Department of Chemical Engineering

Revised Syllabus

of

Second Year

Chemical Engineering

Shri Guru Gobind Singhji Institute of Engineering &Technology,Vishnupuri-Nanded

Year-2019-20

SGGS INSTITUTE OF ENGINEERING & TECHNOLOGY, NANDED

(An Autonomous Institute of Government of Maharashtra)

S.Y. B.Tech. (Chemical Engineering) Curriculum Structure: Academic Year: 2019-2020 onwards

1) Program Education Objectives (PEOs):

1. A fundamental understanding of the basic and engineering sciences and develop computational and analytical skills required for Chemical Engineering.
2. This program will enable students to provide engineering designs that are based on sound principles considering functionality, aesthetics, safety, cost effectiveness and sustainability.
3. Graduates will be competent enough for higher studies, entrepreneurship/start-ups and administrative services in India as well as abroad.
4. To inculcate in the students professional and managerial skills, communication skills and the life-long learning attitude.

2) Program outcomes (POs):

Engineering Graduates will be able to:

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

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

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

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

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

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

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

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

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

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

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

l. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

3) **Table of Correlation of PEOs and POs as below:**

(Correlation Matrix (Correlation between the PEOs and the POs)

PO/PSO ➡ ⬇ PEO	a	b	c	d	e	f	g	h	i	J	k	l
PEO-1	3	3	3	3	3	2	1	1	1	1	1	3
PEO2	2	3	3	3	3	2	3	2	1	1	3	3
PEO3	2	1	1	1	2	3	2	2	3	2	2	2
PEO4	1	1	1	1	2	2	2	2	3	3	3	3

Note: Grading 1-Low ,2-Middle ,3-High

4) Structure of curriculum:

Semester I						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits Th**	**Pr**
BSC271	Mathematics-III: Transform Calculus and Differential Equations	3	--	--	3	--
BSC262	Organic Chemistry	3	--	2	3	1
ESC286	Applied Physical Chemistry	3	--	2	3	1
PCC-CH201	Chemical Process Calculations	3	1	--	4	--
PCC-CH202	Fluid Mechanics	3	--	2	3	1
PCC-CH203	Chemical Engineering Thermodynamics - I	3	--	--	3	--
HMC278	Human Values and Professional Ethics	2	--	--	2	--
BSC261	Mathematical Foundation for Engineering*	2	--	--	Audit	
	Total	**22**	**1**	**6**	**24**	
Semester II						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits Th**	**Pr**
BSC274	Mathematics-IV: Statistical and Numerical Methods	3	--	--	3	--
ESC287	Fundamentals of Electronics	2	--	--	2	--
PCC-CH204	Heat Transfer	3	--	2	3	1
PCC-CH205	Chemical Engineering Thermodynamics - II	3	--	--	3	--
PCC-CH206	Mass Transfer- I	3	--	2	3	1
PCC-CH207	Mechanical Operations	3	--	2	3	1
MAC277	Indian Constitution	2	--	--	Audit	
	Total	**19**	**--**	**6**	**20**	

L – No. of Lecture Hours/week, T – No. of Tutorial Hours/week, P – No. of Practical Hours/week

* This Audit course is only for Direct Second Year students and a MANDATORY course.

Examination scheme having: 10 + 30 +10 + 50= 100 marks pattern

10 + 10 marks: Internal continuous evaluation prior and after mid-term examination

30 marks : Mid-term evaluation

50 marks: End term evaluation

5) Syllabus of course:

Semester I

i) Title of course: **Mathematics-III: Transform Calculus and Differential Equations (BSC271, 03-Credit) (L-3,T-0,P-0)**

ii) Course Outcomes:

On successful completion of this course students will be able to

1. Develop the skills of Laplace transforms, Fourier series and Fourier transforms and their inverses.
2. Develop the skills of solving partial differential equations
3. Solve ODE's and PDE's using the properties of Laplace transform, Fourier series and Fourier transforms.
4. Determine solutions of PDE for vibrating string and heat conduction.
5. Evaluate line integrals, surface integrals, and volume integrals and convert line integrals into area integrals and surface integrals into volume integrals using integral theorems

iii) Course objectives:

1. To understand the concepts of Laplace transforms, Fourier Series, Fourier transforms
2. To apply Laplace transforms for solving ordinary differential equations
3. Define and compute the line integral, surface integral, volume integral using Green's theorem, Stoke's theorem and the divergence theorem.
4. To understand the methods of solving partial differential equations such as wave equation, heat equation and Laplace equation.

iv) Articulation Matrix:

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3										2
CO2	3	3	1	2								2
CO3	3	3	1	2								2
CO4	3	3	1	2								2
CO5	3	3	2	2								2

v) Course Content:

Unit 1: Laplace Transforms (10 hours)

Laplace transforms, inverse Laplace transforms, Properties of Laplace transforms, Laplace transforms of unit step function, impulse function, Convolution theorem; Applications of Laplace transforms - solving certain initial value problems.

Unit 2: Fourier Series (07 hours)

Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions.

Unit 3: Fourier Transforms (10 hours)

Fourier Integrals, Fourier transforms-sine, cosine transforms and inverse transforms - simple illustrations

Unit 4: Vector Calculus (10 hours)

Line integrals, surface integrals, Integral Theorems: Greens theorem, the divergence theorem of Gauss and Stoke's theorem

Unit 5: Partial Differential Equations (08 hours)

Method of Separation of variables for solving partial differential equations, first and second order one dimensional wave equation, heat equation and two dimensional Laplace equation.

Reference/Text books:

1. 1. Erwin Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons, 2015.
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Fifth Edition,Narosa Publishing House, 2016.
3. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, Inc. Mineola New York.

i) Title of course: Organic Chemistry (BSC262, 4-Credit)
(L-3,T-0, P-2)

ii) Outcomes:

1. Able to know basic concepts of organic reaction like oxidation, amination, alkylation, nitration, polymerization.
2. Able to understand its application to chemical engineering.
3. Able to understand mechanism of organic reactions
4. Able to apply and analyse the importance of industrial organic manufacturing.

iii) Objectives:

1. The objective of this subject is to expose students to understand the basic organic reaction like oxidation, amination, alkylation, nitration, polymerization and its application to chemical engineering.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	1	1	3	2	1	3	1	1	1	1	2
CO2	3	2	2	2	2	1	3	1	1	1	1	2
CO3	3	3	3	2	1	2	2	1	1	1	1	2
CO4	3	3	3	2	1	2	2	1	1	1	1	2

v) Course Content:

1. **Oxidation** : Introduction, definition, types of oxidation, oxidizing agents and their properties viz. permanganate, dichromate, sodium chlorite, chlorine dioxide, peroxides like PbO_2, MnO_2, H_2O_2 oxidation reactions, liquid and vapor phase oxidation, kinetics and thermochemistry of such reactions).
2. **Amination by Amminolysis:** General introduction including aminating agents, their properties and survey of aminating reaction, physical and chemical factors affecting these processes, catalysts used in various amination and ammonolysis reactions and their brief kinetic and thermodynamic study. Amination by reduction: General Introduction, definition, chemical reactions in iron and acid (Bechamp) other metals and acid reduction, metal and alkali reduction, sulfide reduction.
3. **Alkylation:** General Introduction, alkylating agents, Factors affecting alkylation: Catalyst, Concentration, Pressure, Temperature, Mechanism, Effect of alkylation.
4. **Nitration:** Introduction, nitrating agents, aromatic nitration, thermal properties, and process equipment nitrators.
5. **Halogenation:** Introduction, kinetics, and thermodynamics of such reactions Manufacturing processes for selected industrially important organic chemicals, design and construction of equipment for halogenation, apparatus for photo-chlorinator.
6. **Polymerization:** Introduction to Polymerization, polymerization processes, polymerization techniques, copolymerization, manufacturing processes for various industrially important polymers.

Reference/Text books:

1. Jagdamba Singh and LDS Yadav; Advanced Organic Chemistry Vol I &II; PragatiPrakashan.
2. Morrison and Byod, Organic Chemistry, 6th edition; Prentice Hall, Inc
3. Groggins P. H.; Units Processes In Organic Synthesis, Tata McGraw Hills Book Co.
4. F. A. Cotton, G. Wilkinson.; Advanced organic chemistry, Interscience Publishers, 1967.

Lab Work:

1) Determination of Acid value of oil. 2) Determination of saponification value of given oil.
3) Identification of organic compounds (at least 6).
4) Estimation of glucose in given solution.
5) Preparation of acetanilide from aniline.
6) Organic Preparations and purification through activated charcoal treatment/ crystallization (Single/ two-step) of the following; Acetanilide, p-Nitro-Acetanilide, p-Bromo-Acetanilide, Aspirin, m- Dinitrobenzene, Oxalic Acid.
7) Esterification reaction. Sulfonation reactions.
8) Preparation of Asprine (acetyl salicylic acid)

i) Title of course: **Applied Physical Chemistry (ESC286,4-Credit)**
(L-3,T-0, P-2)

ii) Outcomes:

1. Basic concepts of different physical processes become clear.
2. Understand the determination of order of reaction.
3. Understand the application of Physical Chemistry in Chemical engineering.
4. Analyse volumetric analysis of given compounds

iii) Objectives:

1. Information of process such as Adsorption, Conductivity and their application.
2. Basic concepts of Physical process become clean.
3. Get idea to determine order of chemical reaction.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	2	2	2	1	1	2	1	1	1	1	2
CO2	3	2	2	3	1	1	1	1	1	1	1	1
CO3	2	2	2	2	1	1	1	1	1	1	1	2
CO4	3	3	3	2	1	1	2	1	1	1	1	2

v) Course Content:

1. **Chemical Kinetics & Equilibrium** : Order and Molecularity of reaction, rates of reaction, factor affecting, first and second order reactions with derivation, Theories of reaction rates collision and transition state theory, pseudo unimolecular reactions, determination of rates of reaction, numerical. The law of Chemical Equilibrium, Lech atelier's principle , solubility and distribution law, explanation and limitations of distribution law, Henry's law, determination of equilibrium constant from distribution coefficient, numerical.
2. **Photo chemistry:** Introduction, laws of photochemistry, quantum efficiency, kinetics of photochemical reactions, photochemical, photosensitized reaction, photochemical phenomenon, photosynthesis.
3. **Catalysis & Surface Chemistry:** Definition, characteristics, types of catalysis, theory of catalysis, (acid/base) catalysis, Enzyme Catalysts (biocatalysts), mechanism of catalysis. Terminology, Factors affecting the adsorption of gases by solids, Types of adsorption. Adsorption isotherms, Langmuir theory of adsorption of a gas on the surface of solids, Ion – exchange absorption, application of adsorption.
4. **Conductometry and Electro Chemistry:** Electrolytic Conductance by solution (Specific, equivalent) factors influencing conductance cell constant, measurement of conductance, conduct metric titrations. Electro-Potential and its measurement , Nernst Equation, Importance of reduction electrode potential, Electro-chemical cell, Determination of free energy from cell potential measurement, Temperature dependence of EMF, Determination of entropy, enthalpy changes from cell potential measurement, Types of electrode, Commercial electro chemical cell

5. **Volumetric analysis** , concentration of solutions (molarity, normality, molality, equivalent weight, strength of solution) normality equation, numerical based on calculation of strength.
6. **Kinetic Theory of gases** : Kinetic gas equation, equi partitioning of energy Distribution of molecular velocities in three dimensional spaces, typesof molecular velocities, Application of kinetic molecular theory.

Reference/Text books:

1. Glassstone S.G.: Physical Chemistry, D. Van Nostrand, New York, New York.
2. Puri B.H. nad Sharma L.R.: Principles of Physical Chemistry, S Chand & Co., New Delhi.
3. Sheenhan W.F.: Principles of Physical Chemistry, Prentice Hall of India Pvt. Ltd. New Delhi
4. Dryden C.E., Outline of chemical technology: East West Press.
5. Bhal&Tuli: Essentials of Physical chemistry, S Chand & Co., New Delhi.
6. A.S. Negi and S.C.Anand: A Textbook of Physical Chemistry, New Age International.

Lab Work:

1. Determination of reaction rate constant of catalyzed hydrolysis of methyl acetate in HCL.
2. Determination of reaction rate constant of catalyzed hydrolysis of methyl acetate H_2SO_4.
3. To determine partition coefficient of benzoic acid in benzene and water.
4. To determine partition coefficient of iodine in carbon tetrachloride and water.
5. Determination of reaction rate constant of reaction between $K_2S_2O_8$and KT.
6. To verify freundlich adsorption isotherm by adsorption of acetic acid on charcoal.
   (a)Preparation of standard solution of oxalic acid and (b) Standardization of NaOH solution.
7. To determination of the amount of oxalic acid and sulphuric acid in solution given NaOH solution and $KMNO_4$ solution.
8. To determine the amounts of Na_2CO_3 and $NaHCO_3$ in the given alkali mixture of Solution.
9. Verification of Lambert Beer's Law.

i) Title of course: **Chemical Process Calculations (PCC-CH201, 4-Credit)**
(L-3, T-1,P-0)

ii) Outcomes:

1. Know the basic concepts regarding unit systems and conversions in chemical engineering process.
2. Able to carry out the material balancing in chemical process involving chemical reactions and without chemical reactions.
3. Able to carry out the energy balancing in chemical process involving chemical reactions and without chemical reactions.
4. Able to provide solution to various unit operations.

iii) Objectives:

1. To understand basic and fundamental chemical engineering calculations.
2. To know the unit systems, conversions.
3. To perform material balance and energy balance calculations on chemical process.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	3	2	3	2	2	2	1	1	1	1	3
CO2	3	3	3	3	3	2	2	1	1	1	1	3
CO3	3	3	3	3	3	2	2	1	1	1	1	3
CO4	3	3	2	3	2	2	2	1	1	1	1	3

v) Course Content:

1. **Basic Chemical Calculations** : Units and Conversions, Pressure, Temperature, Density, Specific Gravity; Mole Concept, Equivalent Weight, Composition of solids, Liquids and Gases, Mass fraction, Mass percent, Mass Ratios, Mole fraction, Mole percent, Volume fraction and Volume percent, Normality, Molarity , Molality
2. **Gases Systems** : Gaseous mixtures, Daltons law, Amagats law, Average molecular weight, Density of gaseous mixture, Estimation of vapour pressure. Humidity and saturation and their applications. Introduction to psychometry humidity and air-conditioning calculations.
3. **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.
4. **Material Balances with Chemical Reaction :** Definition of terms involved; Generalized approach for solving problems; Material balance problems involving chemical reaction; Electrochemical reactions; Metallurgical applications; Recycle, bypass and purge calculations.
5. **Energy Balance on Non-Reactive Processes**: Elements of energy balance calculations; Change in pressure at constant temperature; Change in temperature; Phase change operations; Mixing and solutions, Thermo-physics, Thermochemistry
6. **Energy Balance on Reactive Processes :** 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
7. **Combustion:** Minimum air required, Excess air, Combustion calculation
8. **Stoichiometry** and Industrial problems.

Reference/Text books:

1. Bhatt B.I. and Vora S.M. “Stoichiometry”, Fourth Edition, Tata McGraw-Hill Pub. Co. Ltd.,2004.
2. Himmelblau D.M., “Basic Principles and Calculations in Chemical Engineering”, Sixth Edition,Prentice-Hall of India Pvt. Ltd., 2004.
3. Felder R.M. and Rousseau R.W., “Elementary Principles of Chemical Processes”,ThirdEdition, John Wiley and Sons, Inc., 2000.
4. V. Venkataramani and N.Anantharaman, Process Calculations. 2003.
5. P.L.Ballaney, “Thermal Engineering”.

i) Title of course: **Fluid Mechanics (PCC-CH202, 4- Credit)**
(L-3, T-0, P-2)

ii) Outcomes:

1. Get familiar with the fundamentals, able to generate velocity profile for the given condition.
2. Calculate the flow rate of flowing stream, pressure drop and losses occurring in pipes.
3. Students will be able to use the theoretical knowledge in the practical.
4. Analyse requirements of pump and its characteristics.

iii) Objectives:

1. Fundamentals of fluid flow, Fluid statics, types of fluids, measuring elements for hydrostatic pressure.
2. Behavior of flowing fluid, basic equation of fluid flow, flow of compressible and incompressible fluid.
4. Major and minor energy losses in pipes & pipe fittings.
5. Various valves and their application, measuring devices for flow.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	3	3	2	3	2	1	1	1	1	1	2
CO2	3	2	2	2	2	2	1	1	1	1	1	2
CO3	3	3	3	2	3	2	1	1	1	1	1	2
CO4	3	3	3	2	2	1	1	1	1	1	1	2

v) Course Content:

1. **Fluid Statics and its Applications** : Nature of fluids, Hydrostatic equilibrium, Barometric equation, Hydrostatic equilibrium in centrifugal field, Pascal's Law and Hydrostatic equation, absolute and gauge pressures, Manometers, Types of Manometers, Numericals
2. **Fluid Flow Phenomena** : Behavior of flowing fluid, Types of flow, Newtonian and Non-Newtonian Fluids, viscosity and momentum flux, viscosities of gases and liquids, Turbulence, Reynolds experiment, Eddy viscosity, Flow in boundary layers, Laminar and Turbulent flow in Boundary layers, Boundary layer formation in straight tubes, Boundary layer separation and wake formation.
3. **Basic Equations of Fluids Flow** : Mass balance, mass velocity, momentum balance, Bernoulli's equation without and with friction, Eulers equation, Venturimeter, orifice meter, pitot tube, Problems.
4. **Flow of Incompressible Fluids in Conduits and Thin Layers** : Shear stress distribution in a cylindrical tube, relation between skin friction and wall shear, the friction factor. Relations between skin friction parameters. Laminar flow in pipes, Laminar flow of Newtonian fluids. Average velocity, kinetic energy correction factor (Derivation), Momentum correction factor

(Derivation), Hagen-poiseuilie equation. Turbulent flow in pipes and closed channels. Velocity distribution for turbulent flow, universal velocity distribution equations for laminar sub layer and buffer layer, Relations between maximum and average velocities, Effect of roughness, The friction factor chart (Moody's diagram), friction factor in flow through channels of non-circular section, friction from changes in velocity or direction, Effect of fittings and valves, couette flow, Layer flow with free surfaces, Problems.

5. **Flow of Compressible Fluids** : Mach number, continuity equation, Total energy Balance, velocity of sound, ideal gas equations, stagnation temperature.
6. **Flow past Immersed Bodies**: Drag coefficients of typical shapes, form drag and stream lining, Friction in flow through beds of solids, Erguns equation, Kozeny- Carman equation Burke Plummer equation, Fluidization, Mechanism of fluidization, particulate and aggregative fluidization, minimum fluidization velocity, expansion of –fluidized beds, and application of fluidization.
7. **Transportation and Metering of Fluids:** Pipe and tubing, joints and fittings. Prevention of leakage around moving parts. Valves- Gate valve, globe valve, check valve butterfly valve, needle valve, ball valve etc Measurement of flowing fluids., Classification and performance of Pumps, Turbines, Compressors, Blowers, Selection and specification, Net positive Suction Head.

Reference/Text books:

1. Mc. Cabe, W.L. Smith, J.C. Hariott: Unit Operation of Chemical Engg. McGraw Hill
2. J.M. Coulson, J.F. Richardson: Chemical Engg., Vol. 1, Pergamon.
3. Foust, A.S Wensei, L.A: Clump Principels of Unit Operation, John Wiely.
4. Baoger, W.L. and Banchero, J.T: Introduction to Chemical Engg. McGraw Hill
5. Fox, R.W and Mc Donald A.T: Introduction to Fluid Mechanics 4th Eds John Wiley and sons 1996.
6. Chattopadhya, P.: Unit Operations of Chemical Engg.

Lab Work:

1. To verifyBernoulli's Equation.
2. To determine thecoefficient of friction for pipes of different materials.
3. To study the Operation and working of Drag Coefficient Apparatus.
4. To study the Operation and working of Pitot tube.
5. To determine Reynolds's No and hence the type of flow either Laminar or Turbulent.
6. To conduct an experiment on flow of water through a fluidized bed.
7. Flow measurement by orifice meter.
8. Flow measurement by venturimeter.
9. Characteristics of Reciprocating Pump
10. Characteristics of Centrifugal Pump
11. Losses in pipes due to joints and bends.

i) Title of course: Chemical Engineering Thermodynamics-I (PCC-CH203, 3 credit) (L-3, T-0, P-0)

ii) Outcomes:

1. Able to know fundamental concept of thermodynamics.
2. Able to apply first and second law of thermodynamics for chemical processes.
3. Able to relate PVT relations and equation of state for pure component systems.
4. Evaluate thermodynamics properties in the chemical engineering applications.

iii) Objectives:

1. The students learn the definitions and relationships among the thermodynamic properties of pure materials, such as internal energy, enthalpy, and entropy.
2. The student learns the terminology of thermodynamics: system, properties, processes, reversibility, equilibrium, phases, and components.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	3	2	3	2	1	1	1	1	1	1	2
CO2	3	3	3	3	2	1	1	1	1	1	1	2
CO3	3	3	3	3	2	1	1	1	1	1	1	2
CO4	3	2	2	2	2	1	1	1	1	1	1	2

v) Course Content:

1. **Introduction and First Law of Thermodynamics**: Scope of Thermodynamics, Thermodynamic Systems: Basic Concepts, Joule's Experiments, Concept of Internal Energy, First Law of Thermodynamics, Energy Balance for Closed Systems, Thermodynamic State and State Functions, Equilibrium, The Phase Rule, The Reversible Process, Constant-V and Constant-P Processes, Enthalpy, Heat Capacity, Mass and Energy balances for Open Systems .
2. **Volumetric Properties of Pure Fluids** : General P-V-T Behaviour of Pure Substances, Virial Equations of State, The Ideal Gas, Application of the Virial Equations, Cubic Equations of State, Generalized Correlations for Gases, Generalized Correlations for Liquids.
3. **The Second Law of Thermodynamics:**: Statements of the Second Law, Heat Engines, Thermodynamic Temperature Scales, Entropy, Entropy Changes of an Ideal Gas, Mathematical Statement of the Second Law, Entropy Balance for Open Systems, Calculation of Ideal Work, Lost Work, The Third Law of Thermodynamics, Entropy from the Microscopic Viewpoint.
4. **Thermodynamic Properties of Fluids:**: Thermodynamic Property Relations for Single Phase Systems, Residual Property Relations, Residual Property Calculation by Equations of State, Two-Phase Systems, Thermodynamic Diagrams, Tables of Thermodynamic Properties, Generalized Property Correlations for Gases.
5. **Applications of Thermodynamics to Flow Processes:**: Duct Flow of Compressible Fluids,

Turbines (Expanders), Compression Processes. Conversion of Heat into Work by Power Cycles.

6. **Refrigeration and Liquefaction** : Carnot Refrigerator, Vapour-Compression Cycle, Choice of Refrigerant, Absorption Refrigeration, Heat Pump, Liquefaction Processes.

Reference/Text books:

1. J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engg. Thermodynamics 6th Edition, International student edition, McGraw Hill publication.
2. B.F. Dodge, "Chemical Engg. Thermodynamics", International student edition McGraw Hill Publication.
3. D.A. Hougen, K.M. Watson and R. A. Ragatz, "Chemical Process Principles", (Vol. II) 2nd Edn. Asia Publishing House.
4. K.V. Narayanan, "Chemical Engg. Thermodynamics", Prentice Hall India
5. Y.V.C. Rao, "Chemical Engineering Thermodynamics, University Press (INDIA) Ltd., Orient Longman Ltd., Hyderabad. Hall India Pvt. Ltd., New Delhi.
6. R. R. Rastogi and R. R. Mishra, "An Introduction to Chemical Thermodynamics",

i) Title of course: **Human Values & Professional Ethics (HMC278, 2-Credit) (L-2,T-0, P-0)**

ii) Course Outcome:

1. Understand the core human values that shape the ethical behaviour of a person.
2. Understand how values act as an anchor of actions for life.
3. Learn the need of Human values and Professional ethics in life.
4. Understand Harmony at Four levels of life.
5. Learn the moral issues and problems in profession and find the solution to those problems.

iii) Objectives :

1. To create an awareness on Professional Ethics and Human Values.
2. To help students understand the Harmony for life.
3. To understand co-existence.
4. To study the moral issues and decisions confronting individuals and Organizations in profession

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1			1			2		3				
CO 2								3				
CO 3								3				3
CO 4						2		3				
CO 5			1			2		3	2			3

v) Course Content:

1. **Course Introduction**: Need, Basic Guidelines, Content and Process for Value Education. Understanding the need, basic guidelines, content and process for Value Education. .A look at basic aspirations: Self Exploration, Happiness and Prosperity Fulfilments of human aspirations and harmony
2. **Understanding the Harmony**: Thoughtful human being harmony, sentient, attitude and its importance in relationshipSignificance of restraint and health *(Yama and Niyama).*Human goal settings and life management techniques, existence and co-existence, trust, respect in universal order
3. **Understanding professional Ethics:** Harmony at various levels and understanding professional ethics.Creating environmentally aware engineers. Humanistic universal education, natural acceptance of human values, ethical human conduct
4. **Competence of professional ethics**: Management models for present technologies, strategies for integrating humans in family and at all levels of existence. Relevance of the above strategies in becoming responsible engineers, technologists and managers
5. **Motivation**: Contribution of ancestors in science and technology development to raise self-esteem in Indian context.

Reference/Text books:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Value Education.
2. A Nagraj, 1998, Jeevan VidyaekParichay, Divya Path Sansthan, Amarkantak.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.
5. A.N. Tripathy, 2003, Human Values, New Age International Publishers
6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
7. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
8. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
9. M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd
10. SubrotoBagchi, The Professional
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.

i) Title of course: Mathematical Foundation for Engineering
(BSC261, 0 credit) (L-2, T-0, P-0) (mandatory Audit Course for DSE)

ii) Course Objectives:

1. To develop the sound conceptual understanding of Algebra, coordinate geometry, complex numbers , vectors, matrices, Calculus and Differential Equations.
2. To develop the foundation for engineering mathematics and other engineering courses.

iii) Course Outcomes: At the end of the course student will be able to

CO1	analyze the structure of complex numbers, quadratic equations, vectors and matrices and their uses.
CO2	Find the standard and general equations of lines, circles, conic sections, and their properties.
CO3	Sketch the graphs of functions and can evaluate limit, continuity, derivatives, integrations.
CO4	Formulate and solve first order differential equations.

iv) Articulation Matrix

PO ➡ / CO ⬇	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	1	2								2
CO2	3	3	1	2								1
CO3	3	3										1
CO4	3	3	2									2

Note: 1-Low, 2-Medium or 3- High.

Unit-1 Complex Numbers (05 hours)
Complex numbers as ordered pairs. Argand's diagram. Triangle inequality. Powers and roots of complex numbers, De Moivre's Theorem.

Unit-2 Algebra (05 hours)
Quadratic equations and express-ions. Permutations and Combinations. Binomial theorem for a positive integral index.

Unit-3 Coordinate Geometry (07 hours)
Coordinate Geometry: Locus. Straight lines. Equations of circle, parabola, ellipse and hyperbola in standard forms. Parametric representation.

Unit-4 Vectors and Matrices (08 hours)

Addition of vectors. Multiplication by a scalar. Scalar product, cross product and scalar triple product with geometrical applications. Matrices and Determinants: Algebra of matrices. Determinants and their properties. Inverse of a matrix. Cramer's rule.

Unit-5 Differential Calculus (10 hours)

Function. Inverse function. Elementary functions and their graphs. Limit. Continuity. Derivative and its geometrical significance. Differentiability. Rules of derivatives, Applications of Derivatives: Tangents and Normals, Increasing and decreasing functions. Maxima and Minima

Unit-6 Integral calculus (10 hours)

Integration as the inverse process of differentiation. Integration by parts and by substitution. Definite integral and its application to the determination of areas (simple cases). Solving first order differential equations:Exact differential equations and first order linear differential equations.

References:

1. Bernard and Child, Higher Algebra, Macmillan and Co. Pvt. Ltd, New York.
2. J.V. Uspensky, Theory of equations, macGraw Hill Publications.
3. S. L. Loney, The Elements of Coordinate Geometry, Macmilliams and Co., New York
4. G.B.Thomas, M.D.Weir, J. Hass, Thomas' calculus, 12th edition, Pearson Publications
5. H.Anton, C. Rorrers, Elementary Linear Algebra Applications version, 9th edition, Wiley publications.

Semester-II

i) Title of course: **Mathematics-IV: Statistical and Numerical Methods (BSC274,03-Credit) (L-3,T-0,P-0)**

v) Course Content:

Unit 1: Analysis of Statistical Data (03 hours)

Frequency distribution; Frequency curve and histogram; Measure of central tendency and dispersion.

Unit 2: Random variables and Probability Distributions (08 hrs)

Basic concepts of probability and its properties; Conditional probability and independent events; Random variables, discrete and continuous random variables, Mean and variance of Binomial, Poisson and Normal distributions and applications.

Unit 3: Sampling Distributions and Interval of Estimation (08 hours)

Sampling Distributions: t distribution, Chi-square distribution, F-distribution,; Interval of estimation

Unit 4: Testing of Hypothesis (08 hours)

Relation between confidence interval and testing of hypothesis; testing of hypothesis, classification of hypothesis tests; large sample tests, small sampe tests.

Unit 5: Numerical Methods – 1(08 hours)

Solution of polynomial and transcendental equations – Newton-Raphson method and Regula-Falsi method. Finite differences, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

Unit 6: Numerical Methods – 2 (10 hours)

Numerical solutions to differential equations: Taylor series method, Euler method, Runge-Kutta method, predictor-corrector methods for initial value problems, Adams-Moulton method, Numerical solutions to partial differential equations: Finite difference method, Explicit, implicit, Crank-Nicolson method.

References:

1. E. Kreyszig, *Advanced Engineering Mathematics*, Eighth Edition, John Wiley and Sons, 2015.
2. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, 7th Edition, McGraw Hill.
3. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI learning Pvt. Ltd.
4. V. K. Rohatgi and A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 2nd Edition.

5. D. C. Montgomery and G.C. Runger, "Applied Statistics and Probability for Engineers", 5th edition, John Wiley & Sons, (2009).
6. P. S. Mann, Introductory Statistics, Wiley Publications, 7th edition (2013).

i) Title of course: **Fundamental of Electronics (ESC287, 2-Credit) (L-2,T-0, P-0)**

ii) Outcomes:

1. To know broadly the concepts and functionalities of the electronic devices, tools and instruments
2. To understand use, general specifications and deploy abilities of the electronic devices, and assemblies
3. Confidence in handling and usage of electronic devices, tools and instruments in engineering applications.

iii) Objectives:

1. To provide the students with an introductory and broad treatment of the field of Electronics Engineering to facilitate better understanding of the devices, instruments and sensors used in Chemical Engineering applications

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	2	2	1	3	2	1	1	1	1	1	2
CO2	2	2	3	2	3	1	1	1	1	1	1	2
CO3	2	2	2	3	3	2	2	2	1	1	1	2

v) Course Content:

1. **Module1**: Diodes and Applications covering, Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications;
2. **Module 2**: Transistor Characteristics covering, Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration; Field Effect Transistor (FET) – Construction, Characteristics of Junction FET, Depletion and Enhancement type Metal Oxide Semiconductor (MOS) FETs, Introduction to CMOS circuits;

3. **Module 3:** Transistor Amplifiers and Oscillators covering, Classification, Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC Equivalent Circuit; Feedback Amplifiers – Principle, Advantages of Negative Feedback, Topologies, Current Series and Voltage Series Feedback Amplifiers; Oscillators – Classification, RC Phase Shift, Wien Bridge, High Frequency LC and Non-Sinusoidal type Oscillators;
4. **Module 4:** Operational Amplifiers and Applications covering, Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal OpAmp, Concept of Virtual Ground.

Reference/Text books:

1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India
2. SantiramKal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India
3. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education.
4. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH.
5. R. T. Paynter (2009), Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson.

i) Title of course: Heat Transfer (PCC-CH204, 4-credit) (L3, T-0, P-2)

ii) Outcomes:

1. Capable to apply the concepts of conduction and associated thermal boundary conditions to transform the one dimensional system into a mathematical model.
2. Ability to analyze three dimensional heat conduction equations for flat wall, cylinder and sphere.
3. Get familiar with phenomenon of convection and radiation and able to solve the radiation problems.
4. Understand the different types of heat exchangers, evaporator systems &their designs.

iii) Objectives:

1. To study the basic principles of heat transmission by conduction, convection, and radiation.
2. Teach students how to identify, formulate, and solve engineering problems. involving conduction, convection, and radiation.
3. Teach, students basic heat exchanger design and analysis techniques.
4. To understand the fundamentals about heat transfer coefficients and to solve the examples related to heat transferring devices.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	2	3	3	2	2	2	1	1	1	1	1	3
CO2	3	2	3	3	2	1	1	1	1	1	1	2
CO3	3	3	3	3	3	2	1	1	1	1	1	2
CO4	2	3	3	3	2	2	1	1	1	1	1	3

v) Course Content:

- **Introduction:** The relation of heat transfer with thermodynamics, Modes of heat transfer, Conduction, Convection, Radiation, Material properties of importance in heat transfer , Thermal conductivity of solid, liquid and gases, Specific heat capacity.
- **Heat Conduction :** One dimensional Steady state conduction through plane wall, cylinder and spheres, three dimensional steady state heat conduction through constant areas such as plane wall, cylinder and sphere, Heat conduction in bodies with heat sources. Principle of heat flow in fluids and concept of heat transfer coefficient, Individual and overall heat transfer coefficient, Heat transfer between fluids separated by a flat solid wall, Heat transfer between fluids separated by a cylindrical wall. Contact resistance, Thermal insulation, and critical thickness of insulation. Enhanced heat transfer: concept of fins, Analytical solution of different cases, Fin efficiency, Transient/Unsteady State Heat Conduction.
- **Convective Heat Transfer without Phase Change :** Principle of convection, Forced convection mechanism: Flow over a flat horizontal plate, Flow through a pipe or tube, Turbulent flow, Laminar flow, Flow through a non-circular duct, Momentum and heat transfer analogies: Reynolds analogy, Prandlt analogy, Chilton-Colburn analogy.
- **Natural Convection:** Introduction, Empirical correlations for natural-convective heat transfer, Natural convection around a flat vertical plate, Natural convection around a horizontal cylinder, Natural convection around a horizontal flat surface, Natural convection around sphere, Natural convection in enclosure, Combined natural and forced convection.
- **Convective Heat Transfer with Phase Change:**
    a. **Boiling:** Heat transfer during boiling, Boiling of saturated liquid, Nucleation boiling, Maximum heat flux, Film boiling,
    b. **Condensation:** Heat transfer during condensation, Film condensation, Condensation for horizontal tube, Condensation outside horizontal tube or bank of tube, Condensation on a single horizontal tube, Condensation on a vertical tube of N horizontal tubes, Condensation inside a horizontal tube.
- **Radiation Heat Transfer :** Basic definition pertaining to radiation, Emissive power, Radiosity, Irradiation, Absorptivity, reflectivity, and transmissivity, Black body radiation, Planck's law, Wien's law, Stefan-Boltzmann law, Special characteristics of black body radiation, Kirchhoff's law, Grey body, Radiative heat exchange between surfaces, View factor, Relation between view factors, Heat exchange between non-black bodies, Radiation shield.
- **Heat Exchangers :** Typical heat exchange equipment, Basic types of heat exchangers, Individual and overall heat transfer coefficient, log mean temperature difference, Fouling factor, LMTD in single pass parallel, counter and cross-flow arrangements. N.T.U. –

effectiveness method for parallel and counter flow heat exchangers, general Design aspect of heat exchangers.

- **Evaporation :** Evaporator, Types of evaporators, Capacity and economy, Single and multiple effect evaporators, Boiling point elevation, Temperature profile in an evaporators, Heat Transfer coefficient, Enthalpy balance.
- **Introduction to heat transfer in packed &fluidized beds :** Calculation of heat transfer coefficients. Heat transfer in jacketed vessels, boilers furnaces and agitated vessels.

Reference/Text books:

- Kern D.Q., Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990B.F. Dodge, "Chemical Engg. Thermodynamics", International student edition McGraw Hill Publication.
- J P Holman, "Heat Transfer" 9th edition, Tata McGraw Hill Publications, New Delhi (2004)
- S. P. Sukhatme, "A Textbook on Heat Transfer", 4th ed, Universities Press (India),., 2005
- Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I 5th Edition, Butterworth Heinemann, New Delhi.
- Eckert E.R.G. and Drake R.M.; 2nd Edition, Heat Transfer and Mass Transfer, McGraw Hill Education,Hollman J.P.; Heat Transfer, McGraw Hill, 1993.
- Kothandaram C.P., Subramanyan S.; Heat Transfer and Mass Transfer, Databook, 4th Edition, Wiley eastern Ltd., (1989).
- Kumar D.S., Process Heat Transfer, S.K.Kataria& Sons Publishers, New Delhi.
- McAdams W.H.; Heat Transmission, McGraw Hill Book Co. New York, 1954.

Lab Work:

- Determination of Thermal Conductivity of a metal rod at different rate of heat input using Fourier equation.
- Study of Heat Transfer through composite slab.
- Determine thermal conductivity of insulating powder.
- Determination of critical radius of insulation.
- Study the phenomenon of heat transfer by Natural Convection.
- Determination of Emissivity of test plate.
- Determination of Stefan Boltzman constant.
- Determination of Heat Transfer Coefficient in Jacketed Kettle with or without stirring.
- Determination of Overall Heat Transfer coefficient & LMTD in Shell and Tube Heat Exchanger.
- Determination of Overall Heat Transfer coefficient in Plate Type Heat Exchanger.
- To study economy and the capacity of evaporator & to determine overall HTC (Single/double effect).
- To determine overall HTC for various degree of agitation.
- Verification of Nusselt Equation.

i) Title of course: Chemical Engineering Thermodynamics-II (PCC-CH205,3-Credit)
(L-3, T-0, P-0)

ii) Outcomes:

- The students must be able to find thermodynamic properties of pure component system and inter relate with each other.
- The Students should be to understand thermodynamics of solution system and estimate departures from ideality.
- Apply phase equilibrium criteria and perform VLE calculations for chemical engineering separation techniques.
- Apply chemical reaction equilibrium criteria and perform feasibility calculations for chemical reactions.

iii) Objectives:

- The students learn the applications of energy balances in the analysis of batch, flow, and cyclical processes involving homogeneous systems.
- The students learn how to obtain or to estimate the thermal and volumetric properties of real fluid.
- Study of Phase equilibrium and chemical equilibrium in chemical engineering.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	3	3	3	3	2	2	1	1	1	1	3
CO2	3	3	3	3	2	2	2	1	1	1	1	3
CO3	2	3	3	3	3	2	2	1	1	1	1	3
CO4	2	3	3	3	3	2	2	1	1	1	1	3

v) Course Content:

- **Heat Effects**: Sensible heat effects, Temperature dependency of heat capacity, Latent Heat of pure substance, Standard heats of reaction, formation and combustion, Heat effects of industrial reactions.
- **Thermodynamic properties of homogeneous fluid:** Fundamental property relation, Chemical potential, Partial properties, The ideal gas mixture model, Fugacity and fugacity coefficient, The ideal solution model, Excess properties.
- **Solution Thermodynamics** : Liquid phase properties, Activity coefficient, Excess Gibbs Energy, Models for the excess Gibbs energy, Property changes of mixing, Heat effects of mixing process.
- **Phase equilibrium** : The nature of equilibrium, Criteria of equilibrium, The phase rule, Duhem's theorem, Raoult's law, Henry's law, Modified Raoults's law, Dew point and bubble point calculations, Relative volatility, Flash calculations.

- **Thermodynamic properties and VLE from equations of state**.
- **Chemical Reaction Equilibria**: The reaction coordinate, Equilibrium criteria to chemical reactions, Gibbs free energy change, Equilibrium constant, Effect of temperature on equilibrium constant, Evaluation of equilibrium constants, Relation of equilibrium constant to composition, Equilibrium conversions for single reactions, Phase rule and Duhem's theorem for reacting systems, Multi-reaction equilibria.

Reference/Text books:

- J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engg. Thermodynamics" 6th Edition, International student edition, McGraw Hill publication.
- B.F. Dodge, "Chemical Engg. Thermodynamics", International student edition McGraw Hill Publication.
- D.A. Hougen, K.M. Watson and R.A. Ragatz, "Chemical Process Principles", (Vol. II) 2nd Edn. Asia Publishing House.
- K.V. Narayanan, "Chemical Engg. Thermodynamics", Prentice Hall India
- Y.V.C. Rao, "Chemical Engineering Thermodynamics, University Press (INDIA) Ltd., Orient Longman Ltd., Hyderabad. Hall India Pvt. Ltd., New Delhi.
- R. R. Rastogi and R. R. Mishra, "An Introduction to Chemical Thermodynamics", Vikas Publishing House Pvt. Ltd, New Delhi.
- D. Shrinivasan, "Chemical Engineering Thermodynamics", New Age International, Publisher New Delhi.
- G.N. Pandey and J. C. Chaudhari, "Chemical Engineering Thermodynamics", Khanna Publishers, Delhi.

i) Title of course: Mass Transfer-I (PCC-CH206, 4-Credit)
(L-3, T-0, P-2)

ii) Outcomes:

- Able to solve diffusion equation for concentration and flux as a function of position in rectangular with various boundary conditions.
- Apply fundamentals of phase equilibrium to calculate compositions in equilibrium in liquid/liquid, solid/liquid, and liquid/ vapor separation units.
- Identify and use the correct engineering correlations of diffusion and mass transfer coefficients to model a separation process.
- Capable to analyse a multi-stage equilibrium separation process, simultaneous phase equilibrium and mass balances in continuous separation processes and sizing continuous separation units.
- Learn about designing and calculation of distillation column.

iii) Objectives: Students will learn about

- Fundamentals of Mass transfer i.e., mass transfer coefficient, Ficks Law, classification of mass
- transfer operation etc.
- The concept &application of Diffusion, Distillation and its various types, Extraction and

- adsorption etc.
- Estimate the number of stages required for multistage operation.
- Generation & analysis of equilibrium data.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	3	3	3	2	1	2	2	1	1	1	2
CO2	3	3	3	3	3	2	1	1	1	1	1	3
CO3	2	3	3	3	3	2	2	1	1	1	1	2
CO4	3	3	3	3	3	1	1	1	1	1	1	2
CO5	3	3	3	3	3	1	1	1	1	1	1	2

v) Course Content:

1. **General principles of Mass Transfer :** Classification of Mass Transfer Operations, choice of separation method, methods of conducting mass transfer operations, design principles. Diffusion Mass Transfer Molecular Diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion, Fick's and Maxwell law of diffusion, diffusion in solids, unsteady state mass transfer &numerical.
2. **Types of mass transfer:** Mass transfer Coefficients in laminar flow and turbulent flow, theories of Mass transfer, mass, heat and momentum transfer analogies. Inter-phase mass transfer, equilibrium in mass transfer, the two resistance theory, continuous concurrent, counter current and crosscurrent processes, cascades
3. **Distillation:** Vapour – liquid equilibria, Raoult's law, X-Y and H-X-Y diagrams, differential distillation and equilibrium distillation, steam distillation, azeotropic distillation, extractive distillation. Fractionation, binary distillation, plate and packed columns for distillation analytical and graphical methods for estimation of number of stages required in distillation column, minimum reflux ratio, optimum reflux ratio, number of stages at optimum reflux, murphree plate efficiency and overall plate efficiency, effect of feed conditions on number of plates for separation Concept of HETP, HTU, NTU in distillation, plate and packed columns, packing's for packed columns, pressure drop in plate and packed columns, bubble cap, sieve tray, valve tray plate columns. Introduction to reactive distillation & numerical.
4. **Liquid – Liquid Extraction fundamentals :** selection of solvent for extraction, estimation of mass transfer coefficients, triangular diagram representation, equipment for liquid – liquid extraction, plate and packed columns, spray columns, rotary disc contactors, design procedures and equipment selection criteria. Single stage, multistage operations etc. ,numerical
5. **Solid-Liquid Extraction fundamentals :** Solvent selection, equilibrium relationship, triangular diagram representation, single stage, multistage concurrent and counter

current operation, equipments for solid – liquid extraction, their design procedure and selection criteria,numerical.

6. **Adsorption :** Adsorption isotherms, adsorption agents, equipments for adsorption, pressure swing adsorption technology, adsorption phenomena & numerical.

Reference/Text books:

1. McCabe, W.L. & Smith, J.C. Unit operations of Chemical Engg. McGraw Smith J.C. Hill
2. Foust, A.S Principles of Unit operations, John Willey & Sons.
3. Coulson J.M Chemical Engg. Vol, 2, McGraw Hill
4. Badger W.L Introduction to Chemical Engg. McGraw Hill
5. Perry and Chilton Chemical Engg. Hand Book.

Lab Work:

1. To study & find out effect of dry grinding and determine its critical speed and its efficiency.
2. To find the particle size distribution of a mixture of particles by sieve analysis.
3. To study the size reduction of particle by using ball mill.
4. To apply Screen analysis on vibrating screen and calculating screening Analysis.
5. To determine the efficiency of the crusher for crushing a material of known work index (W_i).
6. To study the batch sedimentation process.
7. To study the operation of plate and frame filter press.
8. To study the operation of cyclone separator.

i) Title of course: Mechanical Operations (PCC-CH207, 4- Credit) (L-3, T-0, P-2)

ii) Outcomes:

1. Get familiar with the fundamentals, able to calculate power requirement and crushing efficiency for jaw crusher, tumbling mill.
2. Able to determine the filtration constants, separation efficiency of classifier.
3. Able to increase the proficiency for the calculations and machinery involved in solid handling operations.
4. To impact the basic concepts of mechanical operations

iii) Objectives:

1. Fundamentals of solid fluid operation, basic laws of crushing & grinding.
2. Calculation of power requirement for the given size reduction.
3. Handling of solids, mixing, size reduction and classification of size reduction equipment, size separation, settling etc.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	3	3	3	2	2	1	1	1	1	1	1	2
CO2	2	3	3	3	3	1	1	1	1	1	1	2
CO3	2	3	3	3	3	1	1	1	1	1	1	2
CO4	3	3	3	3	3	1	1	1	1	1	1	2

v) Course Content:

1. **Handling of Solids** : Properties of particulate masses: Major distinctive properties, pressures in masses of particles, angle of internal friction, angle of repose. Conveying of bulk solids: Basic idea of conveyor, conveyor selection, screw, belt, vibrating, continuous flow and pneumatic conveyors. Storage and weighing: bulk storage, bin storage, feeders (vibrating hopper, screw feeder, belt feeder), batch and continuous weighing. Packaging: Bags, boxes, drums, packaging operations (weighing, filling and weighing equipment, loading, wrapping, sealing, and labeling)
2. **Mixing and Agitation** : Agitation of low viscosity particle suspensions: axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators. Types of mixers, various mixers for cohesive solids, power requirements', mixing index, axial mixing. Mixers for free flowing solids: ribbon blenders, screw mixers, tumbling mixers import wheels, mixing index in blending granular solids, mixing index at zero time, rate of mixing.
3. **Size Reduction** : Principles of Commination: Criteria for commination, characteristics of products, Energy and Power requirements Rittinger'sand Kick's Law and work index. Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.
4. **Screening :** Characterization of solid particles: Shape, size, specific sin face, calculation of number of particles in mixture screen analysis.
5. **Filtration** Classification of filters, various types of cake fitters, principles of cake filtration, clarifying fitters: liquid clarification, Gas cleaning, principles of clarification.
6. **Cross flow Filtration** : Types of membranes permeate flux for ultra filtration concentration polarization, partial rejection of solutes, Microfiltration, selection of filtration Equipment and centrifuges.
7. **Settling: Motion of particles through fluids** : Terminal velocity, hindered setting, stock's law gravity setting processes: Classifiers, clarifies, thickeners, flocculation, rate of sedimentation Design-principles for clarifies and thickener.
8. **Centrifugal Settling processes** Cyclones, hydro cyclones , decanters, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal class fitters, principles of centrifugal sedimentation.

Reference/Text books:

1. McCabe, W.L. & Smith, J.C. Unit operations of Chemical Engg. McGrawSmith J.C. Hill
2. Foust, A.S Principles of Unit operations, John Willey & Sons.
3. Coulson J.M Chemical Engg. Vol, 2, McGraw Hill

4. Badger W.L Introduction to Chemical Engg. McGrawHill
5. Perry and Chilton Chemical Engg. Hand Book.

Lab Work:

1. To study & find out effect of dry grinding and determine its critical speed and its efficiency.
2. To find the particle size distribution of a mixture of particles by sieve analysis.
3. To study the size reduction of particle by using ball mill.
4. To apply Screen analysis on vibrating screen and calculating screening Analysis.
5. To determine the efficiency of the crusher for crushing a material of known work index (W_i).
6. To study the batch sedimentation process.
7. To study the operation of plate and frame filter press.
8. To study the operation of cyclone separator.

i) Title of course: **Indian Constitution (MAC277, Audit Credit)**
(L-2,T-0, P-0)

ii) Outcomes:

1. Student will be able to understand how India has come up with a Constitution which is the combination of the positive aspects of other Constitutions.
2. Student will be able to understand the interpretation of the Preamble.
3. Student will be able to understand the basics of governance of our nation.
4. It helps in understanding the different aspects covered under the different important Articles.

iii) Objectives:

1. To understand the basic foundation and the basic law for the governance of our nation, the history and the different types of Constitutions.
2. To understanding the importance and the different aspects of the Constitution. To know and understand the different rights enshrined in the Constitution and understand the rights and duties of the government.
3. To understand the basis and procedure of amendments.
4. To know the different aspects of the Union and the State Executive.
5. To know how our country was founded, who founded it, what are our rights are, what life was like, how life has changed, how the rights still apply today.

iv) Articulation Matrix:

PO/PSO ➡ ⬇ CO	a	b	c	d	e	f	g	h	i	J	k	l
CO 1	2	1	1	1	1	2	2	3	3	2	1	2
CO2	1	1	1	1	1	2	1	3	3	2	1	2
CO3	1	1	1	1	1	2	2	3	3	2	1	2
CO4	1	1	1	1	1	2	2	3	3	2	1	2

v)Course Content

1. Meaning of the constitution law and constitutionalism. Historical perspective of the Constitution of India. Salient features and characteristics of the Constitution of India
2. Scheme of the fundamental rights. The scheme of the Fundamental Duties and its legal status
3. The Directive Principles of State Policy –Its importance and implementation. Federal structure and distribution of legislative and financial powers between the Union and States.
4. Parliamentary form of Government in India. The constitution powers and status of the President of India.
5. Amendment of the Constitutional Powers and Procedure. The historical perspectives of the constitutional amendments in India.
6. Emergency Provisions: National Emergency, President Rule, Financial Emergency.
7. Local Self Government – Constitutional Scheme in India.
8. Scheme of the Fundamental Right to Equality. Scheme of the Fundamental Right to certain Freedom under Article 19. Scope of the Right to Life and Personal Liberty under Article 21.

Reference/Text books:

1. Introduction to the Constitution of India by Durga Das Basu (Students Edn.) Prentice-Hall EEE, 19th /20th Edition, 2001.
2. An Introduction to Constitution of India by M. V. Pylee, Vikas Publishing, 2002.
3. Constitution of India, by Dr. P.K. Agrawal (Author), Dr. K.N. Chaturvedi (Author), Prabhat Prakashan; First edition (2017).