Chemical Engineering				
Second Year (Third Semester)				
Sl.No	**Course Code**	**Subject (Theory)**	**Contact Hrs. L-T-P**	**Credit**
1	MA1201	Mathematics–III	3-0-0	3
2	CH1201	Professional Core-1: Fuels and Combustion	3-0-0	3
3	CH1202	Professional Core-2: Fluid Mechanics	3-0-0	3
4	CH1203	Professional Core-3:Chemical Process Technology	3-0-0	3
5	CS1204	Advanced Competency Course-1: Programming in Python (PC-4)	3-0-0	2
6	HS1202	Organizational Behaviour	3-0-0	2
Subject (Sessional)				
7	CH1281	Fluid Mechanics Lab	0-0-3	1.5
8	CH1282	Fuel Technology–I Lab	0-0-3	1.5
9	CH1283	Process Technology Lab	0-0-3	1.5
10	CS1284	Programming in Python Lab	0-0-3	1.5
		Total	**18-0-12**	**22**
Second Year (Fourth Semester)				
Sl.No	**Course Code**	**Subject (Theory)**	**Contact Hrs. L-T-P**	**Credit**
1	MA1202	Professional Core-5: Numerical Methods in Engineering	3-0-0	3
2	CH1204	Professional Core-6 : Mechanical Operation	3-0-0	3
3	CH1205	Professional Core-7 : Chemical Engineering Thermodynamics	3-0-0	3
4	CH1206	Professional Core-8 : Chemical Process Calculation	3-0-0	3
5	CS1209	Advanced Competency Course-2: Artificial Intelligence and Machine Learning (PC-9)	3-0-0	2
6	HS1201	Engineering Economics	3-0-0	2
Subject (Sessional)				
7	CH1284	Fuel Technology - II Lab	0-0-3	1.5
8	CH1285	Chemical Engineering Thermodynamics Lab	0-0-3	1.5
9	CH1286	Mechanical Operation Lab	0-0-3	1.5
10	CH1287	Environmental Engineering Lab	0-0-3	1.5
	Summer Internship and Research Experience (SIRE- I) *			
		Total	**18-0-12**	**22**

CHEMICAL ENGINEERING			
Subject Code	**MA1201**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Mathematics–III**		
SYLLABUS			
Module-I	Random variables (Discrete and Continuous. Cumulative Distribution Function (CDF). Variance and standard deviation. Moments. Functions of a random variable. Distributions: Binomial, Poisson, normal, Gaussian, uniform (definitions and examples only). Moment generating function.		**6 Hrs**
Module-II	Pairs of random variables. Joint probability density function. Joint probability mass function. Marginal distribution. Functions of two random variables, PDF and expected values of the sum of two random variables		**6 Hrs**
Module-III	Probability Models of n Random Variables. Vector notation. Independence of random variables and random vectors. Functions of random vectors. Expected value vector and correlation matrix.		**6 Hrs**
Module-IV	Stochastic Processes. Definitions and examples. Types of stochastic processes. Random variables from random processes. The Poisson process.		**6 Hrs**
Module-V	Markov Chains. Discrete-time Markov chain. Discrete-Time Markov chain dynamics. Limiting state probabilities for a finite Markov chain. State classification.		**6 Hrs**
Essential Reading	1. Roy D. Yates, Rutgers and David J. Goodman, Stochastic Processes, 2d Edition, John Wiley and Sons, INC. 2. Gregory F Lawler, Introduction to Stochastic Processe, Chapman & Hall/ CRC Press (Taylor Francis Group).		
Course Outcomes	The objective of this course is to familiarize the prospective engineers with techniques in Probability and Statistics. It aims to equip the students to deal with advanced level of Statistics that would be essential for Engineering disciplines. CO1. To apply different distributions in real life problems of industries CO2. To deal with problems that contains multivariable probability distribution. CO3.To enrich knowledge Probability Models of multi-Random Variables CO4. To learn use of stochastic processes in daily life		

Subject Code	**CH1201**	**Total Contact Hour**	**30**
Semester	3rd	**Total Credit**	**3**
Subject Name	**Fuels and Combustion**		
Pre-requisites	**Knowledge in undergraduate mathematics, physics and chemistry**		
Course Objective	1. To study the solid, liquid and gaseous fuels origin, classification, properties, analysis, and handling. 2. To understand different characterization techniques of fuels. 3. To understand the conversion and treatment processes of fuels with their applications. 4. To study the combustion processes of fuels. 5. To understand combustion stoichiometry relationship		
SYLLABUS			
Module-I	Solid fuels: Coal origin, Chemical composition, Calorific value, Classifications, Characteristics and Distribution of Indian coals.		**6 Hrs**
Module-II	Storage and spontaneous combustion of coal, Coal washing and blending, Petrographic constituents of coal, Carbonization of coal, Manufacture and properties of metallurgical coke, Recovery of by products		**5 Hrs**
Module-III	Liquid fuels: Origin and composition of crude oil, Crude oil distillation and its products with Special reference to gasoline, kerosene and diesel oil, Cracking and reforming, Shale oil, Fischer-Tropsch synthesis		**7 Hrs**
Module-IV	Gaseous fuels: Natural gas, Coal gas, Coke oven and blast furnace gas, Manufacture of water gas and Producer gas, Carburetted water gas Synthetic fuels: Hydrogenation of coal		**6 Hrs**
Module-V	Combustion: Combustion of solid, liquid and gaseous fuels, combustion stoichiometry and thermodynamics, Calculation of volumes and weights of air required for combustion, the gas analysis		**6 Hrs**
Essential Reading	1. Elements of Fuels, furnace and combustion by O P Gupta. 2. Fuels and Combustion by Sameer Sarkar		
Supplementary Reading	1. S.N. Saha, Fuel Combustion Energy Technology, DhanpatRai pub. Co. 2. Himus, Elements of Fuel Technology		
Course Outcomes	At the end of this course CO1. Students will understand the basics of solid, liquid and gaseous fuels. CO2. Students will earn different characterization techniques of fuels. CO3. Students will earn the different conversion techniques of fuels. CO4. Students will understand the combustion process of fuels. CO5. Students will understand and analyze the combustion mechanisms of various fuels		

Subject Code	**CH1202**	**Total Contact Hour**	**30**
Semester	3rd	**Total Credit**	**3**
Subject Name	**Fluid Mechanics**		
Pre-requisites	**Basic of Mathematics and Physics**		
Course Objective	1. To understand the properties of fluids and fluid statics 2. To derive the equation of conservation of mass and its application 3. To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems. 4. To understand the various flow measuring devices 5. To study in detail about boundary layer theory		
Syllabus			
Module-I	Units and dimensional analysis, Types of Fluids. Fluid Statics: Hydrostatic Pressure, Pressure measuring Devices.		**5 Hrs**
Module-II	Introduction to fluids in motion, Flow in boundary layers. Its formation & growth in tubes & plates. Basic equations of fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices: Venturi, Orifice, Pitot tube, and Rotameter.		**7 Hrs**
Module-III	Flow of incompressible fluid in pipes, Relation between skin friction & wall shear. Laminar flow in pipes, Hagen–Poiseuille equation, Friction factor, Friction from changes in velocity or direction, Flow of compressible fluids, Basic equations. Flow past immersed bodies, Drag Coefficient. Motion of particles through fluids. Its mechanics, Terminal velocity.		**8 Hrs**

Module-IV	Friction inflow through beds of solids, Fluidization, Mechanism of fluidization, pressure drop in fluidization, Applications of fluidization.		**5 Hrs**
Module-V	Transportation of fluids, reciprocating, rotary & centrifugal pump. Characteristics curves & calculation of power & efficiency of pumps. Concept of slip.		**5 Hrs**
Essential Reading	1. Unit Operations of Chemical Engineering, 7th ed. by W L McCabe, J C Smith, and P. Harriott, McGraw-Hill. 2. Fluid Mechanics for Chemical Engineers, 3rd ed. by Noel de Nevers, McGraw-Hill.		
Supplementary Reading	1. A Textbook of Fluid Mechanics and Hydraulic Machines, 9th ed. by R K Bansal. 2. Fluid Mechanics: Including Hydraulic Machines by A K Jain. 3. Introduction to Fluid Mechanics and Fluid Machines, 3rd ed. by S K Som, G Biswas, and S. Chakraborty, McGraw-Hill, 2011.		
Course Outcomes	CO1. Apply the knowledge of differential equations of fluid mechanics including the ability to apply and understand the impact of assumptions made in the analysis. CO2. Apply the concepts of boundary layer and its estimation in different flows. CO3. Describe the compressible flow equations and multiphase flow correlations. CO4. Describe the dynamics of drops and bubbles quantitatively. CO5. Describe fluid flow problems with the application of the momentum and energy equations.		
Subject Code	**CH1203**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Chemical Process Technology**		
Pre-requisites	**Basic of Chemistry and Physics**		
Course Objective	1. To understand the manufacturing of various fertilizers. 2. To understand the manufacturing of inorganic chemicals. 3. To Study various natural products industries. 4. To study the various fermentation and coal based chemical industries. 5. To understand manufacturing of various polymers.		
SYLLABUS			
Module-I	Introduction to chemical process technology. Fertilizers Industry: Instrumentation diagrams and process symbols. Ammonia, Urea and NPK.		**5 Hrs**
Module-II	Inorganic Chemical Industries: Manufacture of Soda ash, Caustic Soda and Chlorine. Manufacture of Sulphuric acid, Hydrochloric acid and Nitric acid. Manufacture of Silicon and Calcium carbide.		**7 Hrs**
Module-III	Natural Products Industries: Paper & pulp industries. Manufacture of sugar and allied products. Extraction and refining of edible oil. Fat splitting and hydrogenation of oil. Soaps, detergents and recovery of glycerine.		**8 Hrs**
Module-IV	Fermentation Industries: Manufacture of industrial and absolute alcohol. Coal based chemical industries.		**5 Hrs**
Module-V	Polymerization industries: Polyethylene, polypropylene, PVC and polyester synthetic fibres.		**5 Hrs**
Essential Reading	1. C. L. Dryden, Outlines of Chemical Technology, Edited and Revised by M. Gopala Rao and S. Marshall, 3rd Ed., Affiliated East West, New Delhi, 1997. 2. T. G. Austin and S. Shreve, Chemical Process Industries, 5th Ed., McGraw Hill, New Delhi, 1984.		
Supplementary Reading	1. R. E. Kirk, and D. F. Othmer, Encyclopaedia of Chemical Technology, 4th Ed., Interscience, New York, 1991. 2. P. H. Groggins, Unit Processes in Organic Synthesis, 5th Ed., McGraw Hill, 1984		
Course Outcomes	CO1. Demonstrate the manufacturing of various fertilizers. CO2. Demonstrate the manufacturing of inorganic chemicals. CO3. Express the knowledge of various natural products industries. CO4. Demonstrate the various fermentation and coal based chemical industries. CO5. Develop the manufacturing of various polymers.		
Subject Code	**CS1204**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**2**
Subject Name	**Programming in Python**		
Course Objective	1: Introduction to Python Language and its features. 2: To understand the concept of Python Program using sequence data and Control statements. 3: To be able to understand and create User Defined Function. 4: To understand the concept of OOPs and its implementation. 5: To understand the concept of strings and file handling		
SYLLABUS			
Module-I	**Beginning Python Basics:** Introduction to Python Features of Python, Application of Python Data Types, Keywords, Identifiers, Literals, Constants. Python Indentation. Operators and expressions. Naming Conventions with examples, Managing Input and Output, Concept of Indentation. Conditional statement, Looping statements, break and continue, pass & return statements, Nesting of loops.		**6 Hrs**
Module-II	**Modules:** Built-in Modules, Import statement, Packages, Date and Time Modules. Array and its operations, Handling Strings and Characters, List: slicing, bound, cloning, nested list, list and methods, Adding Element: append, extend, count, index and insert). Mutability: Sort, reverse, remove, clear and pop. Map, Filter.		**8 Hrs**
Module-III	Tuple and methods, Sets and methods, Dictionary: Basic operation, iterator and methods. **Function:** Introduction to Functions, passing arguments, Anonymous functions (Lambda Function), Recursive Functions.		**6 Hrs**
Module-IV	**Object Oriented Programming:** Classes and Objects, Class methods. Encapsulation, Data Abstraction, Constructor, Destructor and Inheritance. **Exception Handling:** Handling Exceptions: try-except, try-finally		**6 Hrs**
Module-V	**Strings and Regular Expressions :** Methods of String Objects, Escape Sequence, Iterating Strings, String Module, String Formatting, Regular Expressions: Re-Module. **File Handling:** Introduction to File Handling, File Operations, Directories.		**4 Hrs**
Essential Reading	1. Python Programming for Beginners by Adam Stewart 2. Python Cookbook by David Beazley and Brian K. Jones		

Supplementary Reading	1. Introduction to Python Programming By Gowrishankar S. Veena A 2.Python Programming: Using Problem Solving Approach, Oxford University Press by Reema Thareja 3.Python Programming University Press by Ch Satyanarayan, M Radhika, B N Jagadesh		
Course Outcomes	CO1: Understand the Python Language and its features. CO2: Apply sequence data and control statements to solve problem CO3: Able to create user defined functions to solve problems. CO4: Analyze the concept of OOPs and its implementation. CO5: Create the python program using strings and files.		
Subject Code	**HS1202**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**2**
Subject Name	**Organizational Behaviour**		
Course Objective	1: To understand the relevance of organizational behavior concepts and theories in real-life organizational settings & to develop skills in critical thinking, decision –making, problem-solving in applying organizational behavior concepts to practical situations. 2: To provide an understanding of individual behavior in the workplace, including personality, motivation, perception, learning, and attitudes. 3: To understand the impact of team composition, diversity, and communication on team performance & to understand the role of motivation and leadership in managing organization. 4: To explore how organisational culture affects behavior, communication and decision making by enhancing creativity and innovation and give an episteme how to cope with change and stress. 5: To Develop intercultural competence, including awareness, knowledge, and skills for effective communication, negotiation, and collaboration across culture		
	SYLLABUS		
Module-I	**Fundamentals of OB & Understanding the Basic Framework of OB:** Evolution of OB through Quality Management movement, Definitions, Scope & Importance of OB,Challenges (Diversity, Globalisation& Ethical Perspective) and opportunities for OB, models of OB, applying OB to solving problems.		**6 Hrs**
Module-II	**Understanding the Determinants of Individual Behavior: Personality:** Determinants of personality, Theories of Personality (Type &Psychoanalytic theory), MBTI, Big five personality traits and other major traits influence workplace behavior. **Perception:** Meaning, Perceptual Process, Application of Perception at Workplace. **Motivation:** Motivation Framework, Content theory (Maslow's need hierarchy & Hertzberg's two factors theory), Process theory (Adam's Equity & Vroom's Expectancy theory), Job Design And motivation, Importance of motivation at Workplace. **Learning:** Theories of learning (Classical Conditioning, Operant Conditioning,& Cognitive Theory), Principles of Learning. Bhavioral modification through learning.		**6 Hrs**
Module-III	**Understanding Group and Team Behavior at Workplace: Group & Team:** Defining and classifying groups, the five-stage model of group development Group properties: Roles, norms, status, size and cohesiveness, Group decision making. **Leadership:** Meaning, Definition & types of leadership, Traditional theories of leadership: Trait theories, Behavioral theories, Contingency theories, Contemporary approaches to leadership, importance of leader in organisations.		**6 Hrs**
Module-IV	**Understanding Group and Team Behavior at Workplace:** **Organisational Culture:** Meaning, Definition, Cultural dimensions,effect of Organisational culture **Organisational Change & Development:** Nature, Levels & types of Change, Change Agents: Resistance to Change, Force field theory of Change, Managing the Change.		**6 Hrs**
Module-V	**Conflict & International Organisational Behavior:** **Managing Conflict and Negotiations:** Meaning,views, & levels of Conflict, Process of conflict, Conflict resolution techniques. **Transactional Analysis:** Meaning, Importance of TA, Life position, Ego states And their encounters. **IOB:** Internationalisation of Business, Cultural differences and similarities, Understanding Interpersonal behavior across culture through Hofstede's Cultural Dimensions		**6 Hrs**
Essential Reading	1. "Organizational Behavior: Text, Cases, & Games" by K. Aswathappa .Publisher: Himalaya Publishing House 2. "Essentials of Organizational Behavior" by Stephen P. Robbins and Timothy A. Judge. Publisher: Pearson Education.		
Supplementary Reading	1. "Organizational Behavior: Improving Performance and Commitment in the Workplace" by Jason A. Colquitt, Jeffery A. LePine, and Michael J. Wesson. Publisher: McGraw-Hill Education. 2. "Organizational Behavior: Human Behavior at Work" by John W. Newstrom and Keith Davis. Publisher: McGraw-Hill Education. 3. "Organizational Behavior: An Evidence-Based Approach" by Fred Luthans. Publisher: McGraw-Hill Education. 4. "Organizational Behavior: Emerging Knowledge, Global Reality" by Steven L. McShane and Mary Ann Von Glinow. Publisher: McGraw-Hill Education. 5. "Organizational Behavior and Management" by Ivancevich, Konopaske, and Matteson. Publisher: McGraw-Hill Education. 6. "Organizational Behavior: Theory, Research, and Practice" by John R. Schermerhorn Jr., James G. Hunt, and Richard N. Osborn. Publisher: Wiley		
Course Outcomes	CO1. Explain the importance of organizational behavior in improving individual and organizational effectiveness with Ethical practices. CO2. Evaluate the effectiveness of different leadership styles and their application in different situations. CO3.Develop critical thinking, Creativity& Innovation, problem-solving, and communication skills necessary for success in organisational settings. CO4. Develop strategies for managing organisational change effectively and maintainingsustainability. CO5. Apply organistional behavior concepts and theories to practical organisational situations.		
	SESSIONAL		
Subject Code	**CH1281**	**Total Contact Hour**	**16**
Semester	3rd	**Total Credit**	**1.5**
Subject Name	**Fluid Mechanics Laboratory**		
	List of Experiments		
1	Manometers –To find the pressure drop for flow through pipes.		
2	Fluidized bed – To determine minimum fluidization velocity and pressure drop		
3	Venturi meter– To find out the flow rate of fluid flowing inside a pipe.		
4	Reynold's Apparatus – To verify the flow whether it is laminar or turbulent.		
5	Bernoulli's Apparatus – To verify Bernoulli's equation.		
6	To measure the flow rate of a fluid by using V–Notch.		

7	To measure the flow rate of a fluid by using rectangular Notch.		
8	Orifice Meter -To find out the flow rate of fluid flowing inside a pipe.		
Subject Code	**CH1282**	**Total Contact Hour**	**16**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Fuel Technology- I Laboratory**		
	List of Experiments		
1	To determine the composition of the supplied sample of Coal by Proximate Analysis.		
2	To perform the ultimate analysis of the supplied sample of coal		
3	To determine the Gross calorific value of the supplied sample of coal using Bomb Calorimeter.		
4	To determine the Gross calorific value of the supplied sample of coal using Automatic Bomb Calorimeter.		
5	To determination of Caking Index of the supplied sample of Coal		
6	To determine the wash ability characteristics of the supplied sample of Coal		
7	To determine the Swelling Index of the supplied sample of coal		
8	To ascertain the agglomerating characteristics of the coal sample.		
Subject Code	**CH1283**	**Total Contact Hour**	**18**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Process Technology Laboratory**		
	List of Experiments		
1	To prepare a soap and determination of the alkali content of soap.		
2	To determine the alkali content of soap.		
3	To determine the saponification value and bromine value of the oil.		
4	To determine the fat content of food stuff.		
5	To find the total organic carbon of the water sample.		
6	To find out the distribution coefficient of iodine in organic solvent and water.		
7	To determine the iron content of a given salt solution.		
8	To determine the lime content of the Portland cement.		
9	To determine the dye concentration using a spectrophotometer.		
Subject Code	**CS1284**	**Total Contact Hour**	**20**
Semester	**3rd**	**Total Credit**	**1.5**
Subject Name	**Programming in Python Laboratory**		
Course Objectives	1: Introduction to Python Language and its features. 2: To understand the concept of Python Program using sequence data and Control statements. 3: To be able to understand and create User Defined Function. 4: To understand the concept of OOPs and its implementation. 5: To understand the concept of strings and file handling		
	List of Experiments		
1	Program on basics of python Programming Language.		
2	Program on basic Data Structures in Python.		
3	Program on Conversion from on data type to another.		
4	Program on Functions in Python.		
5	Program using Object Oriented Programming in Python.		
6	Program using Inheritance in Python.		
7	Program using String in Python.		
8	Program using Regular expression in Python.		
9	Program using File Handling in Python.		
10	Program using basics of Pandas and Matplotlib module in Python.		
Course Outcomes	CO1: Understand the Python Language and its features. CO2: Apply sequence data and control statements to solve problem CO3: Able to create user defined functions to solve problems. CO4: Analyze the concept of OOPs and its implementation. CO5: Create the python program using strings and files.		

4TH SEMESTER

Subject Code	**MA1202**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**3**
Subject Name	**Numerical Methods in Engineering**		
	SYLLABUS		
Module-I	Logic: Proposition and logical operation, conditional statement, methods of proof, mathematical induction. Counting principle: permutation and combination, principle of inclusion and exclusion, pigeonhole principle		**6 Hrs**
Module-II	Relations: Properties of relations, equivalence relations, closure properties of relations, transitive closure by Warshall's algorithm.		**6 Hrs**
Module-III	Recursive definition and structural induction, recurrence relations, solution to recurrence relations, generating functions, partially ordered sets, Hass diagram, lattice, finite Boolean algebra.		**6 Hrs**
Module-IV	Graph Theory: Introduction to graph theory, Graph terminology, Representation of graphs, Isomorphism, Euler and Hamiltonian paths, Planar graph, Graph coloring, Introduction to trees, Application of trees.		**6 Hrs**
Module-V	Semi groups, monoids, groups, subgroups, cosets, Lagrange theorem, permuation groups, isomorphism, homomorphisms, normal subgroups, definitions and examples only for (Rings, integral domain and fields).		**6 Hrs**
Essential Reading	1.Kenneth H Rosen, "Discrete mathematics and its applications", McGraw hill international. 2. C.L Liu, "Elements of Discrete mathematics" McGraw hill international 3. B. Kolman, R C Bosby,. S Ross, " Discrete mathematical structure", PHI		

Course Outcomes	The objective of this course is to familiarize the prospective engineers with techniques in Discrete Mathematics. It aims to equip the students to deal with advanced level of Discrete Mathematics that would be essential for Engineering disciplines, especially for Computer Science, IT, Electronics, Electrical Engineering. **The Students will Learn :** CO1. To enrich knowledge of inference and logic CO2. To deal with problems that involves Warshall's algorithm. CO3. To apply Boolean algebra in engineering fields. CO4.To learn applications of graph theory in daily life CO5.To be familiar with groups, rings and fields in industry.		
Subject Code	**CH1204**	**Total Contact Hour**	**30**
Semester	4th	**Total Credit**	**3**
Subject Name	**Mechanical Operations**		
Pre-requisites	Basic knowledge in mathematics and science		
Course Objective	1. This course acquaints the students of the mechanical method of sizing, separating & transportation of particles. 2. To impart the basic concepts of mechanical operations 3. To develop an understanding of size analysis, size reduction, and solid handling 4. Understand mechanical separation methods such as filtration, sedimentation, transportation of solids etc and associated equipment used for achieving these methods 5. The students are exposed to basic theory, calculations, and machinery involved in various solid handling operations.		
	SYLLABUS		**Contact Hours**
Module-I	Properties and storage of solids: Characteristics of solid particles and solids in bulk. Size Reduction: Objectives, Methods, and Principles of size reduction, Size reduction equipments: Coarse, Intermediate, and Fine Crushers and Ultra-fine grinders, Open & closed circuit grinding.		**7 Hrs**
Module-II	Solid-solid separation: Screening, Electrical separation, Classification, Gravity concentration, and Floatation and their latest equipments.		**5 Hrs**
Module-III	Solid-liquid separation: Sedimentation and equipments (Thickeners and clarifiers), Filtration: Theory and equipments.		**6 Hrs**
Module-IV	Gas-solid separation: Principle and equipments. Transportation of solids: Conveyors and elevators		**6 Hrs**
Module-V	Mixing: Theory of solid and liquid mixing and their equipments. Size enlargement, Crystallization, Feeding, Weighing, and Coagulation.		**6 Hrs**
Essential Reading	1. C.M. Narayanan & B. C. Bhattacharyya, Mechanical Operation for Chemical Engineers, Khanna Publisher, Third Edition, 2005. 2. WI McCabe & JC Smith, P Harriot, Unit Operations of Chemical Engineering, McGraw Hill publication, 2005.		
Supplementary Reading	1. 1 M.C. Fuerstenau and K.N. Han, Principles of Mineral Processing, John Wiley, N.Y, 2003. 2. J. F. Richardson, J. H. Harker & J. Backhurst, Chemical Engineering Volume II, Butterworth-Heinemann,1stEdn, 2002		
Course Outcomes	CO1. Ability to understand fluid particle systems and equipment. CO2. Knowledge to select suitable size reduction equipment, solid-solid separation method and conveying system. CO3. Ability to analyze mixing processes. CO4. Understanding of different unit operations i.e. solid-solid, solid-liquid & gas-solid separations. CO5. Ability to understand about different storage & transportation devices for handling.		
Subject Code	**CH1205**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**3**
Subject Name	**Chemical Engineering Thermodynamics**		
Pre-requisites	**Basic of Mathematics and Chemistry**		
Course Objective	1. To understand the concept of system and surroundings 2. To study in detail about different laws of thermodynamics 3. To analyze the concept of Heat engine, refrigeration. 4. To use important concepts internal energy, enthalpy, entropy and apply the same to problems. 5. To understand the concept of steady state, equilibrium, VLE, Chemical Equilibrium and concept of fugacity.		
	SYLLABUS		**Contact Hours**
Module-I	Basic concepts: Thermodynamics system and surroundings, types of systems, Thermodynamic equilibrium and Phase Rule, Zeroth law of thermodynamics, State and Path functions, Concept of Ideal gas, Properties of pure fluids; P-V-T behaviour of pure substances, Virial equations of state, The Ideal gas, Applications of Virial equations, Cubic equation of state, Theorem of corresponding states. Heat Effects of Phase Change.		**7 Hrs**
Module-II	The first law of Thermodynamics, Concept of Internal Energy and Enthalpy, Application of First law to Open Systems, Heat Engine and Second Law Statements: Carnot Heat engine cycle and Second Law, Concept of Entropy, work function, Introduction to third law		**7 Hrs**
Module-III	Criteria of phase equilibrium, Ideal solutions, Raoult's law, P-x-y and T-x-y diagram for ideal solution, non – ideal behaviour, Partial Molar properties, Partial properties of Binary solution, Gibbs – Duhem equation,		**6 Hrs**
Module-IV	Concept of Fugacity and fugacity coefficient, Lewis – Randall Rule, Activity coefficient for VLE data, Solution thermodynamics – thermodynamic properties and VLE from equation of state, Concept of Chemical Potential		**5 Hrs**
Module-V	Concept of Excess Properties and Residual Properties, Chemical reaction equilibria: Introduction, Reaction Coordinate, criteria to chemical reactions, Gibbs energy change, equilibrium constant of reaction, effect of temperature		**5 Hrs**
Essential Reading	1. J. M. Smith, H. C. V. Ness and M. M. Abbot, Introduction to Chemical Engineering Thermodynamics, McGraw and Hills Publication, 2005 2. K.V. Narayanan, A Textbook of Chemical Engineering Thermodynamics, second edition, PHI Learning private limited, 2013 3. Stanley I Sandler, Chemical, Biochemical and Engineering Thermodynamics, Fifth edition, Willey.		
Supplementary Reading	1. P.K.Nag, Engineering Thermodynamics 5th Edition. 2. Y.A. Cengel, Thermodynamics an engineering approach, 9th Edition, Mc Graw Hill. 3. K. Denbigh, The principles of Chemical equilibria with applications in Chemistry and Chemical Engineering, 1981		

Course Outcomes	CO1.Apply the knowledge of contemporary issues related to chemical engineering thermodynamics. CO2. Apply the knowledge of phase equilibria in two-component and multi-component systems. CO3. Describe the thermodynamic properties of substances in gas or liquid state of ideal and real mixture. CO4.Describe intermolecular potential and excess property behaviour of multi-component systems. CO5.Apply the fundamental concepts of thermodynamics to engineering applications.

Subject Code	CH1206	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	3
Subject Name	**Chemical Process Calculation**		
Pre-requisites	**Basic of Mathematics and Chemistry**		
Course Objective	1. To develop the basic knowledge in material and energy balance in process streams. 2. To develop a systematic approach to make stoichiometric calculations. 3. To provide a solid foundation for developing skills for solving complex chemical engineering process problems. 4. To develop the basic knowledge in energy balance calculation. 5. To develop a basic understanding in thermophysics and thermochemistry.		
	SYLLABUS		**Contact Hours**
Module-I	Units and dimensions, composition of solids, liquids and gases, excess and limiting reactant, conversion, yield, Ideal gas equation, mixtures of ideal gases		**5 Hrs**
Module-II	Real gases, equations of state, vapor pressure and boiling point, Clapeyron equation, ClausiusClapeyron equation, Antoine equation, vapor pressure plot, Ideal solutions and Raoult's law.		**7 Hrs**
Module-III	Material balance calculations for unit operations like mixing, evaporation, crystallization, distillation, bypass, recycle and purging		**8 Hrs**
Module-IV	Internal energy, enthalpy, heat capacities, mean heat capacity, heat capacity of mixtures of gases, heat of fusion, heat of vaporization, Clapeyron equation, Trouton's rule, standard heat of reaction, combustion, and formation, Hess's law of constant heat summation		**5 Hrs**
Module-V	Effect of temperature on heat of reaction, temperature of reaction, adiabatic reaction temperature, adiabatic flame temperature.		**5 Hrs**
Essential Reading	1. Stoichiometry and process calculations, K.V.Narayanan, B.Lakshmikutty, PHI 2. Chemical process principles, Part 1, O.A.Hougen, K.M.Watson, R.A.Ragatz, CBS pub. 3. Elementary principles of chemical processes, Richard M.Felder, Ronald W.Rousseau, John Wiley & sons		
Supplementary Reading	1. Stoichiometry, B.I.Bhatt, S.M.Vora, MGH 2. Basic principles and calculations in chemical engineering, David M.Himmelblau, Pearson education pvt. ltd. 3. Chemical reactions and stoichiometry, R.K.Dave, Campus book international.		
Course Outcomes	CO1. Ability to make material balances on unit operations and processes. CO2. Knowledge to perform simultaneous material and energy balances. CO3. Understanding of ideal gas and real gas behavior. CO4. Understanding of bypass, recycle and purging operation. CO5. Understanding different enthalpy concentration charts, flame temperature.		

Subject Code	CS1209	**Total Contact Hour**	**3**
Semester	4th	**Total Credit**	**30**
Subject Name	Artificial Intelligence and Machine Learning		
Pre-requisites			
Course Objective	1.To familiarize students with the fundamental concepts, theories, and applications of Artificial intelligence& Machine learning. Students will gain insight into the various subfields of AI& ML. 2.Students will have a clear understanding of the fundamental concepts and terminology of Artificial intelligence& Machine learning, enabling them to discuss and comprehend AI-related topics. 3. Students will have a clear understanding about neural networks, Fuzzy logic. 4. Students will have a clear understanding about Clustering and related techniques. 5. Students will have a clear understanding about Classification and related techniques.		
	SYLLABUS		**Contact Hours**
Module-I	Introduction to Artificial Intelligence, Applications of AI, State-space problem, Problem solving by Intelligent search: BFE, DFS, Iterative Deepening Search, Hill climbing, Heuristic search: A*, AO*, MIN_MAX Algorithm, Alpha-beta cutoff		**8 Hrs**
Module-II	Knowledge representation and reasoning: Formalized symbolic logic, propositional logic, First-order predicate logic, wff conversion to clausal form, inference rules, resolution principle.		**5 Hrs**
Module-III	Unsupervised Learning: K-means, K-Medoids, Hierarchical clustering, Density based clustering, Validation Method: LOO, K-fold cross validation.		**5 Hrs**
Module-IV	Supervised Learning: Decision Tree, Naïve Bayes classifier, K-NN, Introduction to regression. Performance matrix: Confusion matrix, Precision, Recall, Sensitivity, Specificity, MAE, MSE		**6 Hrs**
Module-V	Neural Network Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks, Training of ANN, Back propagation, RBFNN.		**6 Hrs**
Essential Reading	1.E.Rich and K. Knight, Artificial Intelligence-TMH 2.Neuro Fuzzy and Soft Computing, J. S. R. JANG,C.T. Sun, E. Mitzutani, PHI		
Supplementary Reading	1.Artificial Intelligence, Dan W Patterson, Prentice Hall of India 2.Computational Intelligence Principles, Techniques and Applications, Amit Konar, Springer publication. 3. M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018		
Course Outcomes	CO1:Understand the basics of Search techniques, Knowledge representation and reasoning in Artificial Intelligence. CO2:Understand the Supervised machine learning and Unsupervised machine learning. CO3:Analyzevarious machine learning models. CO4:Implement various Supervised machine learning techniques and analyze them. CO5:Implement various Unsupervised machine learning techniques and analyze them.		

Subject Code	**HS1201**	**Total Contact Hour**	**30**
Semester	**4th**	**Total Credit**	**2**
Subject Name	**Engineering Economics**		
SYLLABUS			**Contact Hours**
Module-I	**Basic Principles of Economics:** Definition, Nature, Scope and significance of economics for Engineers. Demand & Supply and their Determinants,Elasticity-Government policies and application. Basic Macro economics concept: National income accounting (GDP/GNP/NI/Disposable Income etc) and identities for both closed and open economies.		**6 Hrs**
Module-II	**Utility Analysis:** Cardinal and ordinal measurability of utility, Assumptions of cardinal utility analysis, law of diminishing marginal utility, Consumer's equilibrium: Principle of equi-marginal utility; Indifference curve-Concepts, properties, Budget line, Equilibrium of the consumer, Revealed preference hypothesis, Individual choice under Risk and Uncertainty: St. Petersburg paradox and Bernoulli's hypothesis, Neumann-Morgenstern method of constructing utility index, Friedman-Savage hypothesis		**6 Hrs**
Module-III	**Production, Cost and Market Structure:** Production function: short run production function and law of variable proportion; Long run production function: Isoquants, isocost line, returns to scale, Optimum factor combinations, Cost Analysis: Concepts, Classification- Short run and Long run cost curves, Analytical and accounting cost concepts; Market structure: Market classifications, Perfect competition: Characteristics, price and output determination in Short run and long run, Monopoly market: Price and output determination, price discrimination Modern theories of firms: Baumol's theory of sales revenue maximisation, Bain's limit pricing model.		**6 Hrs**
Module-IV	**Money and Banking:** Money-Function of Money, Demand for Money Theory. Quantity theory of money; Banking: Commercial Banks and their Functions, Central bank's Functions. Role of the Banks in Economic Development, Monetary and Fiscal Policy Tools and their impact on the economy.		**6 Hrs**
Module-V	**Capital Budgeting and Investment Analysis:** Time value of money: use of cash flow diagram, Annual economic worth, present worth, future worth, Internal Rate of Return (IRR), Net Present Value (NPV), Payback period method, Analysis of public projects: Cost-Benefit analysis, Cost effectiveness		**6 Hrs**
Essential Reading	1. Koutsoyiannis, A. (1979). Modern Microeconomics. The Macmillan Press Ltd., London 2. Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, New Delhi 3. Panneerselvam, R. (2007). Engineering Economics, Prentice-Hall of India, New Delhi 4. Mankiw Gregory N. (2002). Principles of Economics, Thomson Asia		
Course Outcomes	CO1- Utilise economics principles in consumption process CO2- Describe the utility measurement and measure the utility associated with risk CO3- Efficient use of resources in production and take decision regarding optimum output CO4- Describe market mechanism and analyse product market to take proper decisions CO5- Implement economic principles in company related decision making		
	SESSIONAL		
Subject Code	**CH1284**	**Total Contact Hour**	**16**
Semester	**4th**	**Total Credit**	**1.5**
Subject Name	**Fuel Technology - II Laboratory**		
	List of Experiments		
1	To determine the cloud and pour point of a given fuel using cloud and pour point apparatus.		
2	To determine the flash and fire point of a given fuel by using Pensky-Martins apparatus		
3	To determine the Acid value of a given fuel/ lubricating oil		
4	To determine the viscosity of a given oil using Engler's viscometer.		
5	To determine the Aniline point of a given fuel or lubricating oil		
6	To determine the smoke point of a given oil using smoke point apparatus		
7	To determine the viscosity of a given oil sample using Red Wood viscometer		
8	To determine carbon residue of a given oil sample using Conradson Apparatus		
	SESSIONAL		
Subject Code	**CH1285**	**Total Contact Hour**	**16**
Semester	**4th**	**Total Credit**	**1.5**
Subject Name	**Chemical Engineering Thermodynamics Laboratory**		
Pre-requisites	None		
	List of Experiments		
1	To measure the specific latent heat of vaporization using an electric method.		
2	To do the study experiment of a water to water heat pump.		
3	To find out the C.O.P of the heat pump.		
4	To find out the dryness fraction of steam using a separating calorimeter.		
5	To do the study experiment of the air conditioner test rig.		
6	To find out the C.O.P of the air conditioner test rig.		
7	To construct the T-x-y plot for Binary Vapour Liquid Equilibrium for a given mixture		
8	To determine the Vapour Liquid Equilibrium curve for a given mixture		
	SESSIONAL		
Subject Code	**CH1286**	**Total Contact Hour**	**20**
Semester	**4th**	**Total Credit**	**1.5**
Subject Name	**Mechanical Operation Laboratory**		
Course Objective			
	List of Experiments		
1	To find out the average size of particles in a sample (Volume-surface mean dia).		
2	To determine the critical speed and time of grinding in a ball mill for producing a product with 80% passing a given screen.		
3	To separate a mixture of coal into two fractions using froth flotation apparatus.		
4	Determination of the effectiveness of a vibrating screen.		
5	To study the characteristics of batch sedimentation using coal samples.		
6	To determine the specific cake resistance and filter medium resistance of a slurry in Plate and frame filter press.		
7	To separate a mixture of sand and iron powder by means of tabling.		
8	To find out the reduction ratio in Jaw Crusher and Hammer Mill.		

9	To find out the separation characteristics of Cyclone separators.
10	To study the operation of a magnetic separator and finding its efficiency.

	SESSIONAL		
Subject Code	**CH1287**	**Total Contact Hour**	**20**
Semester	4th	**Total Credit**	**1.5**
Subject Name	**Environmental Engineering Laboratory**		
	List of Experiments		
1	To determine the pH value of given water samples.		
2	To determine turbidity of given water samples.		
3	To determine the hardness of a given samples by soap solution method.		
4	To determine the acidity of given water samples.		
5	To determine the alkalinity of given water samples.		
6	To determine the residual chlorine of given water samples.		
7	To determine the total solid of given samples.		
8	To determine chloride content of given water samples.		
9	To determine the BOD of given water samples.		
10	To determine the COD of given water samples.		