DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
SECOND YEAR B. TECH
Scheme of Teaching and Evaluation: Semester- III (Chemical Engineering)

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)				Evaluation Scheme (Marks)					
						Theory			Practical		
		L	T	P	Total Credits	Scheme	Max. marks	Min. Passing $	Scheme	Max. marks	Min. Passing
CH211	Chemistry-I	03	-	-	03	CIE SEE	30 70	40	- -	- -	- -
CH212	Chemical Engineering Thermodynamics-I	03	-	-	03	CIE SEE	30 70	40	- -	- -	- -
CH213	Engineering Mathematics-III	03	01	-	04	CIE SEE	30 70	40	- -	- -	- -
CH214	Fluid Flow Operations	04	01	-	05	CIE SEE	30 70	40	- -	- -	- -
CH215	Chemical Process Calculation	03	01	-	04	CIE SEE	30 70	40	- -	- -	- -
CH216	Computer Programming for Chemical Engineers	02	-	-	02	-	-	-	-	-	-
CH211L	Chemistry-I Laboratory	-	-	02	01	-	-	-	IOE EPE	50 50	20 20
CH214L	Fluid Flow Operations Laboratory	-	-	02	01	-	-	-	IOE EPE	50 50	20 20
CH216L	Computer Programming for Chemical Engineers Laboratory	-	-	02	01	-	-	-	IPE	50	20
CH217L	Analytical Chemistry Laboratory	-	-	02	01	-	-	-	IOE	50	20
	Total	**18**	**03**	**08**	**25**	-	**500**	-	-	**300**	-

University Common Audit Course											
HS211	Environmental Studies	**02**	-	-	-	Project* Theory*	30 70	40	-	-	-

Audit Course I											
HS212	Soft Skills Development	**02**	-	-	-	Institute Level	-	-	-	-	-

$ In theory, student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.
Total contact hours per week: **29+2+2=33 and Total Credits=25**
***** Indicates Environmental Studies project evaluation and the theory Evaluation will be at the end the year i.e., along with Semester IV End Examination.

Note: Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students.

CIE: Continuous Internal Evaluation
SEE: Semester End Examination
IPE: Internal Practical Evaluation
EPE: External Practical Evaluation
IOE: Internal Oral Evaluation
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DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
SECOND YEAR B. TECH
Scheme of Teaching: Semester- III (Chemical Engineering)

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)			
		L	T	P	Total Credits
CH211	Chemistry-I	03	-	-	03
CH212	Chemical Engineering Thermodynamics-I	03	-	-	03
CH213	Engineering Mathematics-III	03		-	03
CH214	Fluid Flow Operations	04	01	-	05
CH215	Chemical Process Calculations	03	01	-	04
CH216	Computer Programming for Chemical Engineers	02	-	-	02
CH211L	Chemistry-I Laboratory	-	-	02	01
CH213	Engineering Mathematics-III	-	01	-	01
CH214L	Fluid Flow Operations Laboratory	-	-	02	01
CH216L	Computer Programming for Chemical Engineers Laboratory	-	-	02	01
CH217L	Analytical Chemistry Laboratory	-	-	02	01
	Total	**18**	**03**	**08**	**25**
HS211	Environmental Studies	**02**	**-**	**-**	**Nil**
HS212	Soft Skills Development (Institute level audit course)	**02**	**-**	**-**	**Nil**

Total contact hours per week: **29+2+2=33 and Total Credits=25**

***** Indicates Environmental Studies project evaluation and the theory Evaluation will be at the end the year i.e., along with Semester IV End Examination.

Note: Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students.

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DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
SECOND YEAR B. TECH
Scheme of Teaching and Evaluation: Semester- IV (Chemical Engineering)

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)				Evaluation Scheme (Marks)					
						Theory			Practical		
		L	T	P	Total Credits	Scheme	Max. marks	Min. Passing $	Scheme	Max. marks	Min. Passing
CH221	Chemistry-II	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH222	Chemical Engineering Thermodynamics-II	03	01	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH223	Material Science and Technology	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH224	Heat Transfer Operations	04	01	-	05	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH225	Mechanical Operations	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH221L	Chemistry-II Laboratory	-	-	02	01	-	-	-	EPE	50	20
CH224L	Heat Transfer Operations Laboratory	-	-	02	01	-	-	-	IOE	50	20
									EPE	50	20
CH225L	Mechanical Operations Laboratory	-	-	02	01	-	-	-	EOE	50	20
CH226L	Applied Electrical & Electronics Measurement: Theory & Laboratory	02	-	02	03	-	-	-	IOE	50	20
CH227L	Mini Project	-	01	-	01	-	-	-	IOE	50	20
	Total	**18**	**03**	**08**	**25**	-	**500**	-	-	**300**	-

University Common Audit Course											
HS221	Environmental Studies	**02**	-	-	-	Project	30	40	-	-	-
						Theory	70				

Audit Course II											
HS222	Introduction to Performing Arts	**02**	-	-	-	Institute Level	-	-	-	-	-

$ In theory, student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.

Total contact hours per week: **29+2+2=33 and Total Credits=25**
Note: Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students

CIE: Continuous Internal Evaluation
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DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
SECOND YEAR B. TECH
Scheme of Teaching and Evaluation: Semester- IV (Chemical Engineering)

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)			
		L	T	P	Total Credits
CH221	Chemistry-II	03	-	-	03
CH222	Chemical Engineering Thermodynamics-II	03	01	-	04
CH223	Material Science and Technology	03	-	-	03
CH224	Heat Transfer Operations	04	01	-	05
CH225	Mechanical Operations	03	-	-	03
CH221L	Chemistry-II Laboratory	-	-	02	01
CH224L	Heat Transfer Operations Laboratory	-	-	02	01
CH225L	Mechanical Operations Laboratory	-	-	02	01
CH226L	Applied Electrical & Electronics Measurements: Theory & Laboratory	02	-	02	03
CH227L	Mini Project	-	01	-	01
	Total	**18**	**03**	**08**	**25**
HS221	Environmental Studies	**02**	-	-	Nil
HS222	Introduction to Performing Arts (Institute level audit course)	**02**	-	-	Nil

Total contact hours per week: **29+2+2=33 and Total Credits=25**
Note: Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students

CIE: Continuous Internal Evaluation
IPE: Internal Practical Evaluation
IOE: Internal Oral Evaluation
SEE: Semester End Examination
EPE: External Practical Evaluation
EOE: External Oral Evaluation

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & III**					
Course Title	:	**Chemistry-I**			***Course Code***	:	CH211
Teaching Scheme (Hours)	:	Lecture	03Hours/Week		***Total Credits***	:	03
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS-12A2					
Course Domain	:	Basic Sciences					

Course Rationale: The course is intended to provide background in important concepts and principles of applied chemistry topics. In designing this course, the various reasons why engineering students should learn chemistry are emphasized, and tried to include the engineering chemistry concepts which are not covered elsewhere in the engineering curriculum or which are assumed as engineering courses and also general chemistry concepts which are generally understood in the scientific and engineering multi-disciplinary community.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Define and explain basic concepts of chemical equilibrium, distribution laws as well.	1.	Memorize and the basic concepts of chemical equilibrium, various relevant laws as well.
2.	Discuss various factors affecting reaction rate, basics of Chemical Kinetics and Photochemistry.	2.	Calculate rates of chemical reactions and identify the importance of various concepts pertaining to Photochemistry.
3.	Describe the basics of adsorption phenomenon, adsorption types, catalysts, types of catalysis.	3.	Differentiate between types of adsorptions, catalysts and identify the use of these concepts.
4.	Illustrate basics of structure, bonding and Coordination Chemistry.	4.	Predict behavior of matter based on the knowledge of structure, bonding and Coordination Chemistry.
5.	Outline preparations of important inorganic chemicals and quote their properties uses.	5.	Interpret preparations of important inorganic chemicals, summarize their properties and uses.
6.	Classify solvents, reaction types and discuss solvent characteristics.	6.	List solvents and use those for various purposes based on their characteristics.

Curriculum Content	**Hours**
Unit I Chemical Equilibrium and Distribution Law: Characteristics of chemical equilibrium, law of mass action, Equilibrium constants & their relationship, derivation of law of mass action from chemical potential, Van't Hoff reaction isotherm, isochore and isobar, Rate law, absolute reaction rate of transition state theory, numerical based on above mentioned topics. Introduction to theory of distribution, Nernst distribution law, conditions for the validity of the distribution law, explanation & limitations of distribution law, Henry's law, determination of equilibrium constant from distribution coefficient, applications of distribution law, numerical based on the above topics.	08
Unit II Chemical Kinetics and Photochemistry: The rate equation, factors affecting rate of reaction, order and molecularity of a reaction, half-life time of a reaction, methods of determining order of a reaction. Pseudo molecular reactions, zero, first and second order	10

reactions, reactions of fractional orders, theories of reaction rates, kinetics of fast reactions (relaxation and flow technique), chain reactions, numerical based on the above topics. Electromagnetic radiation, light adsorption, laws of photochemistry-Grotthuss-Draper law, Stark Einstein law and Lambert-Beer law, Photo processes (Jablonski diagram)-internal conversion, inter-system crossing, fluorescence, phosphorescence, Chemiluminescence and photosensitization, quantum efficiency, some examples of photochemical reactions, kinetics of: hydrogen-chlorine reaction, hydrogen-bromine reaction.	
Unit III Adsorption and Catalysis: Characteristics, types of adsorption-Types of isotherms– Freundlich adsorption isotherm, Langmuir adsorption isotherm, applications of adsorption. Characteristics of catalysts, types of catalysis: homogeneous-mechanism of acid-base catalysis, heterogeneous-intermediate compound formation, catalytic poisons, promoters, supported catalysis, solid catalysts like oxides, metal & zeolites, phase transfer catalysts, enzyme catalysts	08
Unit IV Structure and Bonding: Structure and bonding Molecular orbital & valence bond approaches for diatomic molecules, hybridization & structure of H_2O, NH_3, BF_3, SF_6, and PCl_5. Structure of coordination compounds corresponding to coordination number up to 6, types of Ligands, isomerism [geometrical, optical, ionization, linkage and coordination], theories of Bonding in coordination compounds- Werner's coordination theory, effective atomic no. (EAN), valence bond theory and crystal field theory for octahedral complexes, chelation Stresses, Mohr's circle of Stress.	11
Unit V Inorganic Heavy Industries: Manufacture of H_2SO_4 (Contact process), NH_3 (Haber's process) with respect to reactions, reactants, catalyst and physicochemical principles.	05
Unit VI Non aqueous Solvents: Introduction, classification of solvents, characteristic properties of solvents (melting and boiling points, heats of fusion and vaporization, dielectric constant), liquid ammonia and liquid HF, reactions of liquid ammonia-precipitation, acid-base, oxidation- reduction, ammonolysis, reactions of HF precipitation, acid-base, protonation of organic compounds.	08

Suggested Text Books:	
1.	Kund and Jain, 'Physical Chemistry', S.Chand and Company, New Delhi (1996).
2.	Puri B.H., Sharma L.R. and M.S.Prathama, 'Principles of Physical Chemisry', S.Chand and Company, New Delhi (2001)
3.	J.D. Lee, 'Inorganic Chemistry'
Suggested Reference Books:	
1.	B.S.Bahl, Arun Bahl and G.D.Tuli, 'Essentials of Physical Chemistry', S.Chand and Company, New Delhi(2005)
2.	Gordon M. Barrow, 'Physical Chemistry', Sixth Edition, Tata McGraw Hill (1998)
3.	Peter Atkins & Julio de Paula, Atkins' Physical Chemistry, 7th Edition, Oxford University Press (2002)
4.	Cotton & Wilkinson, 'Inorganic Chemistry', Wiley Eastern Ltd-1986
5.	Puri & Sharma, 'Advanced Inorganic Chemistry', Shobhanlal Nagin Chand-1996

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & III**				
Course Title	:	**Chemical Engineering Thermodynamics – I**			***Course Code*** :	CH212
Teaching Scheme (Hours)	:	Lecture 03 Hours/Week Tutorial 00 Hours/Week			***Total Credits*** :	03
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision:	:	Fourth			***Month*** :	June 2021
Pre-requisites *(If any)*	:	BS11A2 and BS12A2				
Course Domain	:	Program Core				

Course Rationale: This is a core subject of Chemical Engineering and is essential for understanding basic concepts, First, Second Law of Thermodynamics, thermodynamic properties of fluid and performance of thermal systems used in industry.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the basic concepts of thermodynamics and PVT behavior of pure substances.	1.	Recall to basic concepts of thermodynamics and calculate heat, work and energy conversions for industrial processes.
2.	Discuss the first law of thermodynamics and its application.	2.	Demonstrate the use and applications of the first law of thermodynamics.
3.	Explain different thermodynamic properties for pure fluids using equations of state (EOS), tables and charts.	3.	Calculate thermodynamic properties of systems using equations of state.
4.	Explain the Second Law of Thermodynamics and various thermodynamic cycles.	4.	Demonstrate the use and applications of the Second Law of Thermodynamics.
5.	Summarize different thermodynamic properties and explain Maxwell relations for the same.	5.	Solve general energy and entropy balances to solve problems and further to sketch and read P-H and T-S diagrams
6.	Illustrate different numerical problems underlying the entire course.	6.	Apply their knowledge of thermodynamics to solve industrial problems.

Curriculum Content	**Hours**
Unit I Basic Concepts & P-V-T Behavior: Properties: Extensive/Intensive, Dependent/Independent, P-V-T behavior of pure substances	07
Unit II First Law of Thermodynamics: First Law of Thermodynamics: Energy balance for closed systems, Reversible & irreversible processes, closed systems, Open systems, Internal energy, Gibbs' phase rule, Equilibrium	07
Unit III Equations of State: Equations of State: Virial equation of state, Equations for Process Calculations for Ideal gases, Application of Virial equations, Cubic equations of state, van der Waals equation of state, Principle of corresponding states	07
Unit IV Second Law of Thermodynamics: Statement of second law, Heat Engines, Carnot's Theorem, Entropy, Entropy changes of an Ideal Gas, Mathematical statement of second law, Thermodynamic Cycles: Carnot and Rankine Cycles	07
Unit V Thermodynamic Properties and Relationships: Thermodynamic Properties and Relationships: Fundamental properties, Maxwell relations and cyclic rules	07

Unit VI Numerical Problems: Various numerical problems will be practiced based on the theory underlying the entire course.	04
Suggested Text Books:	
1.	Smith, van Ness, Abbott, 'Introduction to Chemical Engineering Thermodynamics', McGraw-Hill Companies, Inc., Series in Chemical Engineering, 7th edition
Suggested Reference Books:	
1.	Perry's Chemical Engineers handbook, 7th edition, McGraw, Hill, USA, 2000
2.	K.V. Narayanan, 'A Text book of chemical Engineering thermodynamics', Prentice Hall of India
3.	B.G. Kyle, 'Chemical Process Thermodynamics', 2nd Edn., Prentice Hall of India Pvt. Ltd., New Delhi, 2000
4.	Stanley I. Sandler, 'Chemical, Biochemical and Engineering Thermodynamics', Wiley India Pvt. Ltd., 4th ed., 2007.

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & III**					
Course Title	:	**Engineering Mathematics-III**			***Course Code***	:	CH213
Teaching Scheme (Hours)	:	Lecture	03 Hours/Week		***Total Credits***	:	04
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS-11A1 and BS-12A1					
Course Domain	:	Basic Sciences					

Course Rationale: This course is about the basic mathematics that is fundamental and essential component in all streams of undergraduate studies in sciences and engineering. The course consists of topics in differential equations, partial differential equations, Laplace transform – it's inverse and Vector calculus with applications to various engineering problems.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Explain the basic concepts of mathematics.	1.	Recall to the basic concepts of mathematics useful for Engineering.
2.	Discuss the fundamental concepts of Linear Differential Equations.	2.	Apply linear differential equations to solve numerical related to Chemical Engineering.
3.	Describe types of Partial Differential Equations.	3.	Apply partial differential equations to solve numerical related to Chemical Engineering.
4.	Illustrate the concepts of Laplace transforms.	4.	Solve the Laplace transform examples
5.	Explain the concepts of inverse Laplace transforms.	5.	Use Inverse Laplace transform.
6.	Outline Vector Calculus and its applications.	6.	Solve the problems based on Vector Calculus

Curriculum Content	**Hours**
Unit I Linear Differential Equations: Linear Differential Equations with constant coefficients, Homogeneous Linear differential equations.	06
Unit II Partial Differential Equations: Four standard forms of partial differential equations of first order.	06
Unit III Application of Partial differential Equations: Wave Equation, One dimensional heat flow equation, two-dimensional heat flow, Laplace equation (Steady State)**.**	06
Unit IV Laplace Transform: Definition, transforms of elementary functions, Properties of Laplace transforms, transforms of derivatives, transforms of integral, transforms of periodic function.	07
Unit V Inverse Laplace Transforms: Inverse Laplace transforms by using partial fractions, Convolution theorem, Applications to solve linear differential equations with constant coefficients (Initial value problems) using transform method, evolution of definite integrals.	07
Unit VI Vector Calculus: Differentiation of vectors, Velocity and acceleration, Gradient of scalar point function, Directional derivative, Divergence of vector point function, Curl of a vector point function, Irrotational and Solenoid vector fields. The line integral, surface integral, volume integral, Gauss Divergence theorem, Stoke's theorem, Green's theorem (without proof).	07

Suggested Text Books:	
1.	Dr. B. S. Grewal, 'Higher Engineering Mathematics'.
2.	J. N. Wartikar & P. N. Wartikar, 'A text book of Applied Mathematics: Vol. I, II and III', Vidyarthi Griha Prakashan, Pune.
Suggested Reference Books:	
1.	Erwin Kreyszig, 'Advanced Engineering Mathematics'
2.	N. P. Bali, Ashok Saxena and N. Ch. S. N. Iyengar, 'A textbook of Engineering Mathematics', Laxmi Publication, Delhi
3.	S. C. Gupta, 'Fundamental of Statistics'

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & III**					
Course Title	:	**Fluid Flow Operations**			***Course Code***	:	CH214
Teaching Scheme (Hours)	:	Lecture	04 Hours/Week		***Total Credits***	:	05
		Tutorial	01Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites	:	Basic concepts of Physics, Mathematics and Physical Chemistry of the Higher Secondary School Level.					
Course Domain	:	Program Core					

Course Rationale: This course will provide the student with a basic understanding of fluid properties, fluid statics and dynamics, and fluid flow. The flow of incompressible fluids in pressure systems constitutes the major portion of this course. It introduces students to the mathematical description of fluid flows and the solution of some important flow problems.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain basic concepts of Fluid Statics and the allied topics.	1.	Use basics of Fluid Statics and other topics to solve problems.
2.	Discuss basic laws that explain Fluid Flow systems.	2.	Derive the basic laws pertaining to Fluid Flow systems.
3.	Describe different equations concerning internal and external incompressible viscous flow.	3.	Evaluate pressure drop, power requirements etc. for single phase flow in pipes.
4.	Classify different flow measuring devices & illustrate related equations.	4.	Identify flow measuring devices and use the same for flow estimation.
5.	Compare fluidization systems and outline fluid conveying systems.	5.	Choose fluidization and conveying systems for various applications.
6.	Categorize fluid moving devices and distinguish between those.	6.	Distinguish between fluid moving devices & select the right one for a said purpose.

Curriculum Content	**Hours**
Unit I Fluid Statics: Basic Equation of a fluid statics, pressure variations in a static field. Pressure measuring devices manometer, U-tube, inclined tube, Forced on submerged bodies (Straight and inclined), Centre of pressure.	06
Unit II Basic Equations in Integral Form: Basic laws for a system, relation of system derivatives to the control volume formulation, conservation of mass, continuity equation, momentum balance equation, Introduction to Navier Stoke's and Euler's Equation, Introduction to rotational and irrotational flow, momentum correction factor.	08
Unit III Internal Incompressible Viscous Flow: Introduction, flow of incompressible fluid in circular pipe, laminar flow for Newtonian fluid, Hagen-Poiseuille equation, introduction to turbulent flow in a pipe-Prandtl mixing length, energy consideration in pipe flow, relation between average and maximum velocity, Bernoulli's equation–kinetic energy correction factor, head loss, friction factor-Fanning and Darcy, Moody diagram, major and minor losses, Pipe fittings and valves, schedule no, equivalent diameter.	12
Unit IV Flow Measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturi meter; Weirs, concept of area meters: rotameter; Local velocity measurement:	12

Pitot tube. Hot wire anemometer, mass flow meter. Resistance of immersed bodies: Introduction; concept of drag and lift; variation of drag coefficient with Reynolds number; stream-lined body and bluff body; packed bed; concept of sphericity; Ergun equation, modified friction factor.	
Unit V Fluidization: Introduction; different types of fluidizations; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses.	06
Unit VI Fluid Flow Devices: Introduction; Basic classification of pumps: Non-Mechanical Pumps-acid egg, steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps-cavitation, NPSH, Positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.	08

Suggested Text Books:	
1.	McCabe W L, Smith J C, Harriot P, 'Unit Operations of Chemical Engineering', McGraw Hill
2.	V. Gupta & S.K. Gupta, 'Fluid Mechanics & Application', New Age International Pvt. Ltd
3.	Streeter V.L, 'Fluid Mechanics' McGraw Hill Publishing Company Ltd
4.	R.K. Rajput, 'Fluid Mechanics and Hydraulic Machines', S. Chand & Co.
Suggested Reference Books:	
1.	Bird R.B., Stewart W.E., Lightfoot, 'Transport Phenomena', John Wiley & Sons, Inc.
2.	Richardson J.E. and Coulson, 'Chemical Engineering', Vol. 1 Pergamon Press
3.	F. W. White, 'Fluid Mechanics', McGraw Hill Publishing Company Ltd

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & III**					
Course Title	:	**Chemical Process Calculations**			***Course Code***	:	CH215
Teaching Scheme (Hours)	:	Lecture	03Hours/Week		***Total Credits***	:	04
		Tutorial	01Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS 11A1, BS11A2, BS12A1 and BS12A2					
Course Domain	:	Program Core					

Course Rationale: Through this course, Chemical Engineering students will be introduced to the basic principles and calculation techniques used in the chemical industries and they will be acquainted with the fundamentals of the material and energy balances as applied to chemical engineering processes. Also, the analysis of chemical processes is introduced, emphasizing steady and unsteady state mass and species balances.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	List and explain the basic chemical calculations.	1.	Make basic chemical calculations.
2.	Explain gaseous systems and the laws pertaining to the same.	2.	Gaseous systems and their properties & use the gas laws for various related calculations.
3.	Elaborate material balance procedure for different unit operation.	3.	Make material balances for different unit operations.
4.	Show how to make material balances of types of chemical reactions.	4.	Perceive the procedure of material balances of different chemical reactions.
5.	Describe basics of energy balances for both non-reactive and reactive processes.	5.	Solve energy balance problems for both non-reactive and reactive processes.
6.	Classify fuels and their analysis with explanation of the combustion process.	6.	Identify fuel types and their analysis methods and make combustion calculations.

Curriculum Content	**Hours**
Unit I Basic Chemical Calculations: Units and Conversions, Pressure, Temperature, Density, Specific Gravity, Equivalent Weight, Composition of solids, Liquids and Gases, Mass fraction, Mass percent, Mass Ratios, Mole fraction, Mole percent, Volume fraction and Volume percent, Normality, Morality, Molality.	08
Unit II Gaseous Systems: Gaseous mixtures, Dalton's law, Amagat's law, Average molecular weight, Density of gaseous mixture, Estimation of vapour pressure.	08
Unit III Material Balances without Chemical Reaction: Material balances Guidelines for solving material balance problems; Material balance of important industrial operations (Distillation, Absorption and Striping, Extraction and Leaching, Evaporation, Dryer, Mixing, Crystallization etc.); Recycle and Bypass operations.	08
Unit IV Material Balances with Chemical Reaction: Definition of terms involved;	08

Generalized approach for solving problems; Material balance problems involving chemical reaction; Electrochemical reactions; Metallurgical applications; Recycle, bypass and purge calculations.	
Unit V Energy Balance on Non-Reactive and Reactive Processes: Elements of energy balance calculations; Change in pressure at constant temperature; Change in temperature; Phase change operations; Mixing and solutions. Heat of reaction Measurement and calculation of standard heat of reaction, Hess law; Heat of formation; Heat of combustion; Effect of temperature on heat of reaction; adiabatic reactions.	08
Unit VI Fuels and combustion: Types of fuels, Calorific value of fuels, Problems on combustion of coal, liquid fuels, gaseous fuels, etc., Proximate and ultimate analysis, Combustion calculations, theoretical flame temperature, etc., Air requirement and flue gases	06

Suggested Text Books:	
1.	B.I. Bhatt, S.M. Vora, 'Stoichiometry', McGraw Hill Publishing Company Limited, 4th edition, 2004.
2.	David M. Himmelblau, James B. Riggs, 'Basic Principles & Calculations in Chemical Engineering', PHI Learning Pvt. Ltd, 7th edition, 2006.
3.	K.V. Narayanan, B. Lakshmikutty, 'Stoichiometry and Process Calculations', Prentice-Hall of India Pvt. Ltd., 2006.
4	K. A. Gavhane, 'Introduction to Process Calculations Stoichiometry', Twenty second Edition, Nirali Prakashan, 2009.
Suggested Reference Books:	
1.	Richard M. Felder, Ronald W. Rousseau, 'Elementary Principles of Chemical Processes', Wiley, 3rd edition, 2004.
2.	O. A. Hougen, K. M. Watson, R. A. Ragatz, 'Chemical Process Principles Part-I: Material and Energy Balances', CBS Publishers New Delhi, 2nd edition, 2004.
3.	H.C. Lewis, W.K. Lewis, A.H. Radasch, 'Industrial Stoichiometry: Chemical Calculations of Manufacturing Processes', McGraw-Hill, 2nd edition, 1954.
4.	V. Venkataramani, N. Anantharaman & K.M. Meera Sheriffa Begum 'Process Calculations', PHI Learning Pvt. Ltd. New Delhi, 20011, EEE 2nd Ed.2003.
5.	Felder R.M. and Rousseau R.W., 'Elementary Principles of Chemical Processes', Third Edition, John Wiley and Sons, Inc., 2000

Class, Part & Semester	**:**	**S. Y. B. Tech (Chemical Engineering), II & III**					
Course Title	**:**	**Computer Programming for Chemical Engineers**			***Course Code***	**:**	CH216
Teaching Scheme (Hours)	**:**	Lecture	02 Hours/Week		***Total Credits***	**:**	02
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=NA SEE=NA	IPE = 50	Grand Total=50	***Duration of SEE***	**:**	NA
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	ES11A/B 6, ES11A/B 7, ES12A/B 6 and ES12A/B 7					
Course Domain	**:**	Applied Engineering Sciences					

Course Rationale: As an engineer, students have to prepare technical reports and give presentations in their professional career and software tools such as word processing, spreadsheet calculations, power point presentations and programming languages such as C/C++, visual basics etc. help to achieve these objectives. Design and optimization of various chemical engineering operations requires tedious calculations and writing a computer program to solve these problems help to understand the concepts learnt in theory class better. Such calculations are done on repetitive basis in industry and generalized computer programs are useful. All such duties are made easier for Chemical Engineers with the background of such a course.

Course Objectives: The Course Teacher will		***Course Outcome:*** The student will be able to	
1.	State the purpose of various components of the VB integrated development environment (IDE).	1.	Identify the need to use Visual Basic's Integrated Development environment (IDE)
2.	Explain Arithmetic operators, Logical operators and relational operators to build small applications using Visual Basic.	2.	Design, create, build, and debug Visual Basic applications
3.	Outline the concepts of strings and their use in built-in functions.	3.	Implement syntax rules in Visual Basic programs
4.	Elaborate how to construct conditional and repetition statements and other control structures.	4.	Identify variables and data types used in program development.
5.	Demonstrate how to create Windows applications that store and access data to and from files and databases.	5.	Apply arithmetic operations for displaying numeric output.

Curriculum Content	**Hours**
Unit I Introduction to Visual Basic Programming: Menu bar, Tool bar, Project explorer, Tool box, Properties windows, Form Code, Controls: Command Buttons, Label, Textbox, Pointers, Picture box, frame, Naming Controls, Properties for controls: Height, Width, Left, Top, Font, Forecolor, Backcolor, Name, Caption, Text, and Visible, Events, Saving Visual Basic Project, Examples: Chemical Engineering Applications	06
Unit II Mathematics**:** Arithmetic Operations: +, *, /, \, mod, ^. (Using Simple Example for each Operation, Logical Operations. AND, OR, NOT. And the Truth Table for each Operation, (Using Simple Example for each Operation), Relational Operation: >, <, >=, <=, <>, =, String Concatenation (&), Operation Precedence. For all arithmetic, logical, relational operators, print	04

statement and Formatting, Illustrate (colon, comma, and semicolon), Examples: Chemical Engineering Applications	
Unit III Built **in Functions:** Builtin math functions: Abs(x), Int(x), Rnd (x), sgn(x), sqr(x), str(x), val(x), round (x, n), CInt(x), Fix(x), String Functions, Input Box, Msg Box, Examples: Chemical Engineering Applications.	03
Unit IV Selection Structure/ Reputation Structure: Single Selection: If/Then structure, Double Selection: If/Then/Else structure, Nested If/Then/Else structure, Select Case Multiple Selection Structure, For Next Loop, While- Wend, Do .... While ... Loop, Do ... Loop Until, Exit Do, Exit For, Examples: Chemical Engineering Applications	04
Unit V Variables: Data Types: Boolean, Integer, Long, Single, Double, String, Valid Naming of Variables, Initial Value for each Type of the Variables (Initial Value for each Data Type), Size of each variable Type in Bytes, How to Declare Variables. (Dim statement), Using: Dim variable name As Data type, Using Suffix: Integer, Long, Single, Double, String, Constant Variable, Examples: Chemical Engineering Applications.	04
Unit VI Database: Accessing Database, Data Control DAO, ADO, RDO, Visual Basic and Access Connectivity, Examples: Chemical Engineering Applications.	05

Suggested Reference Books:

1.	Diane Zak, 'Programming with Microsoft Visual Basic 2012', Course Technology, Cengage Learning, 6th edition.
2.	Evangelos Petroutsos, 'Mastering Microsoft Visual Basic 2008', Wiley Publishing, Inc., 1st edition.
3.	Noel Jerke, Osborne, 'Visual Basic 6: The Complete Reference', McGraw- Hill, 1999.
4.	Michael Halvorson, 'E-Book: Microsoft Visual Basic 2010'

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & III**					
Course Title	:	**Chemistry I Laboratory**			***Course Code***	:	CH211L
Teaching Scheme (Hours)	:	Practical	2Hours/Week		***Total Credits***	:	01
Evaluation Scheme (Marks)	:	IOE = 50	EPE =50	Grand Total = 100	***Duration of EPE***	:	02Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS11B3					
Course Domain	:	Basic Sciences					

Course Rationale: The course is to acquaint the students with practical knowledge of the basic phenomenon/concepts of chemistry, the student face during course of their study in the industry and engineering field. The students will be able to understand and explain scientifically the various chemistry related problems in the industry/engineering and develop experimental skills for building technical competence.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Expose the students for practical training through experiments in Physical and Inorganic Chemistry.	1.	Apply practical knowledge to industrial applications for developing or modifying methods
2.	Demonstrate kinetic study of chemicals reactions.	2.	Differentiate between the kinetics of different chemical reactions.
3.	Discuss the Preparation of simple coordination compounds.	3.	Demonstrate the preparations of simple coordination compounds.
4.	Explain simple techniques for purity analysis.	4.	Identify protocols for purity analysis
5.	Illustrate a miniature process plant environment using process utilities.	5.	Sketch miniature processes in the laboratory using process utilities.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	To study the kinetics of reaction between K2S2O8& KI.
2.	To study the kinetics of methyl acetate hydrolysis catalyzed by hydrochloric acid
3.	To determine the partition coefficient of acetic acid between n-butanol and water.
4.	To determine the partition coefficient of benzoic acid between benzene and water
5.	To investigate the adsorption of oxalic acid or Acetic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Longmuir isotherms
6.	Preparation of Tris (Thiourea) Copper (I) sulphate.
7.	Preparation of Hexanitrocobaltate.
8.	Preparation of Hexamine Nickel (II) chloride [Ni $(NH_3)6]$ Cl_2
9.	Preparation of Hexamine Hexamine cobalt chloride [Co $(NH_3)6]$ Cl_2.
10.	To prepare standard solution of sodium thiosulphate & to estimate copper from brass solution.
11.	To prepare standard solution of potassium dichromate & to estimate Iron from ammonium sulphate using external indicator
12.	To prepare standard solution of potassium dichromate & to estimate Iron from ammonium sulphate

	using internal indicator
Suggested Text Books/ Reference Books/Manual	
1.	A. I. Vogel, 'Inorganic chemistry'
2.	Sunita Rattan, 'Experiments in applied chemistry', S. K. Kataria & Sons- 2002
3.	Sudha Rani, 'Laboratory manual on Engineering Chemistry' Dr. Dhanpat Rai Publishing Company (P) Ltd, New Delhi

Class, Part & Semester	**:**	**Second Year B. Tech (Chemical Engineering), II & III**					
Course Title	**:**	**Fluid Flow Operations Laboratory**			***Course Code***	**:**	CH214L
Teaching Scheme (Hours)	**:**	Practical	02 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE =50	EPE =50	Grand Total =100	***Duration of EPE***	**:**	02 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	Basic concepts of Physics, Mathematics and Physical Chemistry of the Higher Secondary School Level.					
Course Domain	**:**	Program Core					

Course Rationale: Through this course the students gain a hands-on experience in fluid mechanics, acquire adequate knowledge on the fundamental concepts of measurement techniques and numerical analysis, experimental data analysis, technical report writing and work in teams.

Course Objectives: The course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Demonstrate different experimental verifications of theoretical concepts in Fluid Mechanics.	1.	Experimentally verify various laws pertaining fluid mechanics.
2.	Explain procedures to calculate the Pressure drop in straight pipes, fluidized bed and packed bed.	2.	Calculate the Pressure drop in straight pipes, fluidized bed and packed bed.
3.	Organize experiments that relate to fluid flow handling like volumetric flow rate measurement, fluid pressure measurement etc.	3.	Acquaint with fluid flow handling and calibrate fluid flow and pressure measuring devices.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	To determine the different types of flow Patterns by Reynolds's experiment.
2.	To determine the Coefficient of discharge through Orifice meter.
3.	To determine the Coefficient of discharge through Venturimeter.
4.	Verification of Bernoulli's theorem.
5.	To determine the Coefficient of discharge by using Pitot tube.
6.	To determine losses in different Pipe fittings.
7.	To determine the Friction factor for the different pipes.
8.	To study pressure measurement procedure and related instruments/devices.
9.	To determine the Cd, Cv, Cc by using Orificemeter Apparatus.

10.	Demonstration Flow through fluidized bed.
11.	Demonstration of centrifugal pump.
12.	Demonstration of Reciprocating Pump.
13.	Demonstration of Rotameter.
14.	Demonstration of Valves.
Suggested Text Books/ Reference Books/Manual	
1.	Sarbjit Singh, 'Experiments in Fluid Mechanics', PHI Learning Pvt. Ltd.
2.	Laboratory Manual Hydraulics and Hydraulic Machines by R V Raikar
3.	Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow

Class, Part & Semester	**:**	**S. Y. B.Tech. (Chemical Engineering), II & III**					
Course Title	**:**	**Computer Programming for Chemical Engineers Laboratory**			***Course Code***	**:**	CH216L
Teaching Scheme (Hours)	**:**	Practical	02 Hours/Weeks		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	CIE=Nil SEE=Nil	IPE =50	Grand Total =50	***Duration of IPE***	**:**	02 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	ES11B6, ES11B7, ES12A6 and ES12A7					
Course Domain	**:**	Applied Engineering Science					

Course Rationale: This course helps the students to apply programming skills in many areas of Chemical engineering. It can be either at the industrial scale or in research labs and it can include everything from process modeling, analysis, identification, planning, setup, control, maintenance etc. Depending on the problem, one has to try to solve, he or she has to use some predefined functions or have to write codes as well. And, even, while working for a company which develops such software tools, he or she has to get a good hold of programming skills.

Course Objectives: The Course Teacher will		***Course Outcome:*** The student will be able to	
1.	Explain VB integrated development environment (IDE).	1.	Visualize VB environment.
2.	Describe Arithmetic operators, Logical operators and relational operators to build small application using Visual Basic.	2.	Implement syntax rules in Visual Basic programs.
3.	Demonstrate the use of concept of strings in built-in functions.	3.	Design, create, build, and debug Visual Basic applications and built-in functions.
4.	Construct conditional and repetition statements and other control structures.	4.	Apply arithmetic operations for displaying numeric output.
5.	Show how to create Windows applications that store and access data to and from files and databases.	5.	Follow procedures, sub-procedures, and functions to create manageable code.

Sr. No.	***List of Experiments***
1.	To study VB environment.
2.	To design and develop form to perform mathematical operations.
3.	To study date, string and math functions.
4.	To design the form using image control and scroll bars.
5.	To design menu editor as text editor.
6.	To design stop watch.
7.	To design form using file controls, OLE control.
8.	To design form using Access Database.
9.	To build a small chemical Engineering application.

Suggested Text Books/ Reference Books/Manual	
1.	Diane Zak, 'Programming with Microsoft Visual Basic 2012', Course Technology, Cengage Learning, 6th edition.
2.	Evangelos Petroutsos, 'Mastering Microsoft Visual Basic 2008', Wiley Publishing, Inc., 1st edition.
3.	Noel Jerke, Osborne, 'Visual Basic 6: The Complete Reference', McGraw- Hill
4.	Michael Halvorson, 'E-Book: Microsoft Visual Basic 2010'

Class, Part& Semester	**:**	**Second Year B. Tech (Chemical Engineering), II, III**					
Course Title	**:**	**Analytical Chemistry Laboratory**			***Course Code***	**:**	CH217L
Teaching Scheme (Hours)	**:**	Practical	02 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE= 50	EPE /EOE = Nil	Grand Total = 50	***Duration of EOE***	**:**	NA
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	BS-11A2 and BS-12A2					
Course Domain	**:**	Basic Sciences					

Course Rationale: The course is to acquaint the students with practical knowledge of the basic phenomenon/concepts of equipment's like conductivity meter, potentiometer, P^H meter and colorimeter, the student face during course of their study in the industry and engineering field. The students will be able to understand and explain scientifically the various chemistry related problems in the industry/engineering and develop experimental skills for building technical competence.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Summarize good laboratory practices & standard operating procedures.	1.	Respond to good laboratory practices & standard operating procedures.
2.	Illustrate preparation of standard solutions and use appropriate calibration methods.	2.	Formulate and solve problems in the laboratory.
3.	Demonstrate uses and operations of various instrumental methods for chemical analysis.	3.	Use standard laboratory equipment, modern instrumentation and classical techniques to carry out experiments.
4.	Show and express procedures to operate colorimeter and P^H meter.	4.	Operate colorimeter and P^H meters.
5.	Explain how to display the results of laboratory experiments through effective writing and verbal communication skills.	5.	Communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	Determination of amount of acetic acid in commercial vinegar using sodium hydroxide
2.	To prepare the standard solution of oxalic acid and to determine the strength of potassium Permanganate solution in terms of normality and kg/dm^3.
3.	To separate and identify the cations from the given mixture by paper chromatographic technique.
4.	To determine the normality of the given strong acid by titrating it against the strong alkali using conductometer.
5.	To estimate the amount of ethyl benzoate in the given solution of ethyl benzoate.
6.	To determine the dissociation constant of dibasic acid P^H metrically.
7.	To determine percentage purity of a given sample of soda-ash.

8.	To determine total hardness of given sample of hard water using 0.01M EDTA solution.
9.	To determine alkali content of antacid tablet using HCl.
10.	To study the principle and demonstration of Gas chromatography.
11.	Determination of amount of sodium present in the given solution of common salt using cation exchange resin column by acid-base titration.
12.	To verify Lambert-Beer's law by using copper sulphate solution using colorimeter.
Suggested Text Books/ Reference Books/Manual	
1.	Analytical chemistry: Gary D. Christian
2.	Experimental physical chemistry: Findlay and Longman
3.	Systematic experimental physical chemistry: Rajbhoj and Chondhekar
4.	Experiments in general chemistry: C. N. R. Rao

Class, Part & Semester	**:**	**Second Year B. Tech (Chemical Engineering), Part II & III**					
Course Title	**:**	**Environmental Studies**			***Course Code***	**:**	HS211
Teaching Scheme (Hours)	**:**	Lecture Tutorial	02 Hours/Week 00 Hours/Week		***Total Credits***	**:**	Nil
Evaluation Scheme (Marks)	**:**	CIE = 00 SEE = 70	IPE=30 Project	Grand Total =100	***Duration of SEE***	**:**	3 Hrs. At the year end
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	Completion of First Year Engineering, Revision of BS-12A2 namely Engineering Chemistry may help for better understanding.					
Course Domain	**:**	Ethics & Environment					

Course Rationale: The Course is all about learning the way we should live and how we can develop sustainable strategies to protect the environment. It helps individuals to develop an understanding of living and physical environment and how to resolve challenging environmental issues affecting nature.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Define the course and indicate the importance of the same to the students.	1.	Recognize the scope and need of the course.
2.	Enumerate the natural resources and make students visualize about associated problems.	2.	Identify the natural resources and detect the associated problems.
3.	Describe and relate the ecosystems the engineering graduates.	3.	Relate values of ecosystems to human, plants and animals.
4.	Explain concepts and theory in biodiversity and management from interdisciplinary perspectives.	4.	Identify key threats of biodiversity.

Curriculum Content	**Hours**
Unit I Nature of Environmental Studies: Definition, scope and importance, Significance of environmental studies, Multidisciplinary nature of environmental studies. Its need for public awareness.	05
Unit II Natural Resources and Associated Problems: a) Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Usage and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problem, changes caused by agriculture effects of modern agriculture, fertilizer-pesticide problems. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. g) Role of an individual in conservation of natural resources. h) Equitable use of resources for sustainable lifestyle.	08
Unit III Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristics features, structure and function of the following Ecosystem: a) Forest ecosystem b) Grassland	08

ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	
Unit IV Biodiversity and Its Conservation: Introduction – Definition: genetic, species and ecosystem diversity, Bio geographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.; Biodiversity at global, National and local levels.; India as a mega-diversity nation; Western Ghats as a bio-diversity region; Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	09

Suggested Text Books:

1.	Agarwal, K. C. 2001, Environmental Biology, Nidi Publ. Ltd., Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 380013, India
3.	Brunner R. C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p

Suggested Reference Books:

1.	Clark R. S., Marine Pollution, Clanderson Press Oxford (TB) Pg No. 6
2.	Cunningham, W. P. Cooper, T. H. Gorhani, E. & Hepworth, M. T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
3.	De A. K., Environmental Chemistry, Wiley Eastern Ltd.
4.	Down to Earth, Centre for Science and Environment (R).
5.	Gleick, H., 1993, Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press 473p.
6.	Hawkins R. e., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7.	Heywood, V. H. & Watson, R. T. 1995, Global Biodiversity Assessment, Cambridge Univ. Press 1140p.
8.	Jadhav, H. & Bhosale, V. M. 1995, Environmental Protection and Laws, Himalaya Pub. House, Delhi, 284p.
9.	Mckinney, M. L. & Schocl. R. M. 1996, Environmental Science Systems & Solutions, Web enhanced edition.
10.	Mhskar A. K., Matter Hazardous, Techno-Science Publications (TB).
11.	Miller T. G. Jr., Environmental Science, Wadsworth Publishing Co. (TB).
12.	Odum, E. P. 1971, Fundamentals of Ecology, W. B. Saunders Co. USA, 574p.
13.	Rao M. N. & Datta, A. K. 1987, Waste Water Treatment, Oxford & IBH Publ. Co. Pvt. Ltd.,
14.	Sharma B. K., 2001, Environmental Chemistry, Goel Publ. House, Meerut.
15.	Survey of the Environment, The Hindu (M).
16.	Townsend C., Harper, J. and Michael Begon, Essentials of Ecology, Blackwell Science (TB).

17.	Trivedi R. K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media (R).
18.	Trivedi R. K. and P. K. Goel, Introduction to air pollution Techno-Science Publications (TB).
19.	Wagner K. D., 1998, Environmental Management, W. B. Saunders Co. Philadelphia, USA.

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), Part II & III**			
Course Title	:	**Soft Skills Development**	***Course Code***	:	HS212
Teaching Scheme (Hours)	:	2 Hours /Week= 2 x13= 26 hours	***Total Credits***	:	Nil
Evaluation Scheme (Marks)	:	Assignments=50 Viva voce=25 Written Test =25 Grand Total=100	***Duration of SEE***	:	NA
Revision	:	Fourth	***Month***	:	June 2021
Pre-requisites *(If any)*	:	H. S. C. Level English language competency			
Course Domain	:	Humanity and Arts			

Course Rationale: The course skills focus on who people are, as opposed to what they are trained in. These skills serve to represent learners' approach to life and work. The course develops interpersonal skills hardwired to an individual's personality, and such skills characterize how we interact with other people in the workplace. These skills are important because they enable students to adjust to the frustrations and challenges, they will encounter in their adult life, as well as the demands of work. Mastering soft skills help students learn, live and work better.

Course Assessment Method: The students will be given five assignments each for 10 marks. At the end of the course, there will be a written test of 25 marks and a viva voce of 25 marks. All these assessments will be for a total of 100 marks. Based on the marks obtained, they will be awarded with a grade similar to other credit courses. Though it is an audit course, obtaining passing grade is essential.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Illustrate the components of self-development and state the importance of career planning.	1.	Identify components of self-development and realize its importance in their career planning.
2.	Define Communication and classify the same.	2.	Differentiate between different communication types and apply the same.
3.	Explain behavioral skills, team skills and interpersonal skills.	3.	Acquire behavioral, team and interpersonal skills and display the same.
4.	Classify documentation types and describe various types of report writing.	4.	Follow different document formats and acquire report and proposal writing skills.
5.	Describe emotional intelligence and its role.	5.	Receive and respond to emotions with intelligence.
6.	Paraphrase interview skills and demonstrate resume writing.	6.	Acquire interview skills and apply those when required.

Curriculum Content	**Hours**
Unit I Self Development: Self-analysis, creativity, attitude, motivation, goal setting. Importance of career visioning and planning.	02
Unit II Effective Communication Skills: Importance of communication, Communication process, Elements of communication, Communication Types-verbal and non-verbal, objectives of communication. Business Communication, current English usage, debates, language games, situational dialogues, precise writing, essay writing, presentations.	06
Unit III Behavioral Skills: Psychological Tests: Aptitude and personality assessment, suggestions for improvement, **Team Skills:** Team building and leadership, evolution of groups into teams, group dynamics, emergence of leadership, intra-group dynamics, inter-group dynamics, conflict management, inter dependency, assessment of team-based projects, **Time**	08

Management: Pareto's Principle, Parkinson's Laws, Murphy's Laws, Law of Clutter, prioritization, goal setting, effective time management, **Interpersonal Skills:** Negotiations, listening skills, social skills, assertive skills, cross-cultural communications, **Leadership Skills:** Concepts of leadership, leadership styles, insights from great leaders.	
Unit IV Documentation: Report Writing-Formal report, study tour report, project report, Writing proposal-solicited proposals and unsolicited proposals.	03
Unit V Emotional Intelligence: Emotional Brain, Nature of emotional intelligence, emotional intelligence applied windows of opportunity, emotional literacy.	04
Unit VI Interview Skills: Importance of Interview Skills, Resume Building, Group discussion and personal interview, Psychometric Test, actual career planning.	03

Suggested Text Books:	
1.	Soft Skills, 2015, Career Development Centre, Green Pearl Publications.
Suggested Reference Books:	
1.	Seven Habits of Highly Effective Teens, Covey Sean, New York, Fireside Publishers, 1998.
2.	How to win Friends and Influence People, Carnegie Dale, New York: Simon & Schuster, 1998.
3.	I am ok, You are ok ,Thomas A Harris, New York-Harper and Row, 1972
4.	Emotional Intelligence, Daniel Goleman, Bantam Book, 2006
5.	Effective communication skill, MTD training & Ventus publishing ApS ISBN 978-87-7681-598-1.

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & IV**				
Course Title	:	**Chemistry II**			***Course Code*** :	CH221
Teaching Scheme (Hours)	:	Lecture	03 Hours/Week		***Total Credits*** :	03
		Tutorial	00 Hours/Week			
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2021
Pre-requisites *(If any)*	:	BS-11A2, BS-12A2 and CH211				
Course Domain	:	Basic Sciences				

Course Rationale: This course provides a systematic study of the theories, principles, and techniques of organic chemistry. Topics include nomenclature, structure, properties, reactions, and mechanisms of hydrocarbons, alkyl halides, alcohols, and ethers; further topics include isomerization, stereochemistry, and spectroscopy. Organic chemistry provides the student with the necessary background to understand the chemistry of carbon-containing compounds.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss basic concepts of Organic Chemistry.	1.	Recall to basic concepts of Organic Chemistry.
2.	Explain the basic mechanisms of organic reactions.	2.	Use those mechanisms in the preparation of organic compounds.
3.	Demonstrate the preparation of the essential organic compounds	3.	Perform preparation of essential organic compounds.
4.	Classify compounds based on preparation and properties.	4.	Manipulate preparations of heterocyclic compounds.
5.	Cite the details about dyes and dye intermediates.	5.	Practice preparation of soaps and dyes etc.
6.	Explain the processes for producing petrochemicals.	6.	Perceive processes for producing petrochemicals.

Curriculum Content	**Hours**
Unit I Unit Processes: Nitration: Nitrating agents, mechanism of aromatic nitration and industrial nitration of benzene to nitrobenzene by continuous processes. Oxidation: Oxidizing agents, mechanism of oxidation, manufacture of acetic acid by oxidation of acetaldehyde. Halogenations.	08
Unit II Organic Reactions: Types of reactions [addition, elimination and substitution reactions] Mechanism in brief and industrial applications of Friedel crafts reactions, Mannich reaction, Gattermann Koch reaction, Claisen rearrangement, Benzidine rearrangement, Cannizzaro reaction, Diels Alder reaction, aldol condensation, Coupling reaction – Mechanism of coupling.	10
Unit III Chemistry of Heterocyclic Compounds: Introduction, classification, Preparation, Physical & Chemical properties and Uses of Pyrrole, Furan, Furfural, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline.	09
Unit IV Dyes and Dye Intermediates: Witt's theory and modern theory of colors, chromophore- auxochrome theory, classification of dyes based upon structure & methods of application, synthesis and applications of Azo dyes – Congo red, Triphenyl methane dyes – malachite green, phenolphthalein, methyl orange, Fluorescence-Eosin dyes. **Soaps and**	09

detergents: Soaps and saponification, cleansing action of soaps, manufacture of soap by modern process, detergents, classification, manufacture of anionic detergents (D.B.B.S.)	
Unit V Drugs: Chemotherapy, synthesis of antibiotics-chloramphenicol, analgesics paracetamol, antimalarial drugs – Quinine, chloroquine and Antibacterial drugs sulfanilamide. Pesticides: Introduction, classification, synthesis, properties and uses of BHC, DDT	09
Unit VI Chemistry of Petroleum: Origin of crude, composition, refining of crude, cracking– catalytic cracking- batch process and continuous process, major petrochemicals like ethylene, propylene butadiene, benzene toluene, (industrial applications only).	07

Suggested Text Books:	
1.	R.T. Morrison and R.N. Boyd, 'Organic Chemistry', VI Edition Prentice Hall Inc USA.
2.	K.S. Tiwari, N.K. Vishnoi and S.N. Malhotra, 'A text book of Organic Chemistry', Second Edition, Vikas Publishing House Pvt. Ltd. (1998) New Delhi
Suggested Reference Books:	
1.	'Chemistry in Engineering and Technology', Vol.2, TMH Publishing Co Ltd., New Delhi, 1994.
2.	I L Finar, 'Organic Chemistry', Vol. I and II, ELBS.
3.	Bahl & Bahl, 'Advanced Organic Chemistry', S. Chand

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & IV**					
Course Title	:	**Chemical Engineering Thermodynamics-II**			***Course Code***	:	CH222
Teaching Scheme (Hours)	:	Lecture	03 Hours/Week		***Total Credits***	:	04
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision:	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS-11A2, BS-12A2 and CH211					
Course Domain	:	Program Core					

Course Rationale: This course introduces the basic thermodynamics concepts of multiphase equilibrium in pure and multi-component systems. Starting with ideal gas mixtures and ideal solutions, the concepts of bubble and dew points are introduced to. Subsequently, various levels of non-ideality and complexity are introduced: 1) activity coefficient models for non-ideal liquid mixtures, 2) fugacity calculations of gas and liquid phases from equations-of-state, 3) systems with chemical reactions.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Describe the solution thermodynamics and phase equilibrium.	1.	Estimate mixture properties from group contribution methods.
2.	Explain modified Raoult's law its use to evaluate VLE of non-ideal mixtures.	2.	Correlate experimental VLE data of pure component and non-ideal mixtures.
3.	Discuss procedure to generate VLE data, its consistency & use to calculate bubble and dew points.	3.	Apply phase equilibrium principles to calculate bubble and dew points of ideal mixtures and construct T-x- y and P-x- y diagrams.
4.	Describe how to find thermodynamic information for pure and real mixtures	4.	Apply activity coefficient models to calculate excess properties of liquids.
5.	Show how to calculate equilibrium conversion for homogeneous and heterogeneous reactions	5.	Calculate chemical equilibrium in non-ideal mixtures. Use thermo chemical data to determine the equilibrium constant for a chemical reaction at any given temperature
6.	State how to solve numerical problems underlying the course.	6.	Solve different numerical problems underlying the course.

Curriculum Content	**Hours**
Unit I Phase Equilibria I: Phase equilibrium criteria for pure substances, Application: Clapeyron equations, Partial molar properties, Gibbs-Duhem equations, Property changes of mixing, Determination of partial molar properties, Multicomponent phase equilibria	07
Unit II Phase Equilibria II: Fugacity: definition, Fugacity in vapor phase, Fugacity coefficients, Mixing of ideal gases	07
Unit III Fugacity & Activity Coefficients: Fugacity in liquid phase: Ideal Solutions (Lewis/Randall) and Henry's Law, Activity coefficients, Excess Gibbs energy, Models for binary activity coefficients: Margules, Van Laar, Wilson, NTRL	07
Unit IV Vapor-Liquid Equilibrium: Vapor-liquid equilibrium: Raoult's Law, Bubble-point and dew-point calculations, Nonideal liquids and azeotropes, Applications for flash and distillation process, Activity coefficients from VLE data, Solubility of gases in liquids, Liquid-liquid equilibrium, Vapor-liquid-liquid equilibrium, Solid-liquid and solid-solid	07

equilibrium, Colligative properties	
Unit V Chemical Reaction Equilibria: Equilibrium for single reaction, Equilibrium constants and their temperature dependence, Heterogeneous reaction, Multiple reactions, Gibbs' phase rule, Reaction equilibria via minimization of Gibbs energy.	07
Unit VI Numerical Problems: Numerical examples based on the theory underlying the course will be practiced.	04

Suggested Text Books:	
1.	Smith, van Ness, Abbott, 'Introduction to Chemical Engineering Thermodynamics', McGraw-Hill Companies, Inc., Series in Chemical Engineering, 7th edition.
Suggested Reference Books:	
1.	Perry's Chemical Engineers Handbook, 7th edition, McGraw, Hill, USA, 2000.
2.	B.G. Kyle, 'Chemical Process Thermodynamic', 2nd Edn., Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
3.	Stanley I. Sandler, 'Chemical, Biochemical and Engineering Thermodynamics', Wiley India Pvt. Ltd., 4th ed., 2007.

Class, Part & Semester	**:**	**Second Year B. Tech (Chemical Engineering), II & IV**					
Course Title	**:**	**Material Science & Technology**			***Course Code***	**:**	CH223
Teaching Scheme (Hours)	**:**	Lecture	03Hours/Week		***Total Credits***	**:**	03
		Tutorial	00Hours/Week				
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE =70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	BS-11A2 and BS-12A2					
Course Domain	**:**	Basic Sciences					

Course Rationale: The course is important both from a scientific perspective as well as for applications field. Materials are of the utmost importance for engineers (or other applied fields), especially for Chemical Engineers because usage of the appropriate materials is crucial when designing various systems.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Summarize need to know about properties of materials and their respective applications.	1.	Identify materials and describe their properties.
2.	Explain magnetic and electrical materials and their properties.	2.	Use Magnetic and electrical materials according to the requirement.
3.	Illustrate characterization and processing of materials.	3.	Recall to the processing and performance w. r. t. economic evaluation of material.
4.	Describe basics of stress, strain and their relationship.	4.	Solve mathematical equations related to elasticity using the concept of stress and strain.
5.	State the concept of torsion and transmission of power.	5.	Interpret the concept of torsion and apply the same at the time of material selection and design tasks.
6.	Discuss various design aspects and criteria of material selection.	6.	Use various criteria for material selection in process and equipment design and drawing.

Curriculum Content	**Hours**
Unit I Fundamentals of Material science, Structure of solids, Band theory of solids, Significance of structure property relationship; Imperfections in solids; Application of diffusion; Principles of solidification, Thermodynamics of solutions; Phase diagrams and phase transformations; Heat treatment; Ceramic materials, Classification, Crystal structure, properties, characterization and applications.	07
Unit II Electrical and magnetic materials Factors affecting the resistivity of conductors, properties of materials such as Ag, Cu, Al, Ni-chrome and Ca as dielectric characteristics, insulating materials such as mineral oil, PVC, Mica fibers, glass and asbestos, Magnetization, soft and hard magnetic materials such as a silicon iron, Alnico types alloys and ferrites.	07
Unit III Processing of materials Introduction to materials processing; Polymer processing, Compounding of plastics and rubber, Molding techniques, Calendaring, Thermoforming, casting, Sintering, Dip coating; Manufacturing process of fibers; Ceramic processing,	07

Pressing, CIP,HIP, Slurry processing, Slip casting, Pressure casting, Tape casting, Gel casting, Sol-gel processing, Thermal and plasma spraying, Thick and thin, film coatings, Metallic processing, Casting process, Solidification and volume shrinkage, Casting design and defects, Fundamentals of deformation processing, Hot and cold working, Metal removal process; Introduction to nontraditional machining; Metal joining process Welding, Brazing and soldering.	
Unit IV Concept of stress and strain Properties of Materials, Linear, lateral, shear and volumetric stresses, bearing stress; Elastic constants (E, G, K and J) and their relationship; Stress strain curves for Brittle and Ductile materials; Allowable Stresses and factor of safety; Uniaxial and Multiracial loading; Generalized Hooke's law. Axial force diagram; Equilibrium and Compatibility Equations; Stresses, strains and deformations in determinate and indeterminate, homogenous and composite bars, under concentrated loads and thermal effects, Principal Stresses, Mohr's circle of Stress.	07
Unit V Torsion of Circular Shaft and cylindrical and Spherical shells Torsion equation, strength and stiffness of solid and hollow circular shafts. Transmission of power. Thin Cylindrical and spherical shells under internal fluid pressure, Lami's theory, Design of thick cylindrical shell, Thick Spherical Shell.	06
Unit VI Material Selection and Design Aspect Design aspects, Material selection and design, Normalization of properties, Weighting factors, Materials Performance index; Design of Engineering structure, The atomic, Nano-scales to macroscopic levels; case studies, Modern metallic, Ceramic, polymeric and biomaterials devices and components.	05

Suggested Text Books:	
1.	R. Abbaschian, R.E. Reed-Hill, 'Physical Metallurgy Principles', 4th ed., Cengage Learning, 2009.
2.	T.A. Ostwald, 'Polymer Processing Fundamentals', Hanser Publications, 1998.
3.	S. Kalpakjian, S.R. Schmid, 'Manufacturing Engineering and Technology', 6th ed., Pearson, 2009.
Suggested Reference Books:	
1.	R.B. Gupta, 'Material science'. 2018.
2.	V.K. Manchanda, 'A Text Book of Material Science', 1996.
3.	V. Raghavan, 'Material Science and Engineering', PHI Learning Pvt. Ltd. New Delhi, 2015.
4.	Punmia B.C. 'Strength of Materials and Mechanics of Structure'- Vol. I- Standard Publications, Delhi, 1990.
5.	Ramamruthm, 'Strength of Materials', Dhanapatray& Sons, Delhi, 1999.

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & IV**					
Course Title	:	**Heat Transfer Operations**			***Course Code***	:	CH 224
Teaching Scheme (Hours)	:	Lecture	04 Hours/Week		***Total Credits***	:	05
		Tutorial	01 Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision:	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS11A2, CH211, CH212 and CH214					
Course Domain	:	Program Core					

Course Rationale: The main purpose to teach this subject is to study the basics of heat transfer. This subject provides knowledge regarding the basic modes and aspects of heat transfer process as well as it also provides an idea about various equipment used for heat transfer.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain three modes of heat transfer with further detailing of conduction heat transfer.	1.	Visualize the fundamentals modes of heat transfer, further apply basics of conduction to industrial situations.
2.	State and distinguish between natural and forced convection with emphasis on various equations governing the same.	2.	Memorize the difference between natural and forced examples with suitable examples.
3.	Detail radiation mode of heat transfer with elaboration of laws pertaining to the same.	3.	Identify examples of heat transfer and apply governing laws to solve the related problems.
4.	Discuss heat transfer with change of phase and explain their industrial relevance.	4.	Distinguish between heat transfer with and without change and perceive condensation and boiling operation w. r. t. heat transfer ideology.
5.	Distinguish between different types of evaporators and describe the procedure to select and assess the evaporators.	5.	Design and analyze heat transfer operations and equipment.
6.	Explain the designing and analyzing heat transfer equipment.	6.	Compare performances and select type of heat transfer equipment.

Curriculum Content	**Hours**
Unit I Conduction Heat Transfer: Introduction to three modes of heat transfer: Conduction convection & radiation. General laws of heat transfer. Conduction: Fourier's law, Thermal Conductivity- its variation with temperature and Pressure and its relationship with electrical conductivity. Heat transfer through composite walls and cylinders. Unsteady state heat transfer through some important shapes. Different types of insulating materials, general properties & application of insulators.	**10**
Unit II Natural and Forced Convection: Natural convection from vertical plates and horizontal cylinders. Forced convection: In laminar flow-Heat transfer in plate and tubes. In turbulent flow-Empirical equations for individual coefficients: inside tubes, outside tubes, outside bundle of tubes, flow past spheres. Significance of Prandtl number, Nusselt number, Grashof number, Graetz number and Peclet number etc. Correction for tube length. Corrections for heating and cooling the fluid. Various analogies between heat & momentum transfer.	**14**
Unit III Radiation: Radiation laws like Stefan Boltzmann's law, Kirchhoff's law, Wien's law, Plank's law etc. Black body, Grey body. Transmissivity, Absorptivity, Reflectivity, Emissivity of black bodies and gray bodies. Application of thermal radiation: Radiation	**07**

Transfer between surfaces. Radiation through semitransparent materials.	
Unit IV Heat Transfer with Phase Change: Boiling of liquids, Pool boiling curve, different types of pool boiling, Condensation of vapor, film wise and drop wise condensation, weighted LMTD & Overall Heat transfer Coefficient for de superheating & sub cooling.	**07**
Unit V Evaporation: Performance of tubular evaporator. Individual & overall Coefficients, Capacity & economy of evaporators. Boiling point elevation, Duhring's rule, Effect of liquid head & friction on pressure drop, Types of evaporators, Multiple effect evaporators. Vapor recompression, Thermal recompression & mechanical recompression.	**07**
Unit VI Heat Exchange Equipment: Double pipe heat exchangers. Individual and overall heat transfer coefficient, LMTD, Variable overall Heat transfer coefficient, fouling factors, Shell & tube heat exchangers, LMTD correction factors, Extended surface heat exchangers, Fin efficiency and fin effectiveness.	**07**

Suggested Text Books:	
1.	D. Q. Kern, 'Process Heat Transfer', McGraw Hill Publishing Company Ltd.
2.	McCabe W L, Smith J C, Harriott P, 'Unit Operations of Chemical Engineering', McGraw Hill.
3.	J. P. Holman, 'Heat Transfer', McGraw Hill Publishing Company Ltd.
Suggested Reference Books:	
1.	Richardson J.E. and Coulson, 'Chemical Engineering', Vol. 1 Pergamon Press.
2.	Don W. Green, Robert H. Perry, 'Perry's Chemical Engineer's Handbook', McGraw Hill.
3.	John H. Lienhard, 'A Heat Transfer Textbook', Phlogiston Press, Cambridge, Massachusetts.

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & IV**					
Course Title	:	**Mechanical Operations**			***Course Code***	:	CH225
Teaching Scheme (Hours)	:	Lecture	03 Hours/Week		***Total Credits***	:	03
		Tutorial	00 Hours/Week				
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS-11A2, BS-12A2, CH211					
Course Domain	:	Applied Engineering Sciences					

Course Rationale: This course covers all those unit operations that involve physically changing a material. This generally refers to change in size reduction or enlargement or shape, it is not limited to that. The contents also include separation of material on the basis of physical/mechanical properties like density, size, wet ability, etc. Mechanical operations may either be individual operations or may be a part of an entire process. Chemical engineers should have knowledge of mechanical operations as very often we do not have the raw material feed in a desirable form so is the course incorporated in this curriculum.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss importance of properties and handling of particulate solids.	1.	Relate the importance of properties and handling of particulate solids.
2.	Explain concept, terminologies and laws pertaining to size reduction.	2.	Solve size reduction related problems using crushing laws and screening of the particulate solids.
3.	Illustrate the sedimentation process; and mixing of solid, liquid etc.	3.	Perceive the processes of sedimentation, settling of solid particle in a liquid and mixing of solid, liquid material etc. & evaluate their performances.
4.	Classify filtration processes, techniques & show how to make related calculations.	4.	Recognize importance of filtration process, perceive different techniques & make related calculations.
5.	Describe gas cleaning process by using different techniques and show how to make related calculations.	5.	Recall to various gas cleaning techniques and demonstrate related calculations.
6.	State the concept of beneficiation processes & list out uses of the same.	6.	Identify different beneficiation processes and their uses in chemical industry.

Curriculum Content	**Hours**
Unit I Properties and Handling of Particulate Solids: Particle characterization, Particle size measuring technologies, Particle size distribution, Mean particle size, mixed particle sizes and shape. Properties of solid masses, Storage of solids (Bulk and Bin), Flow through Hoppers, Angle of repose and angle of friction, Introduction to conveying of solids.	07
Unit II Size Reduction and Screening: Mechanism of size reduction, Energy for size reduction, crushing laws, Methods of operating crushers, Classification of size reduction equipment, Types of crushing equipment, Factors affecting communition, Heat control methods in size reduction. Standard test screens, Standards of screen, Screen effectiveness, Comparison of ideal and actual screens, Industrial screening equipment.	07

Unit III Sedimentation and Mixing of Solids and Pastes: Basic principles, Flocculation, Thickeners, Batch sedimentation test, Design procedure for gravity sedimentation tanks. The degree of mixing, Rate of mixing, Criteria for mixer effectiveness, Solid-liquid mixing, mixing for paste and plastic masses, Solid-Solid mixing.	07
Unit IV Filtration: Classification of filtration, Types of filtrations, Pressure drop through filter cake, Filter medium resistance, cake resistance, Washing of cake, Filter media and selection, Compressible filter cakes, Preliminary treatment of slurries before filtration, Filtration equipment, Filter selection, Filter press, Vacuum filters, Centrifugal filtration and Filtration calculations.	07
Unit V Gas Cleaning: Introduction, Gas cleaning equipment, Gravity separators, Centrifugal separators, Momentum separators, Electrostatic precipitators, Liquid washing, Odour removal, Fabric filters, Impingement method and Miscellaneous methods, Agglomeration and Coal essence.	06
Unit VI Benefaction Process in Chemical Engineering: Froth flotation, Magnetic separators, Scrubbers, Jig classification, Heavy medium separation, Wilfley table, Gravity settling tank.	05

Suggested Text Books:	
1.	McCabe, W.L. Smith, J.C. Harriott, P. 'Unit Operations of Chemical Engineering' 5th ed. McGraw Hill International, Chemical and Petroleum Engineering Series, 1993.ISBN:0-07-112738-0.
2.	Narayanan, C.M., Bhattacharyya B.C.' 'Mechanical Operations for Chemical Engineers, Computer Aided Analysis 3rd ed., Khanna Publishers, 2011. ISBN: 8174090363.
3.	Coulson, J.M. Richardson, J.F. Backhurst, J.R. Harker, J.H. Coulson & Richardson's, 'Chemical Engineering, Vol 2,5th ed. Butterworth-Heinemann, Particle Technology and Separation Process',2002. ISBN: 0750644451.
Suggested Reference Books:	
1.	Foust A.G., 'Principles of Unit Operations', 2nd ed. John, Wiley & Sons, New York 1979.
2.	Sekhar G.C., 'Unit Operations in Chemical Engineering', Pearson education (Singapore) Ltd.
3.	Perry R.H. & Chilton C.H., 'Chemical Engineers Hand Book', 7th ed. McGraw hill.

Class, Part& Semester	**:**	**Second Year B. Tech (Chemical Engineering), II & IV**					
Course Title	**:**	**Chemistry II Laboratory**			***Course Code***	**:**	**CH221L**
Teaching Scheme (Hours)	**:**	Practical	002Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IPE/IOE = Nil	EPE = 50	Grand Total = 50	***Duration of EPE***	**:**	02 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	BS-11A2, BS-12A2 and CH211					
Course Domain	**:**	Basic Sciences					

Course Rationale: The course is to acquaint the students with practical knowledge of the basic phenomenon/concepts of chemistry, the student face during course of their study in the industry and engineering field. The students will be able to understand and explain scientifically the various chemistry related problems in the industry/engineering and develop experimental skills for building technical competence.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Describe the analysis, estimation and preparation of few organic compounds.	1.	Demonstrate the laboratory preparations of organic compounds
2.	Acquaint the students with the handling and analyzing chemicals.	2.	Formulate thought process for organic compounds analysis.
3.	Use the tools to be used to characterize organic compounds.	3.	Interpret the importance of simple approaches to characterize compounds before using sophisticated tools.
4.	Summarize simple techniques like boiling point, melting point etc. to identify compounds.	4.	Demonstrate the work in group and imitate Standard Procedures for practical work underlying the course.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	Analysis of simple organic compounds (minimum 2)
2.	Estimation of Phenol
3.	Estimation of Aniline
4.	Estimation of Acetone
5.	Estimation of Acetamide
6.	Estimation of Glucose.
7.	Estimation of aspirin (acetyl salicylic acid).
8.	Preparation of Methylene Blue.
9.	Preparation of Methyl Orange.
10.	Preparation of Phenolphthalein.
11.	Determination of saponification value of the given oil.
12.	Preparation of soap

Suggested Text Books/ Reference Books/Manual	
1.	Dr. Sudha Rani, 'Laboratory manual on Engineering Chemistry', Dhanpat Rai Publishing Company (P) Ltd, New Delhi.
2.	G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney. 'Vogel's Textbook of Quantitative Chemical Analysis' (Latest ed.)
3.	'Vogel's Textbook of Qualitative Chemical Analysis'.
4.	Srivastava T. N. & Kamboj P. C., 'Systematic Analytical Chemistry'.

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & IV**					
Course Title	:	**Heat Transfer Operations Laboratory**			***Course Code***	:	CH224L
Teaching Scheme (Hours)	:	Practical	02 Hours/Week		***Total Credits***	:	01
Evaluation Scheme (Marks)	:	IOE = 50	EPE =50	Grand Total = 100	***Duration of EPE***	:	02 Hrs.
Revision	:	Fourth			***Month***	:	June 2021
Pre-requisites *(If any)*	:	BS12B2, CH211, CH212 and CH214					
Course Domain	:	Program Core					

Course Rationale: This course provides fundamental and industrial knowledge about modes of heat transfer, like conduction, convection and radiation, and their application. The laboratory work consists of various equipment used to verify basis laws and study modes of heat transfer, Also it provides knowledge regarding various heat transfer process as well as it also provides an idea about various equipment used for heat transfer.

Course Objectives: The course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain fundamental modes of heat transfer operations through experimental set ups.	1.	Verify fundamentals laws of Heat transfer through practical work.
2.	Organize the hands-on training on important heat transfer devices and motivate them for team work	2.	Demonstrate various practical experiments related heat transfer operations.
3.	Expose and elaborate laboratory practices like a miniature process plant environment using steam and the other process utilities.	3.	Apply of heat transfer design principles and operate heat transfer devices.
4.	Help develop skills for safe handling of major heat transfer equipment/devices.	4.	Build foundation for process intensification and adapt to handle heat transfer operations.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	To understand conduction heat transfer.
2.	To understand conduction heat transfer through composite system.
3.	To study heat flow through a sphere and to estimate thermal conducting of powdered insulating material using the set up.
4.	To estimate thermal conductivity of liquid.
5.	To analyze problems involving steady state heat conduction in simple geometries with lagged material.
6.	To estimate the film heat transfer coefficient between the medium in which body is heated.
7.	To understand heat transfer during agitation and mixing.
8.	To understand fundamentals of convective heat transfer process and to evaluate heat transfer coefficients for natural convection.
9.	To understand fundamentals of convective heat transfer process and to evaluate heat transfer coefficients for forced convection.

10.	To understand radiation heat transfer through verification of the basic law of radiation.
11.	To understand radiation heat transfer and to evaluate emissivity of a material.
12.	Analyze heat exchanger performance of different types of heat exchangers.
13.	To study the basic operation of evaporation in the context of heat transfer.
Suggested Text Books/ Reference Books/Manual	
1.	D. Q. Kern, 'Process Heat Transfer', McGraw-Hill, 1st Edition.
2.	Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow

Class, Part & Semester	**:**	**Second Year B. Tech (Chemical Engineering), Part II & IV**					
Course Title	**:**	**Mechanical Operations Laboratory**			***Course Code***	**:**	CH225L
Teaching Scheme (Hours)	**:**	Practical	02 Hours/Week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IPE=Nil	EOE=50	Grand Total =50	***Duration of EOE***	**:**	02 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	BS12B3 and CH214					
Course Domain	**:**	Applied Engineering Sciences					

Course Rationale: The course covers the hands-on experience of working by conducting experiments on most of the basic unit operations under the category of mechanical operations such as ball mill, jaw crusher, cyclone separator, filtration equipment, sieve analysis, hydraulic classifier, sedimentation etc.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Demonstrate operations of types of crushers for size reduction of feed.	1.	Analyze the sizes of particulate material after having size reduced.
2.	Explain and demonstrate the process of sedimentation and mixing of fluid.	2.	Select and classify the appropriate operations for separation of solid and fluids.
3.	Demonstrate working of different filtration techniques & various gas cleaning equipment.	3.	Handle and demonstrate the filtration equipment with enhanced technical skills.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No.	***List of Experiments***
1.	To determine collection efficiency of Cyclone separator for various particle sizes and pressure drops.
2.	To determine the reduction ratio and critical speed of the ball mill.
3.	To find the particle size distribution of a mixture of particles by sieve analysis.
4.	To determine the screen efficiency.
5.	To study and determine crushing efficiency, reduction ratio of jaw crusher.
6.	To study and determine crushing efficiency, reduction ratio of roll crusher.
7.	To study and determine crushing efficiency, reduction ratio of hammer mill.
8.	To study the size reduction and sieve analysis of rod mill.
9.	To determine area of batch thickener by conducting batch sedimentation test.
10.	To study the working of mixer and determine its mixing index.
11.	To determine the specific cake resistance and the filter medium resistance for the filtration of the calcium carbonate slurry using the vacuum leaf filter.

12.	To determine the characteristic of plate and frame filter press at a constant pressure and to calculate the filter cake resistance ‘a’ and the filter cake resistance ‘Rm’
13.	Study of fluid mixing
Suggested Text Books/ Reference Books/Manual	
1.	McCabe, W.L. Smith, J.C. Harriott, P., ‘Unit Operations of Chemical Engineering’ 5th ed. McGraw Hill International, Chemical and Petroleum Engineering Series, 1993.ISBN:0-07-112738-0
2.	Foust, A. S. Wenzel, L. A. Clump, C.W. Maus, L. Andersen, B., ‘Principles of Unit Operations’, 2nd ed. Wiley India Pvt Ltd, 2008. ISBN: 9788126518296, 8126518294
3.	Sekhar, G.C., ‘Unit Operations in Chemical Engineering’, 1st ed. Pearson education (Singapore) Pte Ltd, 2007. ISBN: 9788129707987, 8129707985

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), II & IV**				
Course Title	:	**Applied Electrical and Electronics Measurement: Theory**		***Course Code***	:	CH 226L
Teaching Scheme (Hours)	:	Lecture	02 Hours/Week	***Total Credits***	:	03
		Practical	02 Hours/Week			
Evaluation Scheme (Marks)	:	Students will be evaluated only for their laboratory work as an IOE.		***Duration of* IOE**	:	NA
Revision	:	Fourth		***Month***	:	June 2021
Pre-requisites *(If any)*	:	ES11A3, ES11A6, ES12A3 and ES12A6				
Course Domain	:	Applied Engineering Sciences				

Course Rationale: The lab will emphasize details of electrical and electronic circuit theory or the physical basis of device function and will aim to provide students with the know-how required to use modern electronic instrumentation.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Illustrate how to analyze and design of armature and field system for DC motor.	1.	Perceive working principle, performance, control and applications of AC, DC Machines and transformer.
2.	Discuss speed control methods and starters for DC and AC machine.	2.	Analyze and solve AC, DC machine and Transformer related problems.
3.	Describe fundamental concepts for operation of three phase transformer and Induction motor.	3.	Identify compare various sensors and transducers and conclude for the best selection for the desired applications
4.	Explain different power factor correction techniques with their practical importance.	4.	Judge about failure of components and inform the expert to correct the fault of the same.
5.	Classify the sensors and transducers and their use in the industry.	5.	Recall to operating principles of common electrical and electronic measuring instruments and their application in Chemical Industry.

Curriculum Content	**Hours**
Unit I DC Machines: DC Motor: Working principle, construction, voltage equation, condition for maximum power, characteristics of dc motor, torque developed, starting, speed control methods and motor ratings.	05
Unit II AC Machines: Transformer - Construction, working principle and application of three phase transformer Induction Motor-Working Principles of synchronous and induction motors, their characteristics and starting methods, motor ratings. Induction motor as generalized transformer, Electrical Tariff and Power factor improvement.	06
Unit III Introduction to Measurements: Measurement, purpose of measurement, experimental data and errors: measurement recording and reporting, graphical representation of data, precision and accuracy, resolution and sensitivity, errors in measurement, statistical evolution of measurement data and errors. Analog and digital meters**.**	05
Unit IV Transducers and Display Devices: Transducers Definition Construction working principle of - pressure, temperature, level, humidity, flow measurement transducers and its selection. LED, LCD display, strip-chart recorder, X-Y recorder, 3-D printers.	05

Unit V Microcontrollers: Basics of microcontrollers, Microcontroller based pH measurement system, Data acquisition system, Temperature indicator, Process controllers.	03
Unit VI Review of the Course with Relevance to Chemical Industry	02

Suggested Text Books:	
1.	Text of Electrical Technology; Vol -2; B. L. Theraja, and A. K. Theraja; S. Chand Publication
2.	Electrical machines BY Ashfaq Hussain; Dhanpatrai and Co.
3.	David A. Bell, Electronic Instrumentation and Measurements, Second Edition, Prentice Hall, New Jersy, 1994.
4.	Stanley Wolf, Richard Em. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Prentice-Hall, 1990.
Suggested Reference Books:	
1.	J. B. Gupta ,'Principles of Electrical power systems'.
2.	P S Bhimra,'Generalized theory of rotating machines'
3.	A. K. Sawhney, 'A course in Electrical and Electronic Measurements and Instrumentation', Dhanpat Rai & Sons.

Class, Part & Semester	**:**	**Second Year B. Tech (Chemical Engineering), Part II & IV**				
Course Title	**:**	**Applied Electrical and Electronics Measurement: Laboratory**			***Course Code*** **:**	CH226 L
Teaching Scheme (Hours)	**:**	Practical	02 Hours/Week		***Total Credits*** **:**	Nil
Evaluation Scheme (Marks)	**:**	CIE = Nil SEE = Nil	IPE = 00 IOE = 50	Grand Total =50	***Duration of IOE*** **:**	02 Hrs.
Revision	**:**	Fourth			***Month*** **:**	June 2021
Pre-requisites *(If any)*	**:**	BS-11A3 and ES-11A6				
Course Domain	**:**	Applied Engineering Sciences				

Course Rationale: The lab will emphasize details of electrical and electronic circuit theory or the physical basis of device function and will aim to provide students with the know-how required to use modern electronic instrumentation.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Illustrate how to analyze and design of armature and transducers.	1.	Perceive working principle, performance, control and applications of AC, DC Machines and transducers.
2.	Discuss speed control methods and starters for DC and AC machine.	2.	Analyze and solve AC, DC machine and Transformer related problems.
3.	Describe fundamental concepts for operation of three phase transformer and Induction motor.	3.	Identify compare various sensors and transducers and conclude for the best selection for the desired applications.
4.	Illustrate block diagrams of various power plants.	4.	Identify key features of power plants.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr. No	**List of Experiments**
1.	Study of Break load test on DC motor
2.	To perform Open Circuit and Short circuit Test on a transformer and find its efficiency and regulation.
3.	Speed control of DC Shunt Motor using a) Armature control and b) field control methods
4.	To obtain Speed-Torque characteristics of DC Series Motor
5.	To obtain Speed-Torque characteristics of DC Shunt Motor
6.	To study different starters of D. C. motor
7.	To study different starters of three phase induction motor
8.	To study various power factor improvement methods

9.	To study the block diagram of various power plants
10.	Active and reactive power measurement by using two wattmeter methods
11.	Study of Electronic Components and characteristics
12.	Study of electronics measuring instruments
Suggested Text Books/ Reference Books/Manual	
20.	Institute's Laboratory Course Manual and equipment wise Standard Operating Procedure to follow

<table>
<tr><td>Class, Part & Semester</td><td>:</td><td colspan="5">Second Year B. Tech (Chemical Engineering), II, IV</td></tr>
<tr><td>Course Title</td><td>:</td><td colspan="3">Mini Project</td><td>Course Code</td><td>:</td><td>CH226L</td></tr>
<tr><td rowspan="2">Teaching Scheme (Hours)</td><td rowspan="2">:</td><td>Lecture</td><td colspan="2">00 Hours/Week</td><td rowspan="2">Total Credits</td><td rowspan="2">:</td><td rowspan="2">01</td></tr>
<tr><td>Tutorial</td><td colspan="2">01 Hours/Week</td></tr>
<tr><td>Evaluation Scheme (Marks)</td><td>:</td><td>IOE =50</td><td>EOE = Nil</td><td>Grand Total =50</td><td>Duration of IOE</td><td>:</td><td>03 Hrs.</td></tr>
<tr><td>Revision</td><td>:</td><td colspan="3">Fourth</td><td>Month</td><td>:</td><td>June 2021</td></tr>
<tr><td>Pre-requisites (If any)</td><td>:</td><td colspan="6">Thorough revision of all the courses studied till Semester III with a vigor to undertake small survey type of project work.</td></tr>
<tr><td>Course Domain</td><td>:</td><td colspan="6">Projects</td></tr>
<tr><td colspan="8">Course Rationale: Through this course, students are allowed to express feelings and communicate ideas and thoughts. Such a course provides opportunities for expansion of knowledge, skills and broader learning experience.</td></tr>
<tr><td colspan="4">Course Objectives: The Course Teacher will</td><td colspan="4">Course Outcomes: Students will be able to</td></tr>
<tr><td>1.</td><td colspan="3">Plan for various activities of the project and motivate the students for topic selection.</td><td>1.</td><td colspan="3">Develop the ability to choose the problem and formulate it.</td></tr>
<tr><td>2.</td><td colspan="3">Promote self-study, critical thinking and independent research ability.</td><td>2.</td><td colspan="3">Apply their fundamental knowledge according to their competency to solve project related engineering problems.</td></tr>
<tr><td>3.</td><td colspan="3">State the importance of working in a team.</td><td>3.</td><td colspan="3">Develop their leadership quality</td></tr>
<tr><td>4.</td><td colspan="3">Discuss Research Methodology for its use in the project work execution.</td><td>4.</td><td colspan="3">Achieve the Mini Project's goals.</td></tr>
<tr><td>5.</td><td colspan="3">Illustrate on components of project report writing.</td><td>5.</td><td colspan="3">Prepare a technical report of the Mini Project.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Curriculum Content</td></tr>
<tr><td colspan="8">The students either individually or in a group of maximum 2 members will undertake a mini project on a particular topic under the guidance of an internal course Teacher. Prior to the topic selection, the course in charge will guide them about searching topic. The work progress will be monitored from time to time in batch wise tutorials conducted during the semester. A 15 to 20-pages report is to be written upon completion of the activity. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered. The Department will provide a specific format for report writing. The assessment of the mini project work will be based on the: 1. Attendance to the tutorials 2. Physical Demonstration of their work 3. Seminar delivery based on the work carried out and 4. Mini Project reports submitted.</td></tr>
</table>

Class, Part & Semester	:	**Second Year B. Tech (Chemical Engineering), Part II & IV**				
Course Title	:	**Environmental Studies**			***Course Code*** :	HS221
Teaching Scheme (Hours)	:	Lecture	02 Hour/Week		***Total Credits*** :	Nil
		Tutorial	00 Hours/Week			
Evaluation Scheme (Marks)	:	CIE = 00 SEE = 70	IPE=30 Project	Grand Total =100	***Duration of SEE*** :	3 Hrs. At the year end
Revision	:	Fourth			***Month*** :	June 2021
Pre-requisites *(If any)*	:	HS211				
Course Domain	:	Language and Arts				

Course Rationale: The Course is all about learning the way we should live and how we can develop sustainable strategies to protect the environment. It helps individuals to develop an understanding of living and physical environment and how to resolve challenging environmental issues affecting nature.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the types of environmental pollution.	1.	Identify the pollutants and respond to the pollution problem
2	Make the students recognize social issues and the environment connectivity with the same.	2.	Acquire knowledge of ecological threats and choose for sustainable developments.
3.	Discuss various environmental Protection Acts reveal the students the importance of the same.	3.	Anticipate all these laws and follow the same for the care of the environment.
4.	Explain the students to adapt to various environmental technologies.	4.	Apply their knowledge to implement pollution prevention measure through some practical work.

Curriculum Content	**Hours**
Unit V Environmental Pollution: Definition: Causes, effects and control measures of: a) Air pollution, b) Water pollution, c) Soil pollution, d) Marine pollution, e) Noise pollution, f) Thermal pollution, g) Nuclear hazards Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies Disaster management: Floods, earthquake, cyclone and landslides. Tsunami	06
Unit VI Social Issues and the Environment: From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns; Environmental ethics: Issue and possible solutions; Climate change, Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Wasteland reclamation; Consumerism and waste products.	08
Unit VII Environmental Protection: Environment Protection Act.; Air (Prevention and Control of Pollution) Act.; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Population Growth and Human Health, Human Rights; Field	06

Work-Visit to a local area to document environmental assets river/forest/grassland/hill/mountain or Visit to a local polluted site urban/rural/Industrial/Agricultural or Study of common plants, insects, birds or Study of simple ecosystems-ponds, river, hill slopes, etc.	
Unit VIII Project / Field work:	10

Suggested Text Books:	
1.	Agarwal, K. C. 2001, Environmental Biology, Nidi Publ. Ltd., Bikaner.
2.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 380013, India.
3.	Brunner R. C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.
Suggested Reference Books:	
1.	Clark R. S., Marine Pollution, Clanderson Press Oxford (TB) Pg No. 6
2.	Cunningham, W. P. Cooper, T. H. Gorhani, E. & Hepworth, M. T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p.
3.	De A. K., Environmental Chemistry, Wiley Eastern Ltd.
4.	Down to Earth, Centre for Science and Environment (R).
5.	Gleick, H., 1993, Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press 473p.
6.	Hawkins R. e., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R).
7.	Heywood, V. H. & Watson, R. T. 1995, Global Biodiversity Assessment, Cambridge Univ. Press 1140p.
8.	Jadhav, H. & Bhosale, V. M. 1995, Environmental Protection and Laws, Himalaya Pub. House, Delhi, 284p.
9.	Mckinney, M. L. & Schocl. R. M. 1996, Environmental Science Systems & Solutions, Web enhanced edition.
10.	Mhskar A. K., Matter Hazardous, Techno-Science Publications (TB).
11.	Miller T. G. Jr., Environmental Science, Wadsworth Publishing Co. (TB).
12.	Odum, E. P. 1971, Fundamentals of Ecology, W. B. Saunders Co. USA, 574p.
13.	Rao M. N. & Datta, A. K. 1987, Waste Water Treatment, Oxford & IBH Publ. Co. Pvt. Ltd.,
14.	Sharma B. K., 2001, Environmental Chemistry, Goel Publ. House, Meerut.
15.	Survey of the Environment, The Hindu (M).
16.	Townsend C., Harper, J. and Michael Begon, Essentials of Ecology, Blackwell Science (TB).
17.	Trivedi R. K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media (R).
18.	Trivedi R. K. and P. K. Goel, Introduction to air pollution Techno-Science Publications (TB).
19.	Wagner K. D., 1998, Environmental Management, W. B. Saunders Co. Philadelphia, USA.

Class, Part & Semester	**:**	**Second Year B. Tech (Chemical Engineering), Part II, & IV**			
Course Title	**:**	**Introduction to Performing Arts**	***Course Code***	**:**	HS222
Teaching Scheme (Hours)	**:**	2 Hours /Week= 2 x13= 26 hours	***Total Credits***	**:**	Nil
Evaluation Scheme (Marks)	**:**	Assignments 50 Viva voce 25 Written Test 25 Grand Total 100	***Duration of SEE***	**:**	NA
Revision	**:**	Fourth	***Month***	**:**	June 2021
Pre-requisites *(If any)*	**:**	No pre-requisite as such is needed however students' involvement and interest in the classroom will make it more lively activity.			
Course Domain	**:**	Humanities and Arts			

Course Rationale: Performing arts are an important part of our lives, our communication, and our self-expression. These art forms are categorized as such because, how we embody the idea of practice to performance; The process of experiencing, studying, watching, or performing a piece of music, script, or choreography. So, introducing the learner to such arts will make him/her an all-round personality.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	State about various performing arts and explain the importance of the same.	1.	Identify the types of performing arts and their differences with importance.
2.	Elucidate about drama, Natya-shastra etc.	2.	Acquire knowledge about drama, Natya-shastra, street play etc.
3.	Explain types of dances, will reveal about theaters.	3.	Demonstrate dance skills and organize about theater activities.
4.	Demonstrate about Rag and Taal.	4.	Receive and respond to the Rag and Taal.
5.	List Gharana system and classify Indian musical instruments.	5.	Identify Gharana and instruments of their choice and interest for practice
6.	Summarize contribution of great musicians and outline about music concerts	6.	Recognize contribution of great musicians and display performances for a music concert.

Curriculum Content	**Hours**
Unit I: Introduction to Music, Dance & Drama, History of Indian Music, Various Forms of Vocal Music.	04
Unit II: History and introduction of Drama, Bharat Muni Natya Shastra, street play, Sanskrit Natya, Marathi Sangit Rangbhumi.	04
Unit III: Dance, its type, Greek and Roman theatres.	04
Unit IV: Concept of Raga, Concept of Taal.	04
Unit V: Notation System, Study of Gharana system in Music, Classification of Indian Instruments, Instrumental Music.	05
Unit VI: Contribution of Great Musicians, Appreciation of Music. Performance of a Music Concert.	05

Suggested Reference Books:

1. Vasant, Sangeet Karyalaya. Sangeet Visharad. Hatras Prakashan.
2. Bidkar, Suchita. (2015). Sangeetshastra Vidnyan Bhag 1, Sanskar Prakashan.

3.	Bidkar, Suchita. (2015). Sangeetshastra Vidnyan Bhag 2, Sanskar Prakashan.
4.	Mainkar, Sudhir. Sangeet Kala Aani Shikshan. Sanskar Prakashan.
5.	Chandavarkar, Bhaskar. (2011). Vadyavedh. 2nd Edition.SanskarPrakashan.
6.	Mulgaonkar, Arvind. (2015).Tabla. Popular Prakashan.
7.	Chris Hogget. (1977). Stage Crafts. St Martins Pr.
8.	Sarabhai, Mrinalini. Understanding of Bharat Natyam.
9.	Borysenko, Joan. (2007). Minding the body and mending the mind. Bantam.
10.	Subbanna, V.K., Ragadalli Antrang.

Equivalence of Second Year B. Tech (Chemical Engineering) Semester III and IV

The above syllabus structure is a revised version of the Second Year B. Tech (Chemical Technology) Program being conducted by Shivaji University at its Technology Department. This syllabus is to be implemented from June 2021, (Academic year 2021-22).

The Equivalence for the Courses of Chemical Technology at Second Year B Tech Semester III and IV pre-revised Program under the faculty of Science and Technology is as follows. One major change is in the name of the Program as B. Tech (Chemical Engineering) at the place of B. Tech (Chemical Technology).

Second Year B. Tech Semester III (Chemical Engineering)

Sr. No	Second Year B. Tech (Chemical Technology) Semester III Pre-revised syllabus	Second Year B. Tech (Chemical Engineering) Semester III Revised syllabus	Remark
1.	Chemistry-I	Chemistry-I	Contents are revised
2.	Chemical Engineering Thermodynamics-I	Chemical Engineering Thermodynamics-I	Contents are revised
3.	Engineering Mathematics-III	Engineering Mathematics-III	Contents are revised
4.	Material Science & Technology	Chemical Process Calculations	Shifted from Semester IV with the content revision.
5.	Fluid Flow Operations	Fluid Flow Operations	Contents are revised
6.	Computer Programming for Chemical Engineers	Computer Programming for Chemical Engineers	Contents are revised
7.	Chemistry- I Laboratory	Chemistry- I Laboratory	Contents are revised
8.	Analytical Chemistry Laboratory	Analytical Chemistry Laboratory	Contents are revised
9.	Fluid Flow Operations Laboratory	Fluid Flow Operations Laboratory	Contents are revised
10.	Computer Programming for Chemical Engineers Laboratory	Computer Programming for Chemical Engineers Laboratory	Contents are revised
11.	Environmental Studies	Environmental Studies	Contents are revised
12.	Soft Skills Development	Soft Skills Development	Contents are revised
	Previous Evaluation Scheme	**New Evaluation Scheme**	**Remark**
13.	CIE= 50 (UT I 20 + UT II 20+ Assignments 10), & SEE=50	CIE= 30 (Mid Sem Test 20 + Assignments 10), & SEE=70	Proportion for CIE & SEE is changed with increase in SEE component from 50 % to 70%.

Second Year B. Tech Semester IV (Chemical Engineering)

Sr. No	Second Year B. Tech (Chemical Technology) Semester IV Pre-revised syllabus	Second Year B. Tech (Chemical Engineering) Semester IV Revised syllabus	Remark
1.	Chemistry-II	Chemistry-II	Contents are revised
2.	Chemical Engineering Thermodynamics-II	Chemical Engineering Thermodynamics-II	Contents are revised
3.	Chemical Process Calculations	Material Science & Technology	Shifted from Semester III with the content revision
4.	Heat Transfer Operations	Heat Transfer Operations	Contents are revised
5.	Chemistry-II Laboratory	Chemistry-II Laboratory	Contents are revised
6.	Heat Transfer Operations Laboratory	Heat Transfer Operations Laboratory	Contents are revised
7.	Introduction to Performing Arts	Introduction to Performing Arts	Contents are revised
8.	Mechanical Operations	Mechanical Operations	Contents are revised
9.	Mechanical Operations Laboratory	Mechanical Operations Laboratory	
10.	Applied Electrical & Electronics Laboratory	Applied Electrical & Electronics Theory, Laboratory	Title is bit modified, Contents are revised
11.	-	Mini Project	Newly introduced
	Previous Evaluation Scheme	**New Evaluation Scheme**	**Remark**
12.	CIE= 50(UT I 20 + UT II 20 + Assignments 10), & SEE=50	CIE=30 (Mid Sem Test 20 + Assignments 10), & SEE=70	Proportion for CIE & SEE is changed with increase in SEE component from 50 % to 70%.

Audit courses have been assigned no any credits. But these are the mandatory courses. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. The grade will be based on conversion of marks obtained out of 50. Obtaining passing grade in these audit courses is an essential condition.