review	**(08hrs)**	**CO2**

Based on the selected problem need to know the basic information about previous works knowledge. Therefore, detailed literature study should be conducted using scientific articles.			
Unit III	Experimentation and Methodology	**(08hrs)**	**CO3**
Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the experiment activities like selection of raw materials and methodology etc.			
Unit IV	Results and Discussion	**(08hrs)**	**CO4**
Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize and present their learning information and experimental data.			
Unit V	Project Completion	**(08hrs)**	**CO5**
Activities may include- solving real life problem, investigation /study and writing reports of in depth study, field work, presentation etc.			

Text Books

1. Research Methodology: Methods and Techniques, New Age International Publications, C.R. Kothari and Gaurav Garg
2. Perry's Chemical Engineers' Handbook, by Don W. Green, Marylee Z. Southard,

Reference Books

1. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson, Richardson Chemical Engineering, Volume-1", 6th ed., Butterworth-Heinemann.
2. Coulson J. M. and Richardson J.F. "Chemical Engineering Vol. 2", Pergamon Press.
3. Coulson J. M. and Richardson J.F. "Chemical Engineering Vol. 6", Pergamon Press.
4. Outlines of Chemical Technology, Dryden

Recommended parameters for assessment, evaluation and weightage of the course		
Sr. No.	**Components for Continuous Comprehensive Evaluation**	**Marks Allotted**
1	Selection of the relevant problem	05
2	Literature Review	05
3	Experimentation and Methodology	05
4	Results and Discussion	05
5	Project Completion	05
	Total	**25**

Guidelines for Laboratory Conduction
• Teacher will brief the given experiment to students its procedure, observations calculation, and outcome of this experiment. • Apparatus and equipment's required for the allotted experiment will be provided by the lab assistants using SOP. • Students will perform the allotted experiment in a group (two students in each group) under the supervision of faculty and lab assistant. • After performing the experiment students will check their readings, calculations from the teacher. • After checking they have to write the conclusion of the final result.
Guidelines for Student's Lab Journal
Write-up should include title, aim, and diagram, working principle, procedure, observations, graphs, calculations, conclusion and questions, if any.
Guidelines for Teamwork Assessment
• Each experiment from lab journal is assessed for thirty marks 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.