Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
215ESE05	INTRODUCTION TO CHEMICAL ENGINEERING	3	0	0	3	50	50	100

Objectives:

1. To provide students about the basic knowledge of chemical engineering and concept about unit operations and process calculations
2. To know the basic concepts and applications regarding flow of fluids
3. To learn the basics of heat and mass transfer operations

Unit - I OVERVIEW OF CHEMICAL ENGINEERING Hours: 09

Role of chemical engineers in various disciplines, Chemical Industry-scope, Chemical and Allied Industries, Concepts of unit operations and unit processes, flow sheets and symbols for various operations. Manufacturing of Sulphuric acid and soda ash.

Unit - II BASICS OF PROCESS CALCULATIONS Hours: 09

Basic definitions - gram mole, Normality, Molality, Weight percent, Mole percent, Volume percent, Gases- Ideal gas, Dalton's and Amagat's Law, Relationship between Partial Pressure & Mole Fraction, Average Molecular Weight, Density of gas, Raoult's law & Henry's law. Material balance: Distillation, Extraction & Evaporation, Energy balance: Heat capacity, Heat of Reaction, Heat of Combustion, Hess's Law, Adiabatic process, Latent Heat. Calculations for simple systems.

Unit - III BASIC FLUID CONCEPTS Hours: 09

Dimensions and Units, Viscosity & Surface Tension, Newtonian fluids, Dimensional Analysis- Buckingham PI theorem, Types of flows, Principles of Flow Measuring Devices- Orifice meter, Venturimeter and Rotameter.

Unit - IV HEAT TRANSFER OPERATIONS Hours: 09

Principles of Conduction, Convection and Radiation, Basic laws of Heat transfer- Fourier's law of conduction, Newton's law of Cooling , Stefan- Boltzman law, Wein's Displacement law and Planck's law, Natural and Forced Convection, Heat exchangers- Fundamental principles of Heat Exchangers and Evaporators.

Unit - V MASS TRANSFER OPERATIONS Hours: 09

Fundamental Principles and Operations of simple and steam Distillation, Basics of Drying and extraction-equipments, Introduction to chemical reactors- batch, continuous and semi continuous reactors.

Total Hour: 45

Course Outcomes:

- Students can able to express the fundamental concepts of chemical engineering and to solve problems.
- Students can able to apply basic fluid flow concepts.
- Students can able to know the basics of process calculation.
- Students can able to analyze the basic concepts of heat transfer operations.
- Students can able to analyze the basic concepts of mass transfer operations.

Text Books:

1. Badger, Walter L. and Banchero, Julius T., "Introduction to Chemical Engineering", Tata McGraw Hill Publishers, New Delhi, 2002.
2. Ghosal. S.K., Sanyal, S.K., and Dutta, S., "Introduction to Chemical Engineering", Tata

McGraw Hill, 2006.

References:

1. W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, Sixth Edition, McGraw Hill, 2001.
2. Kenneth A.Solen, JohnN.Harb, Introduction to Chemical Engineering, 5th ed., Wiley India Pvt Ltd,2014.
3. Perry, R.H. "Chemical Engineers' Handbook", McGraw-HillPublications, 2007.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	2	1									3	2	
CO2	3	2	1	2									3	2	
CO3	3	3	2	1									3	1	
CO4	3	3	2	1									3	1	
CO5	3	3	2	1									3	1	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315CHT03	BS	Organic Chemistry	3	0	0	3	50	50	100

Objectives:

- To understand the basic nomenclature in reaction mechanism and organic synthetic methodology.
- To study the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds.

Prerequisite: Engineering Chemistry

Unit - I Organic Reactive intermediates Hours: 09

Generation, stability and reactivity of carbonations, carbanions, free radicals, carbenes, benzynes and nitrenes.

Unit - II Reaction Mechanism Hours: 09

Reduction-MPV, Clemmensen, Wolff-Kishner, Brich. *Oxidation*-Oxidation reactions through $KMnO_4$, OsO_4 and $K_2Cr_2O_7$ oxidants. Friedel-Crafts alkylation and acylation reactions-Nitration- Halogenations-Wittig-Mannich-Diels alder reactions.

Unit - III Heterocyclic Compounds Hours: 09

Preparation, Physical, Chemical properties and uses of Pyrrole, Furan, Furfural, Tetrahydrofuran, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline.

Unit - IV Synthetic Chemistry Hours: 09

Synthesis involving active methylene group (Malonic and acetoacetic esters)-Grignard reagent- Synthesis of Methyl red, Methyl orange, Congo red, Malachite green, para-rosaniline, phenolphthalein, fluorescence and Eosin dyes. Synthesis of Antimalarial drugs - isopentaquine and chloroquine. Synthesis of Antibacterial drugs - Sulphaniliamide and Sulphapyridine.

Unit - V Carbohydrates Hours: 09

Introduction - various definitions and classifications of carbohydrates - Preparation, Physical and Chemical properties- Structure and Uses of Monosaccharides (Glucose and Fructose) Interconversions - aldo pentose to aldo hexose-Aldo hexose to aldo pentose- aldose to isomeric ketose - ketose to isomeric aldose - aldose to epimer- Qualitative test for carbohydrates.

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1. Learn and understand the basic concepts in bonding
2. Understand organic reactions mechanism and rearrangements
3. Understand synthesis of different type of compounds and learn about dyes and carbohydrates.

Text Books:

1. Tiwari K.S. Vishnoi N.K. and Marhotra S.N., A text book of Organic Chemistry, II Edition , Vikas Publishing House Pvt.Ltd., (1998), New Delhi
2. P.L.Soni, A text book of Organic Chemistry, Sultan and Chand Publishers, (2001),New Delhi

References:

1. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition Prentice Hall Inc (1996) USA.
2. I.L.Finar Organic Chemistry Vol I (Fourth edition) Longmans 1963 plus I.L.Finar Organic Chemistry Vol II (Third edition) Longmans Green & Co.1964.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2	1									2	3	2	
CO3	3	2	1									2	3	2	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
315CHT04	Chemical Process Calculations	L	T	P	C	CA	EA	Total
		3	1	0	4	50	50	100

Course Objectives:

1 To become familiar with different unit systems and conversions

2 To understand the concepts of Stoichiometric calculations, different ways of expression of composition, vapour pressure and parameters affecting the vapour pressure and behaviour of ideal gases

3 To understand the concept of material balance & energy balance calculations and different techniques to solve the problems.

4 To apply the material balance calculations to different unit operations and unit processes

5 To understand different Fuels available and characterization of fuels based on its calorific value and combustion calculations of various fuels available

Unit - I **Units, Dimensions and Basic Calculations** Hours: 09

Basic and derived units - different ways of expressing units and quantities - conversion of units. Methods of expressing the composition of mixtures and solutions - weight percent - volume percent - mole fraction and mole percent - Density and Specific gravity. **Behavior of Ideal Gases:** Kinetic theory of gases - Applications of the Ideal gas law - Gaseous mixtures - Dalton's law, Amagat's Law and Henry's Law. **Vapor Pressure:** Liquefaction and the liquid state - vaporization - super heat and quality - boiling point - vapor pressure of solids - effect of temperature on vapor pressure - vapor pressure plots - vapor pressure of immiscible liquids - solutions - Raoult's Law - Equilibrium vapor pressure and composition - Non volatile solutes

Unit - II **Material Balance** Hours: 09

Material Balance without Chemical Reaction: Block Diagrams-Process Flow Sheet-Material Balances-Solving Models: Linear, Matrix, Graphical- Recycle, Bypass & Purge-Unsteady state operations. **Material Balance with Chemical Reaction:** Equations for Reactions-Concepts of Conversion, Yield, Selectivity, Limiting, Excess Reactants-Linear Model for solving problems-Electrochemical Reactions-Metallurgical Applications.

Unit - III **Energy Balance** Hours: 09

Definition of Heat capacity and Specific heat, Heat capacity of gases as a function of temperature, Mean heat capacity, heat capacity of mixture of gases. Heat capacities of solids and liquids - Kopp's rule and Trouton's rule. Standard heat of reaction, formation and combustion, Hess's law of heat summation and its application to determine heat of reaction, heat of neutralization, integral heat of solution, heat of mixing. Effect of pressure and temperature on heat of reaction. Theoretical and actual flame temperature in combustion calculations

Unit - IV **Unit Operations** Hours: 09

Stoichiometric principles - Application of material balance to unit operations - Distillation - Absorption - Extraction - Crystallisation - Evaporation - Drying. **Psychrometry:** Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Calculations based on Humidity chart - Dry bulb temperature - Wet bulb Temperature and Dew point.

Unit - V **Fuels and Combustion** Hours: 09

Types of Fuels:Solid, Liquid & Gas - Calorific Value - Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from

Orsat technique, problems on sulphur and sulphur burning compounds.

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1 Handle different unit systems and conversions between them without any confusion.
2 Understand the expression of compositions of different materials and calculate the other properties depending on Composition, Temperature & Pressure.
3 Apply the knowledge of material and energy balance calculations to different systems.
4 Calculate amounts of material and energy required to carry out a given unit operation and unit process.
5 Familiarize about various fuels available and can do combustion calculations for selection and operation of the fuel.

Text Books:

1 Bhatt.B.I and Thakore.S.B., "Stoichiometry", Fifthe Edition, McGraw-Hill Education (India) Private Limited, 2010.
2 Narayanan, K. V. and Lakshmikutty, B, "Stoichiometry and Process Calculations" Prentice Hall of India, 2009.

Reference Books:

1 Venkataramani, V and Anantharaman, N. "Process Calculations", Prentice Hall of India, 2003.
2 O.A. Hougen, K. M. Watson, and R. A. Ragatz, "Chemical Process Principles. Part I. Material and Energy Balances", 2nd Edition, CBS Publishers, 2004.
3 Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Seventh Edition, Prentice Hall of India, 2006.
4 Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",3rdEdn., John Wiley & Sons, New York, 2000.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	3									3	3		
CO2	3	3	3									3	3		
CO3	3	3	3									3	3		
CO4	3	3	3									3	3		
CO5	3		3									3	3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315EET05	ES	PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING	3	0	0	3	50	50	100

OBJECTIVES:

- To understand the basic concepts of magnetic circuits, AC & DC circuits.
- To explain the working principle, construction, applications of DC & ACmachines and measuring instruments.
- To gain knowledge about the electronic devices and applications.
- To understand the basic concepts of communication engineering.

Unit - I Fundamentals of DC Circuits Hours: 09

Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor , Kirchhoff's laws, Mesh analysis, Nodal analysis, Ideal sources -equivalent resistor, current division, voltage division - Faraday's laws, and induced emfs.

Unit - II AC Fundamentals Hours: 09

Sinusoids, Generation of AC, Average and RMS values, Form and peak factors, concept of phasor representation, J operator. Analysis of R-L, R-C, R-L-C circuits. Introduction to three phase systems - types of connections, relationship between line and phase values.

Unit - III Electrical Machines Hours: 09

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, basic principles of single phase and three phase induction Motor.

Unit - IV Semiconductor Devices and Applications Hours: 09

Characteristics of PN Junction Diode - Zener Effect - Zener Diode and its Characteristics - Bipolar Junction Transistor - CB, CE, CC Configurations. Half wave and Full wave Rectifiers - SCR characteristics.

Unit - V Electrical Drives Hours: 09

Speed control of DC series and shunt motors - Armature and field control, single phase controlled rectifiers - applications Speed control of three phase induction motor - Voltage control, voltage / frequency control- single phase inverters- applications.

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1. Acquire good understanding of basics of electrical circuits
2. Understand the working principles, performance, control and applications of electromechanical energy conversion systems.
3. Gain knowledge on construction and characteristics of various devices.
4. Learn about analyze the steady state behavior of converter fed DC drive.

Text Books:

1. Dash.S. S, Subramani.C, Vijayakumar.K,"Basic Electrical Engineering", Firstedition,Vijay Nicole Imprints Pvt.Ltd,2013

2. V.N. Mittle "Basic Electrical Engineering", TMH Edition, New Delhi, 1990.
3. R.S. Sedha, "Applied Electronics" S. Chand & Co., 2006.

Reference Books:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", TMH, Second Edition, (2006).
2. Nagsarkar T K and Sophia M S, "Basics of Electrical Engineering", Oxford press (2005).
3. Mehta V K, "Principles of Electronics", S.Chand& Company Ltd, (1994).
4. MahmoodNahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, (2002).
5. Premkumar N, "Basic Electrical Engineering", Anuradha Publishers, (2003).

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3		3	3										3	
CO2	3		3	3										3	
CO3	3		3	3										3	
CO4	3		3	3										3	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/ week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315CHE03	PE	Green Chemistry and Engineering	3	0	0	3	50	50	100

Course Objectives:

- To explore the importance of green chemistry to newer synthetic methods.
- To identify alternate solvents for the synthesis of fine chemicals.
- To obtain knowledge in process and operation

Unit - I INTRODUCTION-GREEN CHEMISTRY Hours: 09

Definition-Twelve Principles of Green Chemistry-Measure of Greenness-Safety and Risk Indices-Mass and Energy Indices-The Hierarchical Approach-The Sustainable Process Index.

Unit - II NEWER SYNTHETIC METHODS Hours: 09

Introduction-Use of Microwaves for Synthesis-Electro-Organic Methods-Elegant and Cost-Effective Synthetic Design-Catalysis and Green Chemistry.

Unit - III ALTERNATE SOLVENTS AND INDUSTRIAL EXAMPLES Hours: 09

Industries in Need of Support to Go Green-Safer Solvents-Green Solvents-Water as Solvent-Solvent free Conditions-Ionic Liquids-Maleic Anhydride Manufacturing Process-Surfactant Industry-Dye Industry-Tannery Industry.

Unit - IV PROCESS AND OPERATIONS Hours: 09

Industry Perception-Reactions-Reactor Designs-Micro Mixers-Unit Operations-Reactions with Separation Operations-Other New Reactor Designs-Process Integration - Solvent Recovery.

Unit - V ALTERNATE ENERGY SOURCES AND INHERENT SAFETY Hours: 09

Greenhouse Gases-Renewable Energy-Future Sources of Renewable Energy-Conflicts due to Inherently Safe Designs.

Total Hours: 45

Course Outcomes:

By the end of the course, students will be able to:

1 Familiarize the 12 principles of green chemistry.

2 Familiarize with synthetic design.

3 Understand the applications of green solvents.

4 Understand the design concepts of various reactor design.

5 Understand the alternate energy sources and inherent safety.

Text Books:

1 MukeshDoble and Anil Kumar Kruthiventi, Green Chemistry and Engineering, Academic Press, 2007.

2 Concepción Jiménez-González, David J.C. Constable, Green Chemistry and Engineering: A Practical Design Approach" 1st Edition, John Wiley & Sons, 2011.

Reference Book:

1 Paul T. Anastas, Julie B. Zimmerman. "Innovations in Green Chemistry and Green Engineering" 1st Edition, Springer, 2013.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	3						3	3	
CO2	3	2	3	3	2	3	3						3	2	
CO3	3	3	3	3	2	2	3						3	2	
CO4	3	3	3	3	2	2	3						3	2	
CO5	3	3	3	3	2	2	3						3	2	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/ Week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315CHE05	PE	Material Technology	3	0	0	3	50	50	100

Course Objectives:

- To gain knowledge on the nature of materials, its properties, and the use of materials in engineering
- To acquire an understanding about metallurgy and phase equilibrium
- To understand the important aspects of the chemistry of ferrous metal and non ferrous metals
- To gain knowledge on some selected composites, adhesives, FRPs and their applications
- To gain an understanding of the properties, manufacture and the applications of building materials

Unit - I NATURE OF MATERIALS Hours: 09

Importance of materials, Historical perspective, Selection process of engineering materials (General aspects)-Chemical and physical properties of materials-chemical structure: Micro and macro structure-corrosion resistance-chemical reactivity. Mechanical properties-stress, strain, strength, hardness, malleability, Brittleness, ductility-elasticity-plasticity-toughness, thermal stability. Types of deformation: Plastic, viscous; plastic deformation of single crystal, poly crystalline metals: slip, twinning, dislocations-visco elasticity-creep in metals, amorphous materials.

Unit - II METALLURGY Hours: 09

Extractive Metallurgy: Hydro, pyro and electro metallurgy-refining of metals. Powder Metallurgy: methods of production of metal powder-Mixing of metal powders-compaction of powders-applications. Extraction process of Iron: manufacture of pig iron-blast furnace operations-chemistry of reactions. Manufacture of cast iron-varieties of cast iron-effect of impurities. Production of steel-Bessemer process - open-hearth process-L D methods. Classification of steel-effect of impurities. Heat treatment process: annealing, hardening, tempering, normalizing and gas carburizing. Fe-Carbon phase diagram.

Unit - III NON - FERROUS METALS, ALLOYS Hours: 09

Extraction of Copper, Nickel, Lead-methods involved-properties and applications. Alloys of Cu, Ni andPb-brasses-bronzes-nickel with Cu, Zn, Cr,Fe, Mo-super alloys. Lead alloys-Pb with Sb, Sn.-applications.

Unit - IV COMPOSITES AND ADHESIVES Hours: 09

Polymer composites-introduction-Types of composites-particle reinforced-fiber reinforced-structural composites-examples. Matrix materials, reinforcement materials-Kevlar, Polyamides, fibers, glass, carbon fibers, ceramics and metals . Techniques for producing FRP-applications.

Unit - V BUILDING MATERIALS Hours: 09

Cement-types-portland cement-manufature-properties-uses-environmentaleffectsRefractories: properties of refractories-acidic, basic and neutral-manufacture of refractories-common refractory bricks-insulating refractories. Ceramics: Classification-fabrication methods of clay, silicon carbide, alumina, silicon nitride-Properties

of important engineering ceramics-applications. Abrasives: classification-applications.

Total Hours: 45

Course Outcomes:

By the end of the course, students will be able to

1 Understand the properties of materials and criteria for selecting the material.
2 Apply the principles of metallurgy and phase equilibrium
3 Predict the properties, manufacture and the applications of building materials
4 Describethe importance of the chemistry of ferrous metal and non-ferrous metals in industries.
5 Describe the composite materials, its importance and the different applications.

Text Books:

1 Khanna. O.P, "AText book of Material science and Metallurgy", Dhanpat Rai Publications, 1999.
2 Dara.S.S, "A text book of Engineering Chemistry", S.Chand and company Ltd., 2003.

Reference Books:

1 Rajput.R.K., "A Text book of Material Science and Engineering", S.K Kataria& Sons, Delhi, 2003.
2 Agarwal. C.V, "Chemistry of Engineering materials", Tata McCraws Hill,1997.
3 William F.Smith, "Foundation of Materials Science and Engineering", TataMcCraw Hill, 1998.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3			2			1	2		1		1		
CO2		1	3	3	1			1			1		1		
CO3			3		1	1	3	1	2		1	1	1		
CO4						1	3		2		1		2		
CO5		3	3						3		3	1	2		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315CHP07	BS	Organic Chemistry Laboratory	0	0	4	2	50	50	100

Objective:

To learn basic principles involved in analysis and synthesis of different organic derivatives.

List of Experiments:

1. Analysis of nature of organic compounds - To identify aliphatic / aromatic, saturated/unsaturated compounds.
2. Identification and Characterization of various functional groups by their characteristic reactions: a). alcohol, b) Aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) amide i) nitro compounds.
3. Introduction to organic Synthetic procedures:
   - i. Acetylation - Preparation of acetanilide from aniline.
   - ii. Nitration - Preparation of m-dinitrobenze from nitrobenzene.
   - iii. Oxidation - Preparation of benzoic acid from benzaldehyde / benzylalcohol.

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1. Analyze of nature of organic compounds.
2. Characterize the various functional groups
3. Analyze various organic synthetic compounds

Reference Books:

1. Vogel's Text Book of Practical Organic Chemistry, Fifth Edition, Longman Singapore Publishers PVT. Ltd., Singapore (1989).
2. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Departemnt, A.C. Tech, Anna University (2007).

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	1											3		
CO2	3	1											3		
CO3	3	1											3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	3	2											3		
CO3	3	2											3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315CHP08	PC	Technical Analysis Laboratory	0	0	4	2	50	50	100

Objective:

- To learn basic principles involved in estimation and characterization of industrially important materials.

List of Experiments:

1. Soap Analysis - Estimation of total fatty acid and percentage alkali content
2. Oil Analysis - Estimation of acid value and saponification value
3. Cement Analysis - Estimation of silica content, mixed oxide content and calcium oxide content
4. Fuel Analysis -Proximate analysis of coal
5. Fuel Analysis - Determination of kinematic viscosity using Redwood Viscometer
6. Fuel Analysis - Determination of Flash and Fire point
7. Fuel Analysis - Determination of Pour and Cloud point.
8. Water Analysis - Estimation of Total Dissolved Solid (TDS) and Total Suspended Solids (TSS)
9. Water Analysis - DO Analysis
10. Spectrophotometric Analysis - Determination of specific wavelength and concentration of unknown $KMnO_4$ solution
11. Analysis of Dye / Drug

List of Equipment:

1. Muffle furnace
2. Hot air oven
3. DO Meter
4. Redwood viscometer
5. Flash and Fire point Apparatus
6. Pour and Cloud point Apparatus
7. UV-Vis-Spectrophotometer

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1. Analyze experimentally the various properties of oils, soaps and cement.
2. Analyze and evaluate various properties of water by different methods
3. Analyze and evaluate different properties of various fuels

References:

1. Technical Analysis Manual, Chemistry Division, Chemical Engineering Department, A.C. Tech. Anna University, 2007.
2. Griffin,Hand book of Chemical Analysis

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering									
Course Code	Category	Course Title	Hours/week			Credits	Maximum Marks		
			L	T	P	C	CA	EA	Total
315CHP09	ES	Electrical Engineering Laboratory	0	0	4	2	50	50	100

(Common to B.E. Mechanical Engineering and B.Tech Chemical Engineering)

Objective:

- To gain knowledge on characteristics of Electrical machines and Electronic Devices

LIST OF EXPERIMENTS

1. Ohm's law and kirchoff's laws
2. Diode characteristics
3. Open circuit characteristics of a dc shunt generators
4. Load characteristics of a dc shunt generators
5. Load test of D.C. shunt motor
6. Load test on single phase induction motor
7. Equivalent circuit of a transformer
8. Swinburn's test
9. Load test on 3- phase squirrel cage induction motor
10. Load test on 1 -phase transformer
11. Characteristics of half and full wave rectifiers

Total Hours: 45

Course Outcome:

At the end of the course, students will be able to

1. Analyze the characteristics of DC generators
2. Analyze and test different DC motors
3. Test and analyze the different AC motors & transformers

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2												1	
CO2	3	2												1	
CO3	3	3												1	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
415NMT01	Numerical Methods	3	1	0	4	50	50	100

Objectives:

- This course gives a complete procedure for solving numerically different kinds of problems occurring in engineering and technology
- The students would be acquired with the basic concepts of numerical methods and their applications

Unit - I Solution of Equations and Eigen Value Problems Hours: 09+03

Solution of algebraic and transcendental equations - Fixed point iteration method - Newton Raphson method - Solution of linear system of equations - Gaussian elimination - Gauss-Jordon methods- Iterative methods of Gauss Jacobi and Gauss-Seidel - matrix Inversion of by Gauss Jordon method - Eigen values of a matrix by Power method

Unit - II Interpolation and Approximation Hours: 09+03

Interpolation with equal intervals - Newton's forward and backward difference formulae - Interpolation with unequal intervals - Lagrange interpolation - Newton's divided difference interpolation - Cubic splines

Unit - III Numerical Differentiation and Integration Hours: 09+03

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and 3/8 rules - Two point and Three point Gaussian quadrature formulae - Evaluation of double integrals by Trapezoidal and Simpsons's rules

Unit - IV Initial Value Problems For Ordinary Differential Equations Hours: 09+03

Single step method - Taylor's series method - Euler's Method - modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multistep methods - Milne's and Adam's - Bash forth predictor and corrector methods for solving first order equations.

Unit - V Boundary Value Problems in Ordinary and Partial Differential Equations Hours: 09+03

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain - One dimensional heat flow equation by explicit and implicit (Crank - Nicholson) methods - one dimensional wave equation by explicit method.

Total Hours: 60

Course Outcomes:

Upon completion of this course, the students would be able to

- Distinguish different iteration methods and apply them
- Apply different interpolation and approximation methods
- Apply different interpolation and approximation methods
- Find the numerical solution using appropriate differential and integral method
- Solve ordinary differential equations(Initial value problems) using different methods
- Enhance the knowledge of Laplace and Poison's equation and will apply in one dimensional heat equation.

Text Books:

1. Kandasamy, P., Thilagavathy, K and Gunavathy, K., "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2003.
2. Sankara Rao, K. "Numerical methods for Scientists and Engineers' 3rd Edition Prentice Hall of India Pvt.Ltd., New Delhi, 2007

References:

1. Grewal, B.S and Grewal, J.S., " Numerical Methods in Engineering and Science', 6th Edition, Khanna Publishers, New Delhi, 2004
2. Gerald, C.F, and Wheatley, P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2006.
3. Chapra, S. C and Canale, R.P. "Numerical Methods for Engineers", 5th Edition, Tata McGraw - Hill, New Delhi, 2007.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2	2											1	1
CO2	3	3	2											1	
CO3	3	2	1											1	
CO4	3	3	3											2	1
CO5	3	3	3									2		3	1

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
415CHT02	Physical Chemistry	3	0	0	3	50	50	100

Objectives:

- To acquire knowledge in the field of electro and thermo chemistry,.
- To acquire knowledge in solubility behavior, chemical reaction kinetics.
- To acquire knowledge in distribution and colloidal chemistry towards different applications.

Unit - I THERMOCHEMISTRY Hours: 09

Units of Energy changes - Heat of Reaction or Enthalpy of a Reaction - Exothermic and Endothermic Reactions - Thermo chemical Equations - Heat of Combustion - Heat of Solution - Heat of Neutralisation - Energy Changes during Transitions or Phase changes - Hess's Law of Constant Heat Summation - Applications of Hess's Law -Bond Energy- Measurement of the Heat of Reaction.

Unit - II DISTRIBUTION LAW Hours: 09

Nernst's Distribution Law-Thermodynamics of solutions-Thermo dynamical derivation of distribution law-Calculation of Partition coefficient- Determination of Equilibrium Constant from Partition Coefficient - Extraction with a Solvent - Multiple Extraction- Applications of Distribution Law.

Unit - III COLLOIDS AND COLLIGATIVE PROPERTIES Hours: 09

Types of colloidal systems - classification of colloids - lyophilic and lyophobic sols - kinetic-optical and electrical properties of colloids - theory of electrical double layer - protective colloids- gold number - emulsions - gels- application of colloids. Colligative properties - definition -thermodynamic aspect of lowering of vapour pressure - elevation of boiling point - depression of freezing point - osmotic pressure.

Unit - IV ELECTROCHEMISTRY Hours: 09

Faraday's law of electrolysis- specific- molar and equivalent conductances and their variation with dilution- transport number- Kohlrausch's law-applications of Kohlrausch's law-conductance measurements-applications. Theory of strong electrolytes-Arrhenius theory, limitations- Debye-Huckel theory of strong electrolytes- Onsager equation (no derivation)-solubility product and its applications-pH scale and buffer action.

Unit - V KINETICS AND CATALYSIS Hours: 09

Rate of a reaction-Order of a reaction - Examples and rate equations for Zero order, First order, Second order and Third order reactions -Molecularity of a reaction - Unimolecular and Bimolecular reactions - Half life period- Kinetics of parallel and opposing reactions - Activation energy - Arrhenius equation -Collision theory of reaction rates - Theory of absolute reaction rates - Michalis Menton kinetics of enzyme catalyzed reactions.

Total Hours: 45

Course Outcomes:

Upon completion of this course, the students would be able to

- Understand the thermo chemical reactions and applications of it.
- Understand Distribution law and can determine Equilibrium Constant from Partition Coefficient.
- Understand types, classification and applications of colloids.
- Understand the applications of electrochemistry.

- Determine the kinetics of all types of reaction.

Text Books:

1. Kund and Jain, Physical Chemistry, S. Chand and Company, New Delhi (2014).
2. Puri B.H. Sharma L.R. and M.S. Prathama, "Principles of Physical Chemisry", S. Chand and Company, New Delhi (2010).
3. B.S.Bahl, ArunBahl and G.D.Tuli, "Essentials of Physical Chemistry", S.Chand and Company, New Delhi (2011).

References:

1. Gordon M. Barrow, Physical Chemistry, Sixth Edition, Tata McGraw Hill (2005).
2. Peter Atkins & Julio de Paula, Atkins' Physical Chemistry, 7th Edition, Oxford university press (2011)

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2		3	3								3		
CO2	3	2		3	3								3		
CO3	3	2			3								3		
CO4	3	2			3								3		
CO5	3	3	3		3								3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
415CHT03	Instrumental Methods of Analysis	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To make the students understand the working principles of different types of instruments and their applications.
- To make the students understand the working principles molecular spectroscopy .
- To make the students understand concept electro analysis and surface microscopy

Unit - I UV-VISIBLE SPECTROSCOPY AND COLORIMETRY Hours: 09

Electromagnetic radiation- wave properties-Measurement of Transmittance and Absorbance - Beer Lambert law-Deviations & limitations. Principle, instrumentation (source, optical parts and detectors) and applications of UV-visible spectroscopy, Electronic transitions Determination of λ_{max} using Woodward-Fieser rules-Dubosqcolorimetry-Estimation of inorganic ions such as Fe, Ni using colorimetry.

Unit - II MOLECULAR SPECTROSCOPY Hours: 09

Theory of IR absorption spectrometry-fundamental vibration modes-finger print region-Mutual exclusion principle-Instrumentation of FTIR (IR radiation sources, optical parts and detectors)-hydrogen bonding determination-Theory and Principle of Raman spectroscopy - Instrumentation - applications.

Unit - III AAS, OPTICAL AND THERMAL METHODS Hours: 09

Principle and instrumentation of AAS-Application of AAS to Estimate metal ions. Principle, instrumentation and applications of refractometry. Principle, instrumentation and comparison of TGA, DTA and DSC-factors affecting the shape of thermograms- study of thermograms of compounds ($CuSO_4.5H_2O$, $CaC_2O_4.2H_2O$.

Unit - IV SEPARATION METHODS Hours: 09

General importance of CC, TLC, paper, ion-exchange, size exclusion, Liquid chromatography, partition chromatography, HPLC and GC-Band broadening and optimization of column performance- separation of organic compounds by column and TLC, Separation of amino acids and mixture of Cu, Co & Ni by paper-estimation of organic compounds by GC and HPLC.

Unit - V ELECTRO ANALYSIS AND SURFACE MICROSCOPY Hours: 09

Principle and working of potentiometry - Voltammetry - Cyclic and pulse voltammetry-Applications of voltammetry. Study of surfaces using SEM, TEM, SPM, AFM and STM (Principle, working and sample requirement only).

Total Hours: 45

Course Outcomes:

Upon completion of this course, the students will be able to

- Understand the principle behind UV-VIS spectroscopy and can perform calculations to determine concentrations.
- Understand the theory behind IR spectroscopy and applications of it.
- Understand the theory and applications of AAS, TGA and DTA.
- Understand different separation methods and applications of it in chromatography.
- Understand principle and application of electro analysis like SEM, TEM, SPM and STM.

Text Books:

1. Instrumental Methods of Analysis. D.A. Skoog, F. James Holler, Stanky, R.Crouch. Cengage Learning - 2012.
2. Instrumental Methods of Chemical Analysis, Gurdeep R.Chatwaal and Sham K.Anand, Himalaya Publishing House-2014.

Reference:

1. Instrumental Methods of Analysis (Chemistry) Hobart H. Willard, Lynne L. Merritt Jr., John A. Dean, seventh edition, Cengage Learning - 2014.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	1		3	3				1			1	2	3	1
CO2	3	1		3	3				1			1	2	3	1
CO3	3	1		3	3				1			1	2	3	1
CO4	3	1		3	3				1			1	2	3	1
CO5	3	1		3	3				1			1	2	3	1

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

DEPARTMENT OF CHEMICAL ENGINEERING								
Subject Code	Course Title	Hours/week			Credits	Maximum Marks		
415CHT04	Chemical Engineering Fluid Mechanics	L	T	P	C	IA	EA	Total
		3	0	0	3	50	50	100

OBJECTIVES

- To impart to the student knowledge on fluid properties,
- To impart to the student knowledge on fluid statics, dynamic characteristics for flow through pipes and porous medium,
- To impart to the student knowledge on flow measurement and fluid machineries.

UNIT I DIMENSIONAL ANALYSIS AND FLUID STATICS 9

Unit system - laws of dimensional homogeneity - the principle of dimensional homogeneity - the Pi - theorem - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies - hydrostatic pressure distributions- laws of buoyancy, Pressure drop measurements, types of manometers, decanters - gravity and centrifugal

UNIT II FLUID FLOW PHENOMENA 9

Nature of fluids - Physical properties of fluids - Compressible and incompressible fluids - Types of fluids-Newtonian and Non Newtonian fluids- types of flow - laminar and turbulent, concept of boundary layer. Basic equation of fluid flow - equations of continuity and momentum - energy equations - Bernoulli's equations with and without friction

UNIT III INCOMPRESSIBLE FLOW IN PIPES AND CHANNELS 9

Reynolds number regimes- internal versus viscous flow - laminar flow in pipes and annular pipe - Newtonian liquids - Hagen Poiseuille equations- laminar flow of non - Newtonian liquids - turbulent flow in pipes and channels head losses in fittings and valves

UNIT IV FLOW THROUGH PACKED BED AND FLUIDIZED BED 9

Flow past immersed bodies - skin and form drag - drag coefficients - fluid flow through packed bed - Ergun equation -mechanics of particle motion - terminal velocity - gravity and centrifugal settling- settling regimes- hindered settling

Fluidization - types of fluidization - conditions of fluidization - minimum fluidization velocity

UNIT V METERING AND TRANSPORTATION OF FLUIDS 9

Metering of fluids - orifice meter - venture meter- Pitot tube - Rotameter - weirs - notches - principle and application of Doppler effect and flow measurement - Valves - types of Valves- fluid moving machinery - centrifugal pumps - pump characteristics - positive displacement pumps reciprocating and rotator pumps - air lift and Diaphragm pumps - fans - blowers - compressors - steam jet ejector -selector and specifications

TOTAL: 45

Course Outcome:

Upon completion of this course, the students would be able to

1. Students can get the knowledge about the unit and dimensions and also about the role of pressure in the fluid flow and pressure measurement.
2. Students can get the knowledge about the types of fluid flow and also on the discharge measurement by using different equipment at different conditions.

3. Students would have knowledge on Fluid properties, their characteristics while static and during flow through ducts, pipes and porous medium.
4. Students get the idea about different types of forces, losses and their effects in the fluid flow.
5. Students get the knowledge about several machineries used to transport the fluid and their performance

TEXT BOOKS

1. McCabe, W.L, Smith J.C and Harriot .P., "Unit Operations in Chemical Engineering", Mc-Graw-Hill, 7th Edition, McGraw-Hill International Edition, 2005.
2. White, F.M., "Fluid Mechanics", 8th Edition, McGraw-Hill Inc., 2016.

REFERENCES

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Second Edition, McGraw-Hill, McGraw-Hill International Edition, 2005.
2. Coulson J.M. and Richardson J.E.., Chemical Engineering, Vol. 1 (3rd Edition) Pergamon Press.
3. YunusCengel and John Cimbala "Fluid Mechanics", McGraw-Hill Inc., 2014.
4. Munson, Okiishi, Huebsch, Rothmaye,"Fluid Mechanics", Wiley Inc. 2015
5. Shames, I.H., "Mechanics of Fluids", Third Edition, McGraw-Hill Inc., 1992.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3											3		
CO2	3	3		3									3		2
CO3	3	3											3		
CO4	3	3											3		
CO5		3	2	3									3		2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

DEPARTMENT OF CHEMICAL ENGINEERING								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
415CHT05	Mechanical Operations	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To study the principles of size reduction using various equipments
- To know the techniques of separating solids based on size by different methods
- To study the various aspects of mixing and agitation of solids and liquids and concept of filtration

Unit - I **Particle Technology** Hours: 09

Particle Technology - Characteristics of solid particles - screen analysis, Differential and cumulative mean diameters for mixture of particles, properties of particulate masses. Agglomeration and aggregation of particles - Handling and transport of solids, storage equipment for mechanical conveyors and elevators, pneumatic transport. Communition - principles of communition laws and energy requirements. Size reduction - Description and working of crushing and grinding equipment - jaw, Gyratory and Roll crusher, Hammer mill, Rod mill and Ball mill, Ultra-fine grinders. Cutting machines - Open and closed circuit grinding

Unit - II **Size Separation** Hours: 09

Size Separation: Industrial screening equipment - Grizzlies, Tromels and gyratory. Capacity and effectiveness of screen. Flotation, Frothing and dispersing agents' magnetic separation, electrostatic precipitators.

Classifiers, jigging. Sorting classifiers - Heavy medium and differential settling methods. Principle and working of cyclones and hydro cyclones.

Unit - III **Sedimentation** Hours: 09

Sedimentation: Flocculation - Batch sedimentation - Thickeners - Thickener design. Principles of centrifugal sedimentation - Centrifugal classifiers and decanters - tubular, disc, bowl and scroll centrifuges

Unit - IV **Filtration** Hours: 09

Filtration - equations for batch filtration. Description of plate and frame filter presses, shell and leaf filters. Rotary vacuum drum filters. Membrane filtration, Centrifugal filters. Filter aids, Theory of constant rate and centrifugal filtration.

Unit - V **Mixing and Agitation** Hours: 09

Mixing and Agitation: Agitation of liquids - Agitation equipment - Circulation velocities and power consumption in agitated vessels. Equipment for blending and mixing of liquids - Suspension of solid particles. Critical speed - Dispersion of gas in liquids. Gas holdup and power requirement. Dispersion of liquids in liquids. Equipment for mixing of solids and pastes - Mixers for dry powders - mixing index.

Total Hours: 45

Course Outcomes:

Upon completion of this course, the students would be able to

1. Decide the usage of equipment for industrial application with respect to size reduction.
2. Decide the necessary equipment to screen different particles.
3. Apply the knowledge of different blends and mixing techniques to liquids and solids.
4. Students will be able to understand the concept of filtration techniques.
5. Apply the usage of various filtration equipments and thickeners.

Text Books:

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.
2. Alan S. Foust,Leonard A. Wenzel, Curtis W. Clump, Louis Maus, L and Bryce Andersen "Principles of Unit Operations", Second Edition, Wiley India, 2008.
3. G.G.Brown, "Unit Operations", CBS publishers, 2005.

References:

3. Coulson, J.M and Richardson, J.F., "Chemical Engineering", Volume 2, Fourth Edition, Butterworth-Heineman, 2004.
4. Badger, Walter L. and Banchero, Julius T., "Introduction to Chemical Engineering", Tata McGraw Hill Publishers, New Delhi, 1998.
5. Brown, G.G., Unit Operations,CBS Publishers & Distributors, 2005.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	3	3				1						3		1
CO2	2	3	3				1						3		1
CO3	2	3	3				1						3		1
CO4	2	3	3				1						3		1
CO5	2	3	3				1						3		1

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
415CHE03	Renewable Energy Technology	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objective:

- To impart the basic concepts of Renewable Energy Technologies.
- To gain knowledge about energy harnessing methodology for sustainable development.
- To impart the basic concept on biomass

Unit - I **Introduction to Energy Sources** **Hours: 09**

Energy sources and their availability- Introduction, commercial or conventional energy sources, Energy Reserves of India, Energy Scenario of India. New energy technologies

Renewable energy sources- Prospects of renewable energy sources, Impact of renewable energy generation on Environment, Scope of Renewable energy in India.

Unit - II **Wind Energy and Geothermal Energy** **Hours: 09**

Wind Energy: Introduction- Wind Energy Conversion- Basic components of WECS, Classification of WECS, Types of Wind Energy collectors-Horizontal Axial and Vertical Axial Machines, Energy Storage- Application of Wind Energy- Safety Systems- Environmental Aspects.

Geothermal Energy: Introduction- Nature of Geothermal fields-Geothermal sources, Advantages and disadvantages of Geothermal Energy over other energy forms, Applications of Geothermal Energy.

Unit - III **Solar Energy and Ocean Energy** **Hours: 09**

Solar Energy: Solar Radiation: Introduction-Solar Constant; Solar Radiation measurements

Solar Energy Collectors: Flat Plate Collectors, Concentrating Collectors-Focusing and Non-Focusing type

Solar Energy Storage: Storage System- Solar Ponds- Applications of Solar Ponds.

Application of Solar Energy: Solar Water heating, Solar Water Heating, Solar Distillation, Solar Pumping, Solar Furnace, Solar Cooking.

Ocean Energy :Introduction - Methods of Ocean Thermal Electric Power Generation- Energy Utilization- Hybrid cycle, Energy from Tides- Basic principles of Tidal Power- Components of Tidal Power Plants-Operation Methods of utilization of Tidal Energy- Ocean Waves- Advantages and Disadvantages- Wave Energy- Energy Conversion Devices- Small Scale Hydroelectric plants - Turbines and Generators for small scale hydro-electric power plant

Unit - IV **Energy from Biomass** **Hours: 09**

Biomass: Introduction- Composition of biomass-Source of biomass for energy generation, Biomass conversion technologies-thermo chemical conversion, wet processes and dry processes, Methods for obtaining energy from Biomass

Biogas: Biogas Generation- Classification of Biogas Plants-Types of Biogas plant. Advantages and disadvantages of fixed dome and floating drum type biogas plants - Thermal Gasification and Application, Pyrolysis, Application of biogas in Automotive Engines.

Unit - V **Fuel Cell and MHD Power Generation** **Hours: 09**

Fuel Cells: Introduction, Principles of operation of Fuel Cell, Classification of Fuel cells, Types of fuel Cells, Advantages and Disadvantages of Fuel Cell.

MHD (Magneto Hydro Dynamic): Introduction, Principles of MHD power Generation, MHD systems- Open Cycle and Closed cycle system, Advantages and disadvantages of MHD systems, Cogeneration.

Total Hours: 45

Course Outcomes:

Upon completion of this course, the students would be able to

- Recognize the renewable energy sources with their situation and exploration in detail.
- Understand the different types of energy conversion systems in wind and geothermal energy.
- Understand the various energy conversion systems for solar and ocean energy harnessing.
- Familiarize multiple methods in biomass and biogas conversion and its application.
- Familiar withprinciple operation and application of energy produced from Fuel and MHD in industries.

Text Books:

1. Rai, G.D., "Non conventional energy sources", Khanna Publishers, 1st Edition, 2010.
2. Kothari,D.P.,Singal K.C., and RakeshRanjan, " Renewable Energy Sources and Emerging Technologies"PHI learning Private Limited, 2nd Edition, 2011.

Reference:

1. TasneemAbbasi, Abbasi, S.A., "Renewable Energy Sources their impact on global warming and pollution", PHI learning Private Limited, 1st Edition, 2011.
2. Chetan Singh Solanki, "Renewable Energy Technologies A Practical Guide for Beginners", PHI learning Private Limited, 1stEdition, 2009.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2						2						2		
CO2	2		3				2						2		
CO3	2						2						2		
CO4	2						2						2		
CO5	2		3				2						2		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

DEPARTMENT OF CHEMICAL ENGINEERING								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	IA	EA	Total
415CHP07	Fluid Mechanics Laboratory	0	0	4	2	50	50	100

AIM

To determine experimentally the flow characteristics of fluids and also to determine the efficiency of the flow measuring devices and fluid transport machineries.

OBJECTIVES:

To gain practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EXPERIMENTS

1. Determination of Venturi coefficient
2. Determination of Orifice coefficient
3. Pressure drop studies in packed column
4. Pressure drop studies in Fluidized bed
5. Development of Characteristic curves of Single stage centrifugal pump
6. Development of Characteristic curves of Multi stage centrifugal pump
7. Development of Characteristic curves of Submersible pump
8. Development of Characteristic curves of Reciprocating pump
9. Determination of coefficient of Rectangular notch
10. Determination of coefficient of Triangular notch
11. Determination of coefficient of Vertical orifice
12. Evaluation of head loss coefficients in pipe fittings
13. Determination of friction factor in flow through straight pipe
14. Calibration of Variable area meter

LIST OF EQUIPMENTS REQUIRED

1. Orifice Meter with U tube manometer
2. Venturi meter with U tube Manometer
3. V-notch and Rectangular Notch weirs
4. Straight pipes with U tube Manometers
5. Packed column with U tube manometer
6. Fluidized column with U tube manometer
7. Flow loops for pipes, fittings and valves with U tube manometer
8. Vertical orifice setup
9. Single stage centrifugal pump setup
10. Multi stage centrifugal pump setup
11. Submersible pump setup
12. Reciprocating pump setup
13. Rotameter

*Minimum 10 experiments shall be offered

Course Outcomes:

At the end of the sessions, students will be able to

1. Conduct experiments for fluid flow in circular pipes, orifice and venture meters.
2. Estimate the coefficient of rectangular and triangular notches.

3. Estimate head loss in pipe fittings.
4. Estimate coefficient of discharge for flow through open and closed channels, show relationship between Reynolds number and friction factor.
5. Perform characteristic studies of submersible and centrifugal pump

TEXT BOOKS

1. McCabe, W.L, Smith J.C and Harriot .P., "Unit Operations in Chemical Engineering", Mc-Graw-Hill, 7th Edition, McGraw-Hill International Edition, 2005.
2. White, F.M., "Fluid Mechanics", 8th Edition, McGraw-Hill Inc., 2016.

REFERENCES

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Second Edition, McGraw-Hill, McGraw-Hill International Edition, 2005.
2. Coulson J.M. and Richardson J.E.., Chemical Engineering, Vol. 1 (3rd Edition) Pergamon Press.
3. YunusCengel and John Cimbala "Fluid Mechanics", McGraw-Hill Inc., 2014.
4. Munson, Okiishi, Huebsch, Rothmaye,"Fluid Mechanics", Wiley Inc. 2015
5. Shames, I.H., "Mechanics of Fluids", Third Edition, McGraw-Hill Inc., 1992.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	2				1		3	3	
CO2	3	3	3	3	3	3	2				1		3	3	
CO3	3	3	3	3	3	3	2				1		3	3	
CO4	3	3	3	3	3	3	2				1		3	3	
CO5	3	3	3	3	3	3	2				1		3	3	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
415CHP08	Physical Chemistry Laboratory	L	T	P	C	CA	EA	Total
		0	0	4	2	50	50	100

Objectives:

- To estimate the amount and determine the various physico- chemical properties of different chemical compounds and mixtures
- To improve the practical knowledge on the properties and characteristics of solvents and mixtures

List of Experiments:

1. Determination of velocity constant of hydrolysis of ethyl acetate in alkaline medium
2. Determination of Transition Temperature (TT) of a hydrated salt by Thermometric method
3. Determination of surface tension of liquid using Stalagmometer
4. Determination of molecular weight of solute by Beckmann's method
5. Determination of molecular weight of solute by Rast's method
6. Determination of coefficient of viscosity using Ostwald viscometer
7. Determination of Critical Solution Temperature (CST) of Phenol-water system
8. Determination of rate constant of hydrolysis of ethyl acetate in acidic medium
9. Determination of surfactant's Critical Micelle Concentration (CMC) of sodium salt by conductivity method
10. Estimation of glucose using Polarimeter
11. Determination of partition co-efficient of benzoic acid between two immiscible solvents
12. Determination of molecular weight of a polymer by viscosity method.

List of Equipments:

1. Beckmann's apparatus
2. Thermometers (0 to 110°F)
3. Ostwald Viscometer
4. Drop Pipette
5. Polarimeter
6. Melting point apparatus
7. Transition Temperature apparatus

Total Hours: 45

Course Outcomes:

- Understand the principles, properties and characteristics of solvents and mixtures
- Determine the molecular weight of solute using different methods
- Determine the Critical Micelle Concentration (CMC) of a metal salt
- Apply the kinetics to hydrolysis of ester
- Determine the molecular weight of a polymer

Reference Books:

1. Vogel, A. L.,A text book of Quantitative inorganic Analysis, ELBS, London, 2009.
2. Alexander Findley,Physical Chemistry experiments, McGraw-Hill, Fourth Edition, 2015.
3. Shoemaker D.P. and Gardad, C.W., Experiments in Physical Chemistry, McGraw Hill, London, 2015

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3		3	3								3		
CO2	3	3		3	3								3		
CO3	3	2		3	3								3		
CO4	3	3	3	3	3								3		
CO5	3	2		3	3								3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
415CHP09	Mechanical Operations Lab	L	T	P	C	CA	EA	Total
		0	0	4	2	50	50	100

Objective:

- To impart practical knowledge and have an experience on various mechanical operations involving size reduction and size separation

List of Experiments:

1. Study of crushing strength (Work Index) of solid materials using jaw crusher
2. Study of crushing strength (Work Index) of solid materials using rod mill
3. Study of crushing strength (Work Index) of solid materials using drop weight crusher
4. Study of crushing strength (Work Index and Critical Speed) of solid materials using ball mill
5. Determining the average size of particles (cumulative and differential method) using Tyler Sieves
6. Study of characterization of filtration using the Plate and frame filter press.
7. Study of characterization of filtration using leaf filter
8. Study of separation efficiency (fine particles) using cyclone separator
9. Determining the minimum thickener area (Kynch Theory) by batch sedimentation method
10. Study of separation of fine particles using screens and determination of effectiveness factor
11. Determining the percentage purity of the given sample of mixture of sand and $CaCO_3$ by froth flotation

List of Equipment:

1. Jaw crusher
2. Rod Mill
3. Ball mill
4. Tyler sieving
5. Filter press
6. Leaf filter
7. Cyclone separator
8. 2 liter and one liter Glass Jars, Stop Clock
9. Screens of various mesh sizes
10. Drop weight crusher
11. Froth-Floatation

Total Hours: 45

Text Books:

McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.

Course Outcomes:

- Students will be able to determine work index, average particle size through experiments by crushers, ball mill, rod mill and conducting size analysis by various size sieves.
- Students will be able to design size separation equipments such as cycloneseparator, pressure and vacuum filters
- Students will be able to determine thickener area from batch sedimentation experiment

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3		3										3	1	
CO2	3		3										3	1	
CO3	3		3										3	1	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
515CHT01	Chemical Engineering Thermodynamics	3	1	0	4	50	50	100

Course Objectives:

- The Students will be well versed with the behavior of fluids under PVT conditions and also apply them for practical purpose. Main advantage will be to deal with power production and refrigeration processes. The study further provides a comprehensive exposition to theory and application of solution thermodynamics

Unit - I Basic Concepts and Laws of Thermodynamics Hours: 09 + 03

Terminologies of thermodynamics, categorization of systems and processes, Laws of Thermodynamics. Reversible and Irreversible process. Entropy change in reversible and irreversible process, Internal energy and entropy as a function of Temperature and pressure

Unit - II Thermodynamic Properties Hours: 09 + 03

PVT behavior gases. Equation of state. Thermodynamics relations, Maxwell relations. Fugacity and fugacity coefficients. Estimation of thermodynamic properties.

Unit - III Phase Equillibria and Vapour Liquid Equillibria Hours: 09 + 03

Phase equillibria - Activity and activity coefficients. Gibbs-Duhem equations. Van Laar equation, Margules equation, Consistency test, Prediction of VLE.

Unit - IV Chemical Reaction Equillibria Hours: 09 + 03

Criteria of equilibrium. Standard free energy change and equilibrium constants. Effect of temperature. Evaluation of equilibrium constants.

Unit - V Application of Laws of Thermodynamics Hours: 09 + 03

Compression and expansion of fluids. Theory of multistage compression. Refrigeration principles and applications.

Total Hours: 60

Course Outcomes:

At the end of the course, students will be able to

1 Outline the terminology associated with engineering thermodynamics, apply the concepts of heat, work and energy conversion to calculate heat and work quantities for industrial processes and predict the properties of ideal and real mixtures based on thermodynamic principles.

2 Apply the basic concepts of first and second laws of thermodynamics for the design and analyze of the open and closed system in chemical process plants

3 Predict the changes in the properties of real fluids undergoing changes in process plant equipment.

4 Use empirical correlations and experimental data to evaluate thermodynamic quantities that relate to the vapour-liquid or liquid-liquid equillibria of ideal and non-ideal chemical mixtures.

5 Determine equilibrium constants, standard enthalpy, Gibbs free energy and equilibrium compositions for single and multiple reaction systems.

Text Books:

1 Smith J.M., Van Ness H.C., Abbott M.M., Introduction to Chemical Engineering Thermodynamics, Seventh Edition, Tata McGraw Hill International Student Edition, 2007.

2 Narayanan K.V "A Text Book of Chemical Engineering Thermodynamics" Prentice Hall of India Pvt. Ltd. 2011.

Reference Books:

1 Dodge, B.F., Chemical Engineering Thermodynamics, McGraw Hill International Student Edition, 1960.

2 Sandler, S.I., Chemical and Engineering Thermodynamics, Second Edition, John Wiley International Student Edition, 1989.

3 Rao .Y.V.C., Chemical Engineering Thermodynamics, united press (India) ltd.1997.

4 Merle Potter, Craig Somerton., Schaum's outline of Thermodynamics for Engineers, Second Edition, McGraw Hill, 2009

5 Hendrick.C.Vanness, Michael M.Abbott., Schaum's outline of Thermodynamics with Chemical Applications, McGraw Hill Professional, 1989.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	3										3		
CO2	3	3	3										3	2	
CO3	3	2	3										3	2	
CO4	3	2	3										3	2	
CO5	3	2	3										3	3	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
515CHT02	Chemical Process Industries	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Course Objectives:

- To study the basic concepts of process industries and various methodology used in process industries
- To know the process methodology regarding chlorine and sulphur.
- To study the basic ideas of fertilizer and nitrogen and phosphorous industries.
- To know the process methodology regarding paper, pulp and oil industry.
- To study the process methodology regarding rubber and fiber industry.

Unit - I Introduction & Inorganic Chemical Industries Hours: 09

The role of a chemical engineers in process industries, Introduction to common devices used in manufacturing processes, block diagrams, flow charts and standard symbols used for devices, unit operations, unit process, process utilities and economics.

Manufacture of Soda ash, sodium bicarbonate, sodium chloride, caustic soda, Bleaching powder.

Unit - II Acid and Fertilized Industries Hours: 09

Sulphuric acid, Hydrochloric acid, Phosphoric acid, Ammonia and Nitric acid

Plant nutrients, growth elements and regulators. Manufacture of ammonium sulphate, ammonium nitrate, ammonium phosphate, potassium chloride, potassium sulphate, single, triple super phosphate and Urea.

Unit - III Pulp and Paper, Sugar Industries Hours: 09

Manufacture of pulp - different processes of pulping - Manufacture of paper and Boards.

Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

Unit - IV Oil & Dye Industries Hours: 09

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, soaps, synthetic detergents.

Manufacture of dye- Azo Dyes, anthraquinone dye, vat dyes, pigments and explosives - TNT, RDX & HMX.

Unit - V Rubber and Polymers, Synthetic Fibre and Film Industries Hours: 09

Monomers - Thermosetting and Thermoplastic materials, Natural rubber; Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic rubbers. Natural and synthetic fibers - properties of - Poly amides - manufacture of Nylon 6. 6. Polyesters Fibers - manufacturer of- Viscose Rayon production manufacture of films - PVC, Polyesters - polyethylene

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1 Acquire knowledge about basics of various aspects of process industries and understands the methods of production of different chemicals.

2 Get fundamental knowledge about plant and equipment design

3 Apply knowledge about sulphur, nitrogen and fertilizer industry.

4 Acquire knowledge about the Manufacturing and processing of paper and pulp, Sugar, byproducts of sugar and starch and oil, fat products.

5 Get skilled in monomers, types of polymers, properties and applications of Resins, types of rubbers. Know the properties and manufacture of Natural and synthetic fibers and films.

Text Books:

1 Austin, G.T.,Shreve's Chemical Process Industries, Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984.

2 Dryden, C.E., Outlines of Chemicals Technology, Edited and Revised by Gopala Rao, M. and M.Sittig, Third Edition, Affiliated East-West press, 1997.

Reference Books:

1 Shukla and G.N. Pandey "Text book on Chemical Technology", Vikas publishing company,1997

2 Kirk and Othmer,"Encyclopedia of Chemical Technology", Fifth Edition, Wiley, 2007.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	3	3	2			3					2	3		
CO2	2	3	3	2			3					2	3		
CO3	2	3	3	2			3					2	3		
CO4	2	3	3	2			3					2	3		
CO5	2	3	3	2			3					2	3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
515CHT03	Heat Transfer	3	0	0	3	50	50	100

Course Objectives:

- To provide an overall view of different modes of heat transfer applicable to process industries
- To impart the concept and functioning of different heat exchangers

Unit - I **Conduction** Hours: 09 + 03

Modes of heat transfer- basic laws of heat transfer - Fourier's law of heat conduction. One dimensional steady state heat conduction-Flat plate, hollow cylinder, hollow spheres and their composite structures. Heat transfer from extended surfaces and applications; Critical insulation thickness\radius. Introduction to transient heat conduction

Unit - II **Convection** Hours: 09 + 03

Natural and forced convection- Application of dimensional analysis for convection and dimensionless numbers. Natural and forced convection through vertical and horizontal plates and tubes

Unit - III **Radiations** Hours: 09 + 03

Nature of thermal radiations- Concept of grey and black bodies. Laws of radiations- Stefan's Boltzmann law, Kirchhoff's law and Planck's law. Radiation exchange between surfaces - plates and , cylinders. Radiation shield and its applications.

Unit - IV **Heat Transfer with Phase change** Hours: 09 + 03

Introduction to boiling and condensation- Condenser- vertical and horizontal.Evaporators- Types and application. Methods of feed In multiple effect evaporator. Calculation of steam consumption, steam economy and heat transfer area in single effect evaporator.

Unit - V **Heat Exchangers** Hours: 09 + 03

Types of Heat exchangers-LMTD -use of correction temperature factors-Fouling Heat transfer area for shall and tube and double pipe heat exchanger. Heat exchanger Effectiveness and NTU .Wilson plot applications. Compact heat exchanger -applications.

Total Hours: 60

Course Outcomes:

By the end of the course, students will be able to

1 Distinguish different modes of heat transfer

2 Find the rate of heat transfer with and without change of phase

3 Evaluate film coefficients in convection under different situations (forced, natural convection, Boiling and Condensation Heat)

4 Decide the type of evaporator required for a specific purpose

5 Analyze the concepts of heat exchangers

Text Books:

1 McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.

2 BinayK.Dutta "Heat Transfer Principles and Applications", Prentice Hall of India, 2001.

3 Holman, J.P., " Heat Transfer", Mcgraw Hill Education, Tenth Edition, 2009

Reference Books:

1 Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Sixth Edition, Butterworth, 2001.

2 Kern, D.Q., "Process Heat Transfer", McGraw-Hill - Revised Edition - 1999

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3											3		
CO2	3	3	1	2									3		2
CO3	3	3	3										3		
CO4	3		3	3									3		2
CO5	3	3											3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
515CHT04	Mass transfer - I	3	0	0	3	50	50	100

Course Objectives:

- To understand the mass diffusion .fundamentals in gas, Liquid and solid mediums
- To understand the interphase mass transfer and transfer coefficient concepts.
- To Understand the mass transfer operations and design calculations in humidification, drying and crystallization operations

Prerequisite: Fundamentals of process calculations, fluid flow and heat flow

Unit - I **Diffusion** Hours: 09 + 03

Molecular and eddy diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow conditions Diffusivity measurement and prediction, multicomponent diffusion, diffusion in solids and its applications

Unit - II **Mass Transfer Coefficients** Hours: 09 + 03

Concept of mass transfer coefficients, mass transfer under laminar and turbulent flow past solids, boundary layers, mass transfer at fluids surfaces correlation of mass transfer coefficients, HTU, and NTU concepts, theories of mass transfer and their applications, interphase mass transfer and over all mass transfer coefficients in binary systems; application to gas-liquid and liquid-liquid systems

Unit - III **Humidification and Air Conditioning** Hours: 09 + 03

Basic concepts, psychrometric chart construction, Humidification and dehumidification operations, design calculations, cooling tower principle, operation, types and design calculations.

Unit - IV **Drying** Hours: 09 + 03

Theory and mechanism of drying, drying characteristics of materials, batch and continuous drying, drying equipment, design and performance of various drying equipments, Vacuum Drying.

Unit - V **Crystallization** Hours: 09 + 03

Nuclei formation and crystal growth, theory of crystallization, growth coefficients and the factors affecting the crystallization, batch and continuous industrial crystallizers, design principles.

Total Hours: 60

Course Outcomes:

By the end of the course, students will be able to

1 Write rate equations for mass transfer operations

2 Apply the diffusion principles in mass transfer calculations

3 Apply the concepts of inter phase mass transfer in gas- liquid, liquid-liquid and solid - liquid mass transfer operations

4 Design Cooling towers, dryers and crystallizers

Text Books:

1 Treybal, R.E., "Mass Transfer Operations", McGraw-Hill Kogakusha, 1980.

2 Anantharaman, N., Begum, K. M. MeeraSheriffa, Mass Transfer : Theory And Practice, PHI Learning, 2011.

3 Binay K.Dutta "Principles of Mass Transfer and Separation Processes", Prentice Hall India, 2007.

4 Narayan K.V.,"Mass Transfer Theory & Applications",CBS Publishers & Distributors, 2014

Reference Books:

1 McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.

2 Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Sixth Edition, Butterworth, 2001.

3 Foust, A.S.Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", Second Edition, Wiley, 1980.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	2										3		
CO2	3	2	3										3		
CO3	3		3										3		
CO4	2	3											3	1	
CO5	3	2					1						3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
515CHE01	Process Instrumentation	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Course Objectives:

- To give fundamental concepts about different instruments in chemical process industries
- To study the instruments and their applications that leads to safety of employee and industry.

Unit - I Hours: 09

Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer, static accuracy and response of thermometry

Thermo electricity: Industrial thermocouples, thermo couple wires, thermo couple wells and response of thermo couples

Unit - II Hours: 09

Thermal coefficient of resistance, industrial resistance, thermometer bulbs and circuits, radiation receiving elements, radiation photo electric and optical pyrometers

Composition analysis, spectroscopic analysis by absorption, emission, mass and color measurement spectrometers, gas analysis by thermal conductivity, analysis of moisture, refractometer

Unit - III Hours: 09

Pressure vacuum and head: liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids, static accuracy and response of pressure gauges

Unit - IV Hours: 09

Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, measurement of interface level, density measurement, and level of dry materials

Head flow meters, area flow meters, open channel meters, viscosity meters, quantity meters, flow of dry materials, viscosity measurements

Unit - V Hours: 09

Recording instruments, indicating and signaling instruments, transmission of instrument readings, controls center, instrumentation diagram, process analysis

Total Hours: 45

Course Outcomes:

By the end of the course, students will be able to

1 Understand the working mechanism of important instruments used in process industry.
2 Learn the applications of various instruments in the required fields.

Text Book:

1 Donald P.Eckman , "Industrial instrumentation" , 1st Edition, CBS, 2004

Reference Books:

1 Patranabis. D, "Principles of industrial instrumentation" 3rd Edition, Tata McGraw Hill, 2010

2 Gregory K. McMillan, Douglas M. Considine"Process/ Industrial Instruments And Controls Handbook", 5th Edition, Tata McGraw Hill.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	E	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2											3		1
CO2	3	2	3										3		1
CO3	3	2	3										3		1
CO4	3	2	2	3									3		1
CO5	3	2	2	3	1								3	1	2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
515CHP07	Heat Transfer Laboratory	0	0	4	2	50	50	100

Course Objectives:

- To determine the heat transfer coefficient in different equipments.
- To have a wide knowledge on the conductive, convective and radiation type of heat transfer under different operative conditions.

List of Experiments:

1. Determination of the natural convective heat transfer coefficient for a vertical tube
2. Determination of forced convective heat transfer coefficient for air flowing through a pipe
3. Determination of thermal conductivity of a Lagged material
4. Determination of Emissivity of a grey surface
5. Determination of thermal conductivity of a metal rod
6. Determination of heat transfer coefficient of Pin-Fin Apparatus (Natural and Forced Convection).
7. Determination of thermal conductivity of an insulating powder
8. Determination of Stefan Boltzmann Constant
9. Determination of overall heat transfer coefficient in double pipe heat exchanger
10. Determination of overall heat transfer coefficient in horizontal condenser
11. Boiling heat transfer experiment.
12. Single effect evaporator.

List of Equipment

1. Natural Convection Experimental Setup
2. Forced Convection Experimental Setup
3. Heat Transfer Through Lagged Pipe Setup
4. Emissivity Experiment Setup
5. Thermal Conductivity of a Metal Rod Setup
6. Pin-Fin Apparatus
7. Insulating Powder Experiment Setup
8. Stefan Boltzmann Constant Apparatus
9. Double Pipe Heat Exchanger Setup
10. Horizontal Condenser Setup

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1 Determine the thermal conductivity for various conductors and Stefan Boltzmann constants through experiments.

2 Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipments including heat exchangers, condensers.

3 Determine the heat transfer co-efficient under natural and forced convection mode of heat transfer.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	2										3		
CO2	3	3	2										3		
CO3	3	3	2										3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
515CHP08	Chemical Engineering Computational Laboratory	0	0	4	2	50	50	100

Course Objectives:

- To acquire basic knowledge on the different mass transfer operations
- To carry out experiments and to find certain parameters like diffusivity, mass transfer coefficient, efficiency of a process
- To gain knowledge on the different distillation operations

List of Experiments

Numerical Oriented Computation using C / C++/MATLAB and Excel Programming

1. The Solution of Non linear equation, f(x) = 0
   a. Fixed - Point Iteration
   b. Bisection Method
   c. Regular falsi method
   d. Newton Rapson Iteration
   e. SecantMethod
   f. Newton - Rapson Method in two dimension.
2. The Solution of Linear Systems AX = B
   a. Back substitution
   b. Upper Triangularization followed by back substitution
   c. PA = LU Factorization with Pivoting
   d. Jacobi Iteration
   e. Gauss Seidal Iteration
3. Interpolation and polynomial approximation
   a. Evaluation of a Taylor's series
   b. Lagrange Approximation
4. Curve Fitting
   a. Least Square Line
   b.Non-Linear curve Fitting
5. Numerical Differentiation
   a. Differentiation using Limits
   b. Differentiation using Extrapolation
   c. Differentiation based on N + 1 Nodes
6. Numerial Integration
   a. Compositie Trapezoidal Rule
   b. Composite Simpson Rule
7. Numerical Optimization
   a. Golden Search for minimum
8. Solution of differential equation
   a. Euler's Method
   b. R.K. Method
   c. Predictor - Corrector Method
9. Solution of Partial Differential Equation
   a. Finite - Difference Solution for the Wave Equation
   b. Forward - Difference method for the Heat Equation
   c. Crank - Nicholson Method.

Total Hours: 45

Course Outcomes:

At the end of the course, students will be able to

1 Apply the basic principles of mass transfer operations

2 Perform experiments and determine diffusivity, mass transfer rate, drying rate, efficiency in leaching/extraction operations and mass transfer coefficient of a given system using fundamental principles

3 Identify a mass transfer operation for the separation of a mixture into its pure components

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	3	2	1	1									3	
CO2	2	3	2	1	1									3	
CO3	2	3	2	1	1									3	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
515CHP09	Employability Skills Lab	L	T	P	C	CA	EA	Total
		0	0	4	2	50	50	100

Objectives:

- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them enrich their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their career.
- To enhance the performance of the students in the recruitment processes, self enhancement and launching start ups.

Listening Audios and answering MCQs - Watching video clips on famous speeches, motivational videos, documentaries and answering MCQs - Listening Comprehension and TED talks.

Prepared talk - Extempore - story knitting - Picture Talk - Brainstorming - Debates - Group Discussions - Elevator Speech - Mock HR Interviews - Story Narration - Miming - Short Skits.

Reading Comprehension - Verbal Analogy - Classification - Alphabet Test - Logical Sequence of Words - Statement & Conclusions - Statement & Courses of Action - Situation Reaction Test - Theme Detection - Deriving Conclusions from Passages.

Business Letters - Email Writing (hints development) - Essay Writing - Paragraph Writing - Paraphrasing.

Vocabulary Test (GRE, TOEFL, TOEIC & CAT Exam words) - Confused Pair of words - Contronyms - One Word Substitution - Sequencing of Sentences - Sentence correction.

Total Hours: 45

Course Outcomes:

On completion of the course, the students shall have the ability to:

1: Comprehend the various strategies of listening and its significance.
2: Articulate their views clearly and concisely with self-confidence and persuasiveness.
3: Understand the prevailing practices of testing in the recruitment process by the corporates and the institutional selection processes.
4: Communicate the corporate and social requirements in an impressive written mode.
5: Enhance their verbal skills in the screening tests competently both for recruitment and pursuing higher studies as well.

Text Books:

1. Agarwal R. S., A Modern Approach to Verbal and Non-verbal Reasoning, Chand & Co., New Delhi, 2012.

References:

1. Lingua: Essays for TOEFL/IELTS, Dreamtech Press, New Delhi, 2016.

2. Lily Mangalam, Global English Comprehension, Allied Publishers Pvt. Ltd., New Delhi, 2014.
3. Sharon Weiner Green and Ira K. Wolf, Barron's GRE, Glagotia Publications Pvt. Ltd., 18th Edition, New Delhi, 2011.
4. Mohamed Elias, R. Gupta's IELTS/TOEFL Essays, Ramesh Publishing House, 6th Edition, New Delhi, 2016.

Lab Requirements:

1. Teacher console and systems for students.
2. English Language Lab Software
3. Career Lab Software

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1										3		3	-	-	-
CO2										3		3	-	-	-
CO3										3		2	-	-	-

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
615CHT01	Mass Transfer - II	3	0	0	3	50	50	100

SEMESTER VI

Objectives:

- To discuss the fundamental concepts of mass transfer operations and principles
- To provide students with the theoretical or analytical background to understand mass transfer operations.
- To understand the basic concepts regarding extraction and leaching.

Unit - I Absorption Hours: 09

Equilibrium and operating line concept in absorption calculations; selection of solvent for absorption, types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of HETP, NTU, HTU and overall volumetric mass transfer coefficients; multi component absorption; absorption with chemical reaction.

Unit - II Distillation -I Hours: 09

Vapour-liquid equilibria, Raoult's law, positive and negative deviations from ideality, flash distillation, steam distillation and differential distillation for binary mixtures, Continuous rectification - binary systems, multistage tray towers - method of McCabe and Thiele, enriching section, stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, types of condensers, tray efficiencies.

Unit - III Distillation -II Hours: 09

The Ponchon-Savarit method; the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios; continuous contact distillation, packed tower design calculations; extractive and azeotropic distillation, comparison of azeotropic and extractive distillation, low pressure distillation. Introduction to multi component distillation

Unit - IV Liquid-Liquid Extraction Hours: 09

Equilibrium in ternary systems; solvent selection, equilibrium stage wise contact calculations for batch and continuous extractors, differential contact extraction equipment - spray, packed and mechanically agitated extractors; pulsed extractors, centrifugal extractors; selection of extractors.

Unit - V Solid-Liquid Extraction (Leaching), Membrane Separation Process and Adsorption Hours: 09

Solid-liquid equilibria; leaching equipment-batch and continuous types; calculation of number of stages. Principle of Ion exchange techniques and applications; Solid and liquid membranes; Concept of Osmosis; Reverse osmosis; Dialysis and Electro dialysis;

Microfiltration; Ultrafilteration. Theories of adsorption of gases and liquids; industrial adsorbents, adsorption equipment for batch and continuous operations; principles of ion-exchange.

Course Outcomes:

1. Able to apply mass transfer and separation principles in several unit operations like absorption, distillation.
2. Able to determine the number of theoretical stages in a stage-wise mass transfer processes
3. Able to determine the height requirements of continuous separation columns.
4. Able to apply mass transfer and separation principles in several unit operations like liquid-liquid extraction, leaching and adsorption.
5. Able to understand the principle of ion exchange.

Text Books:

1. Treybal, R.E., "Mass Transfer Operations", McGraw-Hill, Kogakusha, 1980
2. Binay. K.Dutta,"Principles of Mass Transfer and separation processes, Prentice Hall of India,2007
3. Anantharaman, N., Begum, K. M. MeeraSheriffa, "Mass Transfer: Theory and Practice", Prentice hall of India, 2011.

References:

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005
2. Roman Zarfyki and AndrzejChacuk, "Absorption Fundamentals and Applications", Pergamon Press, 1993.
3. Wankat,"Equilibrium Stage Separations", Prentice Hall, 1993

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	3	3									1	3		
CO2	2	3	3										3		
CO3	2	3	3									1	3		
CO4	2	3	3									1	3		
CO5	2	3	3									1	3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
615CHT02	Chemical Reaction Engineering	L	T	P	C	CA	EA	Total
		3	1	0	4	50	50	100

Objective:

- To understand the basic concepts of kinetics, types of reactors, non ideality in reactors.
- To study the various types of reactors used to carry out single and multiple reactions.
- To gain knowledge on the selection of right type of reactor for the required reaction

Unit - I CHEMICAL KINETICS Hours: 09+03

Need of chemical reaction engineering, reaction system, chemical kinetics, rate equation, elementary and non-elementary equations, molecularity and order, dependence of rate on concentration, temperature dependency term of rate equation, concept of activation energy-arrhenius, collision theory, transition state theory, determination of rate equation for non-elementary reactions.

Unit - II IDEAL REACTORS Hours: 09+03

Introduction to batch reactors, semi-batch reactors, plug-flow reactors, mixed-flow reactors, packed-bed reactors, fluidized-bed reactors, concept of ideal flow, space time and velocity, performance of design equations for batch, plug-flow reactors, mixed-flow reactors, methods to determine order of a reaction, integral and differential methods of analysis of data, half -life method.

Unit - III SINGLE AND MULTIPLE REATOR SYSTEMS Hours: 09+03

Design for single reaction, size comparison of single reactor, multiple reactor system, PFR in series and parallel equal size MFR in series, determination of best system for CSTR, introduction to multiple reactions, series and parallel and independent reactions, qualitative analysis of product distribution, determination of quantity of reactants to be maintained in the system for various contacting patterns.

Unit - IV IDEAL AND NON-IDEAL FLOW Hours: 09+03

Reason for non-ideality, resident time distribution, e-curve, f-curve, relationship between e and f curve, relationship between mean resident time and space time, state of aggregation, micro and macro fluids, earliness and lateness of mixing and basic methods for non-ideal reactors like tank in series model.

Unit - V HETEROGENOUS REACTION Hours: 09+03

Introduction to catalytic reaction, promoters, poisons, preparation of catalyst, determination of surface area and pore volume, fluid -solid reactions, selection of a model, introduction to shrinking -core model, determination of rate-controlling step, resistance afford by a gas film, chemical reactions, diffusion.

Total Hours: 60

Course Outcomes:

1. Students will be able to apply the basic principles of reaction kinetics, reactor design and non ideality in reactors in process industries
2. Students will be able to choose a suitable single or multiple reactor system for a given process
3. Students will be able to design a reactor for a given process in industries

4. Students will be acquire basic knowledge on non ideal flow reactors.
5. Students will be to understand the concept of heterogeneous reactions.

Text Books:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd ed., WEE, 1999
2. Fogler H.S., "Elements of Chemical Reaction Engineering", 4th ed., PHI, 2005

References:

1. J.M.Smith, "Chemical Engineering Kinetics", 3 rd ed., MGH, 1981
2. Lanny D. Schmidt, "The Engineering of Chemical Reactions", 2nd Edition, Oxford University Press, 2007

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2		2									3		
CO2	3	3	2	3									3		
CO3	3	2	2	3									3		
CO4	3	2	3										3		
CO5	3	3		3									3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
615CHT03	Process Dynamics and Control	3	0	0	3	50	50	100

Objectives:

- To introduce control equipments used to control the production process of a chemical factory and to introduce the control mechanism thro' automation and computers
- To gain knowledge in designing a control system and identifying the alternative control configuration for a given process plant or entire plant.
- To become familiar with the control mechanism before attempting to tackle process control problems

Unit - I Introduction Hours: 09

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics

Unit - II Loop control systems Hours: 09

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, Transfer function for controllers and final control element, transportation lag, transient response of closed-loop control systems and their stability

Unit - III Frequency response of closed-loop systems Hours: 09

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, stability criterion, Nyquist diagram; Tuning of controller settings

Unit - IV Advanced control systems Hours: 09

Introduction to advanced control systems, fractional order control, cascade control, ratio control, override control, nonlinear and adaptive control, valve position control, split range control and feed forward control, introduction to DCS & Fractional order controls. Control design by frequency response techniques.

Unit - V Dynamics and control of chemical reactors Hours: 09

Dynamics and control of chemical reactors, bioreactors, distillation columns, condensers, boilers and heat exchangers. Introduction to computer control of chemical processes, Microprocessor based controllers and distributed control systems.

Total Hours: 45

Course Outcomes:

1. Students understand the prerequisites of control strategies.
2. Students will be able to design of process control systems.
3. Students will be able to suggest the suitable controllers for different chemical process.
4. Students will be able to understand the concept of advanced control systems.
5. Students will be able to design control systems.

Text Books:

1. Coughanowr and Koppel, "Process Systems Analysis and Control", McGraw-Hill, New York, 1991
2. George Stephanopolous, "Chemical Process Control", Prentice-Hall of India Pvt. Ltd.,

New Delhi, 1990.
3. William L.Luyben/Michael L.Luyben, Essentials of Process Control, McGraw - Hill Companies, Inc., 1997.

Reference:

1. Thomas, E.Marlin, Process Control, 2nd Edn, McGraw-Hills International Edn. 2000.
2. Peter Harriott, Process control, Tata McGraw-Hill Publishing Co., Reprint 2004.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3											3		
CO2	3	3	2										3		
CO3	3	3											3		
CO4	3	3	3										3		
CO5	2				3								3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
615CHT04	Chemical Process Plant Safety	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To provide effective knowledge about process plant layout and various safety programmes
- To know about the importance of industrial safety, safety performances and importance of prevention of accidents
- To provide knowledge about Health hazards and legal aspects regarding safety

Unit - I Introduction to Safety Programmes Hours: 09

Safety in industries; need for development; importance safety consciousness in Indian chemical industry; social environmental setup; tolerance limit of the society; psychological attitude towards safety programmes. Elements of safety programme; effective realization; economic and social benefits; effective communication training at various levels of production and operation

Unit - II Toxicology - Industrial hygiene Hours: 09

Toxicology: entry, elimination and effects of toxicants on organisms, toxicological studies, dose versus response, relative toxicity and threshold limit values. Color codes of chemicals, first aid.
Industrial hygiene: laws and regulations, OSHA, EPA, DHS and material safety data sheets. Identification, evaluation and control of industrial hygiene. Mock drill.

Unit - III Fires and Explosions Hours: 09

The fire triangle, distinction between fires and explosion, definitions, flammability characteristics of liquids and vapors. Limiting oxygen concentration and inerting, flammability diagram, ignition energy, auto ignition, auto oxidation, adiabatic compression, ignition sources, sprays and mist explosions.
Prevention of fires and explosions: inerting static electricity, explosion proof equipment and instruments, ventilation and sprinkler systems.

Unit - IV Chemical Reactivity, Hazards Hours: 09

Chemical Reactivity: Identification, characterization and control of reactive chemical hazards.
Reliefs: Concepts, definitions. Location, types and characteristics. Relief systems.
Hazards identification: process hazard check list, hazard survey, hazards and operability studies(HAZOP), safety reviews.

Unit - V Risk assessment, safety procedures and design Hours: 09

Risk assessment: review of probability theory, event tree analysis, fault tree analysis, quantitative risk analysis(QRA), layers of protection analysis (LOPA)
Safety Procedures and Designs: Process safety hierarchy and strategies, managing safety operating procedure, permit procedures, safety reviews and accident investigation.
Designs of process safety, fires and explosions run away reactions and handling dust

Total Hours: 45

Course Outcome:

1. Student understands various safety principles.
2. Student gets the ability to do Hazard analysis.
3. Student gets the ability to identify various accidents ..
4. Students will be able to provide proper remedial measures.
5. Students will be able to understand the safe working environment

Text Books:

1. Ridley, Safety at Work, Seventh Edition, Butterworth-Heinman, 2007.
2. William Handley, Industrial Safety Hand Book McGraw-Hill Book Company, 2nd Edition, 1977.
3. Fawatt, H.H. and Wood, W.S. Safety and Accident Prevention in Chemical Operation, Interscience, 1965.

Reference:

1. Heinrich, H.W. Dan Peterson, P.E. and Nester Rood. Industrial Accident Prevention, McGraw-Hill Book Co., 1980
2. Blake, R.P., Industrial Safety, Prentice Hall Inc., New Jersy - 3rd Edn. 1963.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3					3	1						2		
CO2	2	2							1				2		
CO3	3	2				2			2				2		
CO4	2		2			2			2				2		2
CO5	2	1	1			2	3		1			2	2		2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
615CHE02	Industrial Management	3	0	0	3	50	50	100

Objective:

- To understand fundamental concepts and principles of management, including the basic roles, skills and functions of management
- To be knowledgeable of historical development, theoretical aspects and practice application of managerial process
- To be familiar with interactions between the environment, technology, human resources and organizations in order to achieve high performance

Unit - I Basics of Management Hours:09

Introduction, Definition of management, characteristics of management, functions of management - Planning, Organising, Staffing, Directing, Co-ordination, Controlling,Motivating, Communication, Decision Making, Principles of management - F.W.Taylor, HenryFayol, Elton Mayo, Administration and management, Nature of management, levels ofmanagement, managerial skills, managerial roles, Forms of Organization- Line , Line -staffetc. Forms of ownerships - Partnership, Proprietorship, Joint stock, Co-operative society, Govt. Sector etc, concept of Globalisation

Unit - II Strategic Management Hours:09

Military origins of strategy - Evolution - Concept and Characteristics of strategicmanagement - Defining strategy - Mintzberg's 5P's of strategy - Corporate, Business andFunctional Levels of strategy - Strategic Management Process. Preparing an EnvironmentalThreat and Opportunity Profile (ETOP) - Industry Analysis - Porter's Five Forces Model ofcompetition.BCG Matrix - GE 9 Cell Model -Balanced Scorecard, Generic CompetitiveStrategies: Low cost, Differentiation, Focus.

Unit - III Quality Management Hours:09

Definition of quality, goalpost view of quality, continuous improvement definition of quality,types of quality - quality of design, conformance and performance, phases of qualitymanagement, Juran's and Demings view of quality, Quality Management Assistance Tools:Ishikawa diagram - Pareto Analysis - Pokka Yoke (Mistake Proofing).quality circles, TQM,Kaizen, Five S (5S), Six sigma Quality Management Standards (Introductory aspects only)-The ISO 9001:2000 Quality Management System Standard- The ISO 14001:2004Environmental Management System Standard- ISO 27001:2005 Information SecurityManagement System

Unit - IV Financial & Project Management Hours:09

Capital Structure, Fixed & working capital, Role of Securities and Exchange Board of India(SEBI), function of money market and capital Market, sources of finance. Introduction tocapital budgeting, Techniques of capital budgeting. Break even analysis - assumptions,importance, Cost-Benefit analysis, CVP graph, Project Management, Project networkanalysis, CPM, PERT and Project crashing and resource Leveling.

Unit - V Human Resource Development Hours:09

Strategic importance HRM; objectives of HRM; challenges to HR professionals; role,Responsibilities and competencies of HR professionals; HR department operations; HumanResource Planning - objectives and process; human resource information system. Talent acquisition; recruitment and selection strategies, career planning and management, training and development, investment in training programme; executive development.

Total Hours: 45

Course Outcomes:

- Students understand the function of leadership and organizing culture, importance of quality control in process and planning operations.
- Students understand the necessity of planning process and objectives, decision making processes under different conditions.
- Students understand the nature and purpose of organization and importance of staffing selection recruitment.
- Students understand the function of leadership and organizing culture.
- Students understand importance of quality control in process and planning operations.

Text Books:

1. P. Khanna, "Industrial Engineering and Management", Dhanpatrai publications Ltd, New Delhi.

2. L.C.Jhamb , SavitriJhamb , Industrial Management - I , Everest Publishing House

Reference:

1. Dinesh Seth and Subhash C. Rastogi, "Global Management Solutions", Cengage Learning, Second Edition, USA.
2. M.Y. Khan and P. K. Jain, "Financial Management", Tata McGraw Hill, New Delhi
3. Ravi M. Kishore, "Project Management", Tata McGraw Hill, New Delhi

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1								3		2	3	3			2
CO2	1					1	1	2	1	2	3	3			1
CO3								3			3	2			1
CO4								3	2	3	3	2			1
CO5	2	1				2	2	3	1	2	3	2			1

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
615CHE06	Food Science and Technology	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Course Objectives:

1 To create awareness on the need for processing and preservatives of Foods.

2 To design processing equipments for Food Industries.

Unit - I An Overview of Food Industry, Food Constituents Quality and Derivative Factor Hours: 09

General aspects of food industry, world food needs and Indian situation. Constituents of food - Proteins, Lipids and Vitamins, quality and nutritive aspects, food additives, Preservatives, Flavours, standards, deteriorative factors and their control.

Unit - II General Engineering Aspects in Food Microbiology and Processing Methods Hours: 09

Food and microorganisms, Microbes in food spoilage and control; Microbial agents in food borne illness; Food engineering operations, food sorting, cleaning, grading, harvesting, winnowing, drying and storage. Conversion and preservation operations.

Unit - III Heat Preservation and Processing Hours: 09

Degrees of preservation, Selection of Heat treatments, Heat resistance of microorganisms, heat transfer, protective effects of Food constituents, Inoculated Pack studies, Temperature-Time combinations, Heating before or After packaging, Government regulations.

Unit - IV Cold Preservation and Processing Hours: 09

Preservation by Refrigeration and cool storage, Freezing and Frozen storage, dehydration, concentration, drying irradiation, microwave heating, sterilization and pasteurization, fermentation and pickling, packing methods.

Unit - V Production and Utilization of Food Products Hours: 09

Cereal grains, pulses, vegetables, fruits, spices, fats and oils, bakery, confectionery and chocolate products, soft and alcoholic beverages, dairy products, meat, poultry and fish products. Food detoxification, Production of starch and aminoacids.

Total Hours: 45

Course Outcomes:

By the end of the course, students will be able to:

1 Understand the problems related to food and food industries by implementing properties related to food.
2 Apply the basic skills related to heat preservation, cold preservation with processing and various methods followed for that in food processing industries.
3 Apply the knowledge in aspects of food microbiology, production and utilization of various food products and the processing.
4 Understand the methods of Cold Preservation and Storage
5 Understand the Production and Utilization of Food Products

Text Books:

1 Potter N.N., "Food Science", 5th Ed., CBS Publishers, 2007.
2 Frazier W.C., Westhoff D.C., "Food Microbiology", 5th Ed., McGraw Hill Publishing Co., 2013.
3 Heid J.L. Joslyn M.A., "Fundamentals of Food Processing Operation", The AVI publishing Co., West port, 1967.
4 Sivasankar. B, "Food Processing and Preservation", PHI publications, 2002.

References:

1 Heldman D.R., "Food Process Engineering", The AVI publishing co., 1981.
2 Charm S.E., "The Fundamentals of Foods Engineering", 2nd Edition, The AVI Publishing Co., Westport, 1971.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	1	1			1	1	2		1			2			1
CO2	2	2		1		1	1	2				2			1
CO3	2	2				2	2	2	1						1
CO4	2					2	2	2	1	2		2			1
CO5	2					2	2	1	1	2		1			

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
615CHP07	Process Control Laboratory	0	0	4	2	50	50	100

Objectives:

- To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.
- To gain knowledge on the development and use of right type of control dynamics for process control under different operative conditions.

List of Experiments:

1. Evaluation of time constant of Thermometer
2. Study of two tank Interacting system
3. Study of two tank Non-Interacting system
4. Simulation of First order system
5. Simulation of Second order system
6. Optimum Controller tuning by closed loop method
7. Optimum Controller tuning by open loop method
8. Simulation of P,PI,PID controller
9. Evaluation of parameters of second order system by simulation
10. Control valve characteristics with and without positioned
11. Modeling of second order over damped system
12. Simulation of nonlinear system

List of Equipment:

Control valve characteristics setup

1. Time constant of Thermometer setup
2. Interacting, Non-Interacting setup
3. 10 Computers with MATLAB

*Minimum 10 experiments shall be offered

Total Hours: 45

Course Outcomes:

1. Understands the importance of dynamics of process in controller design
2. Students will be able to design of controller and evaluation of its performance
3. Students will be able to use MATLAB Simu-link software in dynamic study of processes, and design of controllers.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2			3			2						3		1
CO2	2		2	3			2						3		1
CO3	1						3						3		1

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
615CHP08	Mass Transfer Laboratory	L	T	P	C	CA	EA	Total
		0	0	3	2	50	50	100

Objectives:

- To acquire basic knowledge on the different mass transfer operations
- To carry out experiments and to find certain parameters like diffusivity, mass transfer coefficient, efficiency of a process
- To gain knowledge on the different distillation operations

List of Experiments

1. To verify the Raleigh's equation using the simple distillation experiment for the methanol-water system
2. To find the Thermal efficiency, Vaporization efficiency and Theoretical steam distillation temperature using steam distillation experiment
3. To determine the mass transfer coefficient for the given system using the experimental setup
4. To determine the Height Equivalent to Theoretical Plate (HETP) of the given packed column for the distillation of methanol-water system under total reflux condition
5. To determine the diffusivity (coefficient of diffusion) of acetone in air at a known constant temperature
6. To carry out three stage cross current extraction operation for the separation of Benzoic acid from a Toluene
7. To carry out three stage cross current leaching operation for the separation of Na_2CO_3 from sand-Na_2Co_3 mixture using water as the solvent at room temperature Vapor liquid equilibrium
8. To study the drying characteristics of a wet material.
9. To study the equilibrium moisture content of the given material under vacuum in tray drier.
10. To plot T-x-y diagram for a given system using VLE Setup.
11. To determine the rate of adsorption of oxalic acid on charcoal.

List of Equipment:

1. Simple distillation setup
2. Steam distillation setup
3. Wetted wall column setup
4. Packed column distillation setup
5. Diffusivity measurement setup
6. Liquid-liquid extraction setup
7. Leaching setup
8. Rotary dryer
9. Vacuum tray dryer
10. Vapor liquid column setup
11. Adsorption set up

*Minimum 10 experiments shall be offered

Total Hours: 45

Course Outcomes:

1. Students will be able to apply the basic principles of mass transfer operations
2. Students will be able to perform experiments and to Determine diffusivity, mass transfer rate, drying rate, efficiency in leaching / extraction and mass transfer coefficient of a given system using fundamental principles
3. Students will be able to choose a mass transfer operation for separation of a mixture into pure components

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	2	2										3		
CO2	2	2	3										3		
CO3	2	3	3										3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
615CHP09	Chemical Process Equipment Design & Drawing Lab -I	0	0	4	2	50	50	100

Objectives:

To integrate the various courses such as Chemistry, Engineering mechanism, Engineering Graphics, unit operation, Mechanics of solids Materials Technology for a comprehension approach to the design of the process equipments

To develop skill to design and install process equipments used widely in a chemical industry.

All Tables/ Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination

List of Experiments:

1. Design and drawing considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements. Pipe fittings
2. Design and Drawing of storage tanks
3. Design and Drawing of Pressure vessels
4. Design and Drawing of Packed-bed Reaction vessels
5. Design and Drawing of Cyclone Separator
6. Design and Drawing of agitated vessel

Total Hours: 45

Course Outcomes:

1. Students understands design and drawing considerations of process equipment
2. Students will be able to perform required calculations for the process equipment design
3. Students will be able to design and draw process equipments

Text books:

1. Khurmi, . R. S and Gupta, J. K.," Machine Design" Eurasia Publishing House, 2005.
2. Joshi M.V. and Mahajan, V.V. "Process Equipment Design", MacMillan India Ltd.
3. Brownell L.E. and Young, E. "Process equipment design" John Wiley, New York, 1963.

Reference:

1. Dawande, S.D.,"Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian
3. Standards Institution, New Delhi.
4. Perry, R.H. "Chemical Engineers' Handbook", McGraw-Hill.
5. McCabeW.L., Smith J.Cand Harriot, P. "Unit Operation of Chemical Engineering", McGraw-Hill, 2001.
6. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.1980
7. Coulson and Richardson, J.M. "Chemical Engineering", Vol. 6, Asian Books Printers Ltd.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3										2	1		
CO2	3	3										2	1		
CO3	3	3										2	1		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
715CHT01	Process Modeling and Simulation	L	T	P	C	CA	EA	Total
		3	1	0	3	50	50	100

Objective: To impart knowledge on modeling of various equipments and their simulation

Unit - I **Basic Modeling** Hours: 09+03

Introduction to modeling; uses of mathematical models; scope of coverage; principles of formation; review on algebraic, ordinary and partial differential equations- solutions of the above equations; linearization; probabilization models; development of models by experiment and statics; regression and correlation analysis.

Unit - II **Matrix Models** Hours: 09+03

Elementary matrix concepts; simple array models; multi-component distillation; dynamic simulation of distillation column; solution techniques for matrix differential equations; matrix formation of distributed parameter system; flow pattern in stirred tanks; design of mixers.

Unit - III **Lumped Parameter Model** Hours: 09+03

Introduction to lumped parameter system; mathematical description of multiphase transfer process; non isothermal reactors etc.; Axial dispersion in packed beds; reactor design from response curves; reactor effectiveness factor; computer aided modeling of reaction networks.

Unit - IV **Distributed Parameter Model** Hours: 09+03

Formation and solution of one-dimensional unsteady state problem in heat transfer and mass transfer systems; multidimensional problems; application in heat and mass transfer equipments.

Unit - V **Optimization and Simulations** Hours: 09+03

Introduction; application; analytical and numerical techniques for multivariable problems; techniques for constrained optimization; simulation; introduction; discrete event and continuous simulation; dynamic simulation of reactors, distillation columns, absorbers, evaporators and crystallizers; simulation in process control.

Total Hours: 60

Course Outcome:

1. Able to apply the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics
2. Able to formulate the mathematical models of stirred tank heaters, heat exchangers, evaporators, reactors and distillation column.
3. Able to analyze the simulation principles of steady state processes
4. Able to apply in heat transfer and mass transfer equipments.
5. Able to optimize analytical and numerical techniques for multivariable problems.

Text Books:

1. Ramirez, W.; "Computational Methods in Process Simulation", Butterworths Publishers, New York, 1989.
2. Edgar, T.F.; Himmelblau, D.M.; "Optimisation of Chemical Processes", McGraw-Hill Book Co., New York, 1989, Wiley inter science, New York, 1972.

Reference:

1. Luyben, W.L., "Process Modelling Simulation and Control", McGraw-Hill Book Co., 1973.
2. Myers, A.L., Seider, W.D.; "Introduction to Chemical Engineering and Computer Calculations", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.
3. Chemical Engineering Refresher Series on "Process Dynamics", McGraw-Hill Publications, 1983.
4. Mickley, H.S.; Sherwood, T.S.; Reed C.E.; "Applied Mathematics for Chemical Engineers", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1989

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	2	2									3		
CO2	3	3	2	3									3		
CO3	3	3	3	3									3		
CO4	3	3	3	3									3		
CO5	3		3	3									3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
715CHT02	Chemical Engineering Plant Design and Economics	3	0	0	3	50	50	100

Objective:

The course is aimed at training the students to perform economic evaluation of chemical processes and chemical projects & gain familiarity of the professional conventions and formats for representing engineering results.

Unit - I Hours: 09

Introduction to Process Design: Introduction - Process design development, design confederations, Cost and asset accounting, Cash flow for industrial operations, Factors effecting investment, Production cost

Plant Design: Design basis, process selection - selection of equipment, specification and design of equipment's, material of construction, plant location, plant layout and installation, safety, startup, shutdown and operating guidelines

Unit - II Hours: 09

Process industries - Capital and interests, economics and process engineering, value of money, equations for economic studies, equivalence. The bond, capital recovery, depreciation, interest in depreciation capital

Unit - III Hours: 09

Cost indices, equipment cost, the William's six-tenths factor, service facilities, capital requirements for complete plants, total and process investment, the balance sheet, sources of capital, Variable cost, fixed cost, use of cost data, profits and earnings economic production charts

Unit - IV Hours: 09

Annual cost method, present worth method, equivalent alternatives, rate of return method, pay out lime method, effect of source of capital, replacement of existing facilities

Unit - V Hours: 09

Profitability & Optimum Design: Profitability, Alternative investments and replacements, Profitability standards, discounted cash flow, Capitalized cost payout period, Alternative investments, Optimum design, Design strategy, Optimum condition, and Optimum production rates fluid dynamics.

Total Hours: 45

Course Outcome:

1. Able to calculate various costs involved in a process industry and Compute break even period for rate of return. Calculate the taxes by different methods
2. Able to estimate profitability of a company, how to work with balance sheets, understand relationship between demand & supply
3. Acquire the concept of management and also personnel management, labour management relations.
4. Acquire the concept of Annual cost method and replacement of existing facilities.
5. Acquire knowledge about Profitability & Optimum Design.

Text Books:

1. Plant Design and Economics for Chemical Engineering; by M.S.Peters and K.D.Timmerhaus, Mc Graw Hill, 4th Ed.,1991.
2. Schweyer.H.E. "Process Engineering Economics "-McGraw-Hill, (ISE) 1995.

References:

1. Chemical Process Engineering - Design & Economics by Harry Silla
2. Perry, Robert H. and Green, Don W. (1984). Perry's Chemical Engineers' Handbook (6th Edition ed.). McGraw-Hill. ISBN 0-07-049479-7

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	E	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	2				2	1		2		3	2			2
CO2	2	2	2								3				2
CO3						1		2	2	3	3				2
CO4	2		2	2							3				2
CO5	2		2	2							3				2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
715CHT03	Transport Phenomena	L	T	P	C	CA	EA	Total
		3	1	0	4	50	50	100

Objectives:

Different types of Fluids, their flow characteristics and different mathematical models are analyzed and applied to actual situations. This subject helps the students to understand the mechanism of fluids in motion under different conditions.

Prerequisite: Basic knowledge of momentum, heat and mass transfer is required. Basics of numerical solutions of ODE and PDE are necessary.

Unit - I Momentum transport in laminar flow (shell balance) Hours: 09+03

Newton's law of viscosity ; Newtonian and non Newtonian fluids; rheological models; General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus

Unit - II Heat and mass transport in laminar flow (shell Balance) Hours: 09+03

Fourier's law of heat conduction; Definitions of concentrations, velocities, and mass fluxes; Fick's law of diffusion. Heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection

Unit - III Equations of Change and Their Applications Hours: 09+03

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multi components systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up

Unit - IV Transport in Turbulent and Boundary Layer Flow Hours: 09+03

Turbulent phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface

Unit - V Analogies between Transport Processes Hours: 09+03

Importance of analogy; development and applications of analogies between momentum heat and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

Total Hours: 60

Course Outcomes:

1. Able to develop mathematical models of momentum, heat and mass transport to determine respective fluxes and velocity, temperature and concentration distribution.
2. Able to apply equations of change to determine the velocity, temperature and concentration profile of complex transport processes.
3. Able to understand the turbulence and boundary layer concept and analogy between transport processes.
4. Able to apply in Transport in Turbulent and Boundary Layer Flow.
5. Able to understand Analogies between Transport Processes.

Text Books:

1. R.B. Bird, W.E. Stewart and E.W. Lighfoot, "Transport Phenomena", John Wiley, 1978
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn. 1988.
3. B.M.Suryavanshi and L.R..Dongre, "Transport Phenomena", Nirali Prakashan ,First Edison

References:

1. L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.
2. R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, "Fundamentals of Momentum Heat and Mass Transfer", 2nd Edn. John Wiley, New York, 1973

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2	2										3		
CO2	3	2	3	2									3	2	
CO3	3	2	3										3	2	
CO4	3	2	3										3	2	
CO5	3	2	3										3	2	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
715CHT04	Modern Separation Techniques	3	1	0	3	50	50	100

Objective: To understand the recent advances in separation techniques and their applications in different chemical processes.

Unit I Introduction to separation techniques Hours: 9+3

Review of conventional processes, recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electrofiltration, dual functional filter, Surface based solid - liquid separations involving a second liquid, Sirofloc filter.

Unit II Membrane Separations Hours: 9+3

Types and choice of membranes: Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commerical, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes

Unit III Separations By Adsorption Techniques Hours: 9+3

Mechanism, Types and choice of adsorbents: Normal adsorption techniques,

Affinity chromatography and immuno Chromatography, Types of equipment and commercial process, Recent advances and process economics.

Unit IV Ionic Separations Hours: 9+3

Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography and electrodialysis, Commercial processes.

Unit V Other Techniques Hours: 9+3

Separations involving Lyophilisation, Pervaporation and permeation techniques for solids, liquids and gases, Industrial viability and examples, zone melting, Addluctive crystallization, Other separation processes, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

Total Hours: 60

Course Outcome:

1. Explain different types of separation techniques based on size, surface properties, cross flow filtration and derive the equations for the same.
2. Develop design equations for membrane separation processes such as RO&UF. Design the affinity and immuno chromatographic columns.
3. Understand type of equipment employed for electrophoresis, design the ion exchange chromatography and industrial effluent treatment by modern techniques.

Text Books

1. Lacey, R.E. and S.Looeb - Industrial Processing with Membranes Wiley - Inter Science, N.Y.1972.
2. King, C.J. Separation Processes, Tata McGraw-Hill Publishing Co. Ltd., 1982.

References

1. Schoew, H.M. - New Chemical Engineering Separation Techniques, Interscience Publishers, 1972.

2. Ronald W. Roussel - Handbook of Separation Process Technology, John Wiley, New York, 1987.
3. Kestory, R.E. - Synthetic polymeric membranes, Wiley. Interscience, N.Y. 1985.
4. Osadar, Varid Nakagawal - Membrane Science and Technology, Marcel Dekkar (1992).

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2					2						2	3		2
CO2	2		3			2	2					2	3		2
CO3	2					2	2					2	3		2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
715CHE05	Solid waste Management	3	0	0	3	50	50	100

Objectives:

To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

Unit - I SOURCES AND TYPES Hours: 09

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management -Social and Financial aspects - Municipal solid waste (M&H) rules - integrated management-Public awareness; Role of NGO's.

Unit - II ON-SITE STORAGE AND PROCESSING Hours: 09

On-site storage methods - Effect of storage, materials used for containers - segregation of solid wastes - Public health and economic aspects of open storage - waste segregation and storage - case studies under Indian conditions - source reduction of waste - Reduction, Reuse and Recycling.

Unit - III COLLECTION AND TRANSFER Hours: 09

Methods of Residential and commercial waste collection - Collection vehicles - Manpower- Collection routes - Analysis of collection systems; Transfer stations - Selection of location, operation & maintenance; options under Indian conditions - Field problems- solving.

Unit - IV OFF-SITE PROCESSING Hours: 09

Objectives of waste processing - Physical Processing techniques and Equipments; Resource recovery from solid waste composting and biomethanation; Thermal processing options - case studies under Indian conditions.

Unit - V DISPOSAL Hours: 09

Land disposal of solid waste; Sanitary landfills - site selection, design and operation of sanitary landfills - Landfill liners - Management of leachate and landfill gas- Landfill bioreactor- Dumpsite Rehabilitation

Total Hours: 45

Course Outcomes: The students completing the course will have

- An understanding of the nature and characteristics of municipal solid wastes and the regulatory requirements regarding municipal solid waste management
- Ability to plan waste minimization, design and storage to reduce waste.
- An ability to understand the collection, transport, processing of municipal waste.
- The students would be able to understand the thermal processing of waste.
- The students would be able to understand disposal of municipal solid waste

Text Books:

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.
2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981
3. Paul T Willams, "Waste Treatment and Disposal", John Wiley and Sons, 2000

References:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of UrbanDevelopment, New Delhi, 2000.
2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
3. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996
4. George Tchobanoglous and Frank Kreith"Handbook of Solidwaste Management", McGraw Hill, New York, 2002

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	1	1		2		2	3						1		2
CO2	1	1		1					1				1		3
CO3	1	3		3									1		3
CO4	1	2	3	3									1		3
CO5	1	2	3	3					3				1		3

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
715CHE08	Industrial Waste Water Treatment	3	0	0	3	50	50	100

Objectives:

- To learn constituents associated with wastewater and their effects
- To learn fundamentals of biological treatment
- To learn most commonly applied wastewater treatment technologies for industrial wastes and classify the technologies based on the conventional series of primary, secondary, tertiary, and in-plant treatment

Unit - I Sources and types of Industrial Wastewater Hours: 09

Sources and types of industrial wastewater - Characterization: Physical, Inorganic non metallic constituents, metallic constituents, organic constituents, biological Characteristic.

Unit - II Introduction to process selection Hours: 09

Physical unit operation: Screening, coarse solid reduction, Mixing and flocculation, equalization, Gravity separation, Grit removal, Sedimentation, Neutralization, Clarification, Floatation.

Role of Chemical unit operations in wastewater treatment, Chemical unit Process: Chemical Coagulation, Chemical Precipitation - Heavy metal removal, Phosphorous removal, Chemical oxidation.

Unit - III Biological Treatment Hours: 09

Composition and Classification, bacterial growth, Microbial growth, Aerobic biological oxidation, biological nitrification, Anaerobic fermentation and oxidation, Activated sludge process, Trickling filters, Rotating biological contactors, Combined aerobic treatment processes, Anaerobic treatment process, Anaerobic sludge blanket process, Attached growth process.

Unit - IV Advanced wastewater treatment Hours: 09

Depth filtration, surface filtration, Adsorption, Ion Exchange, advanced oxidation process, Photo catalysis, wet air oxidation, Evaporation, Disinfection Processes: Disinfection with chlorine, Disinfection with chlorine dioxide, Dechlorination, Disinfection with ozone.

Unit - V Effluent Treatment Plants Hours: 09

Individual and common Effluent Treatment plants - Zero effluent discharge systems - wastewater reuse - Disposal of effluent on land - Quantification, characteristics and disposal of Sludge.

Industrial process description, wastewater characteristics, source reduction options and waste treatment flow sheet for textiles - tanneries - pulp and paper - metal finishing - petrochemical - pharmaceuticals - thermal power plants.

Total Periods: 45

Course Outcome: The student will be able to

1. Understand the fundamentals of wastewater treatments
2. Understand the common physical, chemical and biological unit operations encountered in treatment processes
3. Analyse various characteristics of wastewater
4. Able to understand importance of advanced waste water treatment processes
5. Able to understand various effluent treatment plants and find solutions

Text Books:

1. George Tchobanoqlous, Franklin L. Burton, H.David Stensel, Waste water Engineering Treatment and Reuse: Mc Graw Hill,4th Edition, 2002.
2. Metcalf and Eddy. Wastewater Engineering, Treatment and reuse, Tata McGraw Hill Education, 4th Edition,2003.

Reference:

1. Water Environment Federation, Industrial Waste Water Management Treatment and Disposal,
Tata-Graw Hill 3rd Edition, 2008.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	1					1	2								2
CO2	1	2	2				2								2
CO3	1	2	2				2								2
CO4	2	1	1				2								2
CO5	3	3	3	1			2								2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
715CHE10	Fundamentals of Nanotechnology	L	T	P	C	CA	EA	Total
		3	0	0	2	50	50	100

Objective: To understand the description of nanotechnology, its technological development and different applications. To get exposure to the general preparation methods of nano-materials and different techniques in their preparation

Unit - I **Hours: 09**

Background and Definition of Nanotechnology, Why Nano? Applications in Different Fields, Chemical Approaches to Nanostructured Materials, Molecular Switches and Logic Gates, Solid State Devices

Unit - II **Hours: 09**

Carbon Nanotubes - Structure of Carbon Nanotubes, Synthesis of Carbon Nanotubes, Growth Mechanisms of Carbon Nanotubes, Properties of Carbon Nanotubes, Carbon Nanotube-Based Nano-Objects, Applications of Carbon Nanotubes, Nano wires - Synthesis, Characterization and Physical Properties of Nanowires, Applications

Unit - III **Hours: 09**

Basic Microfabrication Techniques, MEMS Fabrication Techniques, Nanofabrication techniques, Stamping techniques - High Resolution Stamps, Microcontact Printing, Nanotransfer Printing, Applications.

Unit - IV **Hours: 09**

Material aspects of NEMS and MEMS - Silicon, Germanium-Based Materials, Metals, GaAs, InP, and Related III-V Materials, MEMS Devices and Applications - Pressure Sensor, Inertial Sensor, Optical MEMS, RF MEMS, NEMS Devices and Applications, Current Challenges and Future Trends.

Unit - V **Hours: 09**

Microscopy - Scanning Tunneling Microscope, Atomic Force Microscope, Scanning Electron Microscopy, FESEM, TEM, Principles of Noncontact Atomic Force Microscope (NCAFM).

Total Hours: 45

Course Outcome:

1. Learn and understand the purpose of Nanotechnology.
2. Understand application of carbon nanotubes and process the involved, learn microfabrication.
3. Understanding different types of NEMS, MEMS and learn principles of microscopes
4. Understand material aspects of NEMS, MEMs and their applications
5. Understand the principle and applications of Microscopy.

Text Books:

1. B. Bhushan, (in Eds.) "Springer handbook of nanotechnology", 3rd Edition, Springer - Verlag, 2010.

Reference:

1. Charles P. Poole; Frank K. J Owens, "Introduction to Nanotechnology", A John Wiley and Sons , Inc, Publication 2003.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO 3
CO1	2		2										3		
CO2	2		2										3		
CO3	2												3		
CO4	2												3		
CO5	2												3		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
715CHP07	Chemical Reaction Engineering Lab	L	T	P	C	CA	EA	Total
		0	0	3	2	50	50	100

Objectives:

1. To determine experimentally the kinetics and rate constants of reactions in different types of reactors
2. To evaluate the parameters (order, rate constant)and mode of a reactor (Plug flow, mixed flow) for optimum performance
3. To provides a practical knowledge to students about the different chemical reactors used in chemical engineering industries

Prerequisite: Chemical Reaction Engineering - I

List of Experiments:

1	To study the kinetics of liquid phase reaction in a batch reactor - Equimolar feed.
2	To study the kinetics of liquid phase reaction in a batch reactor - Non-Equimolar feed.
3	Kinetic studies in Plug Flow Reactor- Coiled tube
4	Kinetic studies in Plug Flow Reactor- Straight tube
5	Kinetic studies in Continuous Stirred Tank Reactor
6	To study residence time distribution (RTD) in a PFR- coiled tube.
7	To study residence time distribution (RTD) in a Continuous Stirred Tank Reactor
8	Kinetics studies in cascade Continuous Stirred Tank Reactorsetup
9	To determine the activation energy and frequency factor for the exothermic reaction between sodium thiosulphate and hydrogen peroxide adiabatically.
10	Kinetic studies in Packed Bed Reactor

List of Equipment

1. Batch Reactor Setup (2 No's)
2. PFR Setup -Straight
3. PFR Setup - Coiled
4. CSTR Setup
5. RTD in PFR Setup
6. RTD in CSTR Setup
7. CSTR's in Series Setup
8. Packed Bed Reactor Setup
9. Activation energy Setup

Total Hours: 45

Course Outcome:

1. Able to find rate constant in different types of reactors.
2. Able to carry out kinetic studies in different reactors and to calculate conversion, rate constant.
3. Able to analyze the performance of PFR, PBR, CSTR and RTD in reactors and kinetics studies.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	2	1	1	2								2	3	
CO2	3	3	3	2	2								2	3	
CO3	2	2	2	2									2	3	
CO4	2	2	2	2									2	3	
CO5	2	2	3	2	2								2	3	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
715CHP08	Chemical Process Equipment Design & Drawing Lab - II	0	0	3	2	50	50	100

Objectives:

1. To acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. double pipe heat exchanger, shell and tube heat exchanger, evaporator and packet column, supports etc.).
2. To understand the application of the equipment for the desired conditions.
3. To enhance the skill of design and drawing of process equipment.

All Tables/ Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.

Prerequisite: knowledge of Heat exchange equipment and Distillation

List of experiments:

1. Design and drawing of Double Pipe Heat Exchanger
2. Design and drawing of Shell and Tube Heat Exchanger
3. Design and drawing of Packed Column
4. Design and drawing of Plate Column
5. Design and drawing of Evaporators
6. Rotary Dryer

Total Hours: 45

Course Outcome:

1. Knowledge of basics of process equipment design and important parameters of equipment design and drawing.
2. Ability to design and draw heat exchange equipment and mass transfer equipment (e. g. Double pipe heat exchanger).
3. Ability to design and draw various parts of vessels (e.g. heads)
4. Gain knowledge about design of Evaporators
5. Ability to do design of rotary driers.

Text Books:

1. V.V. Mahajani, "Joshi's Process Equipment Design", 5th Ed., Trinity Press, 2014.
2. L.E. Brownell and E. Young, "Process equipment design" John Wiley, New York, 2009.

References:

1. S.D. Dawande, "Process Design of Equipments", Vol. 1&2, 6th Ed., Central Techno Publications, Nagpur, 2009.
2. Don W. Green, Robert H. Perry, "Perry's Chemical Engineers' Handbook", 8th Ed., McGraw-Hill, 2007.
3. Kern D.Q., Process Heat Transfer, McGraw Hill, 2001.
4. Robert E Treybal, "Mass Transfer Operations", 3rd Ed., McGraw-Hill, 2012.
5. J.M. Coulson J. F. Richardson, R.K. Sinnott "Chemical Engineering Design Vol. 6, 3rd Ed., Butter worth - Heinemann, 1999.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	1	1			1	1	2		1			2			1
CO2	2	2		1		1	1	2				2			1
CO3	2	2				2	2	2	1						1
CO4	2					2	2	2	1	2		2			1
CO5	2					2	2	1	1	2		1			

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
715CHP09	Technical Seminar & Report Writing	L	T	P	C	CA	EA	Total
		0	0	3	2	50	50	100

Objectives: To assess the ability of the student to study, present and submit a report on a given topic of chemical engineering or allied areas

It enables the students to gain knowledge in any of the technically relevant topics and acquire the confidence in presentation. The student will undertake a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences. Each student has to submit a report, based on the literature/ collected information; the report must not be reproduction of any published material.

The student shall give at least one seminar for about thirty minutes before a committee consisting of three faculty members of the department.

Evaluation: Total Marks (Internal) -100

Method of Evaluation for Continuous assessment: Evaluation through periodical seminar/viva/report submission

Method of Evaluation for End assessment: The student should give a presentation based on their submitted technical report

Total Hours: 45

Course Outcomes:

1. Ability to study and present a seminar on a topic of current relevance in chemical engineering or allied areas.
2. Able to do a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences to prepare one own report.
3. Able to apply knowledge acquired during the academic program to real-life problems by comprehension test.
4. Able to study and present projects related to design of equipments.
5. Able to troubleshoot problems and find solutions practically.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	2		2					2	2			3	3	2
CO2	2	2	3	2	2				2	2			3	3	2
CO3	2	2	2	2	2				3	3			3	3	2
CO4	3	3	3	3	2				3	3			3	3	2
CO5	3	3	3	3	3				3	3			3	3	2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
815CHT01	Total Quality Management	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To understand the Total Quality Management concept and principles, various tools available to achieve Total Quality Management.
- To understand the statistical approach for quality control.
- To create an awareness about ISO and QS certification process and its need for the industries.

Unit - I Introduction Hours: 09

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership - Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

Unit - II TQM Principles Hours: 09

Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure.

Unit - III Statistical Process Control (SPC) Hours: 09

The seven tools of quality, Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

Unit - IV TQM Tools Hours: 09

Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA

Unit - V Quality Systems Hours: 09

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits.

Total Hour: 45

Course Outcomes:

By the end of the course students will be able to

1. Understand definition of quality, analysis techniques for quality costs, role of senior management and its functions.
2. Understand the principles of TQM,
3. Understand the importance of seven tools of quality.
4. Apply benchmarking tools.
5. Explain importance of quality systems and need of quality systems.

Text Books:

1. Dale H. Besterfield, Hemant Urdhwareshe, Mary Besterfield-Sacre, Carol Besterfield-Michna, Rashmi Urdhwareshe, Glen H. Besterfield, Total Quality Management, Pearson Education Asia, 3rd Edition, 2010.
2. James R.Evans& William M.Lidsay, The Management and Control of Quality, 6th Edition, South-Western (Thomson Learning), 2004.

References:

1. Feigenbaum.A.V., Total Quality Management, McGraw Hill, 1991.
2. Oakland.J.S. Total Quality Management, Butterworth - Heinemann Ltd., Oxford,1989.
3. Narayana V and Sreenivasan, N.S., Quality Management - Concepts and Tasks, New Age International,2007.
4. Zeiri. Total Quality Management for Engineers, Wood Head Publishers, 1991.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1				3							3	3			2
CO2								2			3	3			2
CO3								2			2	3			2
CO4								2			2	3			2
CO5						3	3			1	2	3			2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
815CHE02	Petroleum Refinery Engineering	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To well verse with the properties of petroleum products
- To provide knowledge on crude petroleum exploration
- To understand separation processes involved in petroleum refining, conversion processes and treatment methods.

Unit - I Introduction Hours: 09

Origin Formation, World petroleum resources, petroleum industries in India. Composition and classification of crude oil: evaluation of petroleum ASTM, TBP and EFV distillation, Correlation index, density, carbon distribution.

Unit - II Exploration Techniques Hours: 09

Methods of exploration, drilling and production of petroleum crude, Drilling rigs, Drilling Procedure, Transportation of crude and product. Crude pretreatment

Unit - III Properties and Specifications of Petroleum Products Hours: 09

Composition and Properties of products FG, Gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes and hydrocarbon compounds- paraffinic, naphthanic, aromatic and olefinic.

Unit - IV Separation Processes Hours: 09

Fractionation of Petroleum: dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline. Operation of topping and vacuum distillation units. Tube still furnaces, Solvent extraction processes for lube oil base stocks, aromatics, naphtha and kerosene streams. Solvent de-waxing

Unit - V Conversion Processes and Treatment Methods Hours: 09

Conversion process: Thermal cracking, vis-breaking and coking processes, catalytic cracking, reforming, hydro processing, alkylation, polymerization and isomerization.
Treatment methods: Sweetening, Hydrodesulphurization, and Smoke point Improvement. Safety and pollution consideration in refineries and Case Studies

Total Hours: 45

Course outcomes:

By the end of the course students will be able to

1. Have knowledge on petroleum properties, resources and composition.
2. Familiarize on different exploration techniques.
3. Identify the petroleum products based on the properties and give specifications.
4. Differentiate separation processes required for refining of petroleum.
5. Understand different conversion processes and treatment methods of petroleum refining.

Text Books:

1. Nelson. E. L., "Petroleum Refinery Engineering", Fourth Edition, McGraw Hill, New York, 1985.
2. Bhaskara Rao. B.K. "Modern Petroleum Refining Process", Oxford & IBH, New Delhi, 2010

References:

1. Sarkar. G.N. "Petroleum Refining", Khanna Publishers, New Delhi, 1998
2. Gary. J.H. and Glen. E.H., "Petroleum Refining: Technology and Economic", Volume. V, Marcel Dekker Inc., New York, 1975
3. Meyers. R.E., "Handbook of Petroleum Refining Process", McGraw Hill, New York, 1986
4. Ram Prasad., "Petroleum Refining Technology", Khanna Publishers, 1st Edition, 2008

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	1		2				1						1	1	
CO2	1		2				1						1	1	
CO3	1		2				1						1	1	
CO4	1		2				1						1	1	
CO5	1		2				1						1	1	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
815CHE05	Air Pollution Control and Design of Equipment	3	0	0	3	50	50	100

Objectives:

- To know the effects, sources and laws & regulations related to air pollution
- To have knowledge of terminology, design equations for various equipment used for air pollution control
- To design air pollution control equipments

Unit - I Air Pollution-Selection of Air Control Equipment Hours:09

Introduction to air pollution, sources and effects, laws and regulations
Process parameters, operating conditions, gas characteristics, dust characteristics, performance required, process of selection, auxiliary equipment

Unit - II AIR (P&CP) Act, 1981 Hours:09

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate - Conditions of the consents - Outlet - Legal sampling procedures, State Air Laboratory - Appellate Authority - Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Unit - III Air Pollution Monitoring Hours:09

Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants -Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants - Air Pollution Climatology.

Unit - IV Cyclone Separators & Fabric Filters Hours:09

Introduction, principle and theory, terminology, design, operation and maintenance, improving performance of cyclone separator and fabric filter.

Unit - V Electrostatic Precipitator & Wet Scrubbers Hours:09

Introduction, principle and theory, terminology on the following equipment: Electrostatic Precipitator, Spray towers and Venturi Scrubbers.

Total Hours: 45

Course Outcomes:

By the end of the course students will be able to

1. Understand sources and effects of air pollution
2. Understand Air act 1981
3. Know the techniques of monitoring air pollution
4. Design and improvise cyclone separator and fabric filter
5. Design and improvise electrostatic precipitator and wet scrubber

Text Books:

1 Louis Theodore, "Air Pollution Control Equipment Calculations", John Wiley and Sons, 2008.
2 Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung ,"Air Pollution Control Engineering", Volume 1,Humana Press, 2004.
3 Noel de Nevers, "Air Pollution Control Engg"., Mc Graw Hill, New York, 1995.

References:

1. Karl B. Schnelle, Jr, Charles A. Brown, "Air pollution control technology Handbook", CRC Press, 2002.
2. Anjaneyulu. Y, “Air Pollution & Control Technologies” Allied Publishers (P) Ltd.,India, 2002.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO 3
CO1	2	2				2	3								2
CO2	2	2			1		3								2
CO3		2	3	3			3						2		2
CO4		2	3	3			3						2		2
CO5							3								2

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
815CHE06	Drugs and Pharmaceutical Technology	3	0	0	3	50	50	100

Objectives:

- To gain fundamental knowledge about drugs, the basic engineering principles and unit operations pertaining to pharmaceutical plants.
- To learn about pharmacokinetic parameters like drug disposition, absorption, nonlinear and time dependant pharmacokinetics.
- To understand the principles involved in the determination and analysis of different bulk drugs and their formulation.

Unit - I Introduction Hours:09

Development of drugs and pharmaceutical industry; organic therapeutic agents uses and Economics.

Unit - II Drug Metabolism and Pharmaco Kinetics & Microbiological and Animal Products Hours:09

Drug metabolism; physicochemical principles; pharmaco kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

Unit - III Important Unit Processes and Applications Hours:09

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

Unit - IV Manufacturing Principles, Packing and Quality Control Hours:09

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

Unit - V Pharmaceutical Products & Pharmaceutical Analysis Hours:09

Products: Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others.

Analytical methods and tests: spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry

Total Hours: 45

Course Outcomes:

By the end of the course students will be able to

1. Understand the Drug Metabolism and pharmaco-kinetics principles
2. Apply knowledge of unit processes and analytical methods to develop new processes and product formulations.
3. Demonstrate statistical quality control procedure and quality assurance programmes in various stages of pharmaceutical process.
4. Understand the formulation and use of excipients in tablets, powders, capsules, microcapsules and coating techniques.
5. Apply knowledge to design and develop new drug.

Text Book:

1. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, Bailliere Tindall, London, 1977.

References:

1. Yalkonsky, S.H.; Swarbick. J.; " Drug and Pharamaceutical Sciences ", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2	1				1							2		2
CO2	2		3										2		2
CO3	2										2		2		
CO4	1	2	2			2	1	2				2	2		1
CO5	1	2	3			2	1	2				2	2		1

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
815CHE07	Heterogeneous Catalysis	3	0	0	3	50	50	100

Objectives:

- To gain knowledge about different types of heterogeneous catalysts, their structures, synthesis processes, characterisation and solid state chemistry associated with these catalyst
- To understand the mechanism and kinetics of heterogeneous catalytic reactions
- To overview selected applications of heterogeneous catalysis

Unit - I Introduction Hours:09

Heterogeneous catalytic processes, types of heterogeneous reactions.Introduction and basic concept of green catalysis. Adsorption, adsorption isotherms, rates of adsorption, Physisorption and chemisorptions. Solid catalysis, types of catalysts, catalyst formulations and preparation methods. Environmental catalysis.

Unit - II Catalyst preparation and Characterization Hours:09

Fundamentals of solid state chemistry, structure of solids. Selection, design and preparation of catalysts. Optimal distribution of catalyst in a pellet of different geometry.Structure-property relationship and analysis: BET surface area and pore volume analysis, X-ray diffraction, scanning electron microscopy, infrared spectroscopy.

Unit - III Catalyst Deactivation Hours:09

Reactor design, catalyst applications and deactivation kinetics: Applications of heterogeneous catalysts in different fields, various deactivation models of solid catalysts.

Unit - IV Kinetic modeling and interpretation of heterogeneous data analysis Hours:09

Mechanisms of solid catalyzed reactions: Rates of adsorption, desorption, surface reactions, rate determining steps, development of reaction mechanism. Deducing a rate law from the experimental data, Evaluation of Rate law parameters. Kinetic modeling and parameter estimations. Effect of external and internal transport processes on observed rate of reactions, Heat and Mass transfer effects in heterogeneous catalysis, internal and external mass transfer limitations.

Unit - V Industrial catalytic reactors and latest developments Hours:09

Commercial Catalytic Reactors (Adiabatic, packed and fluidized bed, trickle bed and slurry reactors). Industrially important catalysts and processes such as oxidation, regeneration, New development in solid catalysis, monolith catalysts, nanocatalysts, Fuel cell catalysts, Environmental catalysts, Insitu characterization.

Total Hours: 45

Course Outcomes:

By the end of the course students will be able to

1. Apply the knowledge of heterogeneous catalytic reactions in industry
2. Develop mechanism and kinetics of heterogeneous catalytic reactions
3. Prepare and characterize various catalysts
4. Consider the mass & heat transfer and other effects in design
5. Design reactors for heterogeneous catalytic reactions

Text Books:

1. Fogler H.S., "Elements of Chemical Reaction Engineering", 4th ed., PHI, 2005.
2. J. M. Smith, "Chemical Engineering Kinetics", 3 rd ed., MGH, 1981.
3. R.A Sheldon, I. Arends, U. Hanefeld 'Green Chemistry and Catalysis', Wiley-VCH 2007.

References:

1. Lann D. Schmidt, "The Engineering of Chemical Reactions", 2nd Edition, Oxford University Press, 2007.
2. J.J. Carberry , "Chemical and catalytic reaction Engineering", Dover Publications, 2001.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	2												2		
CO2	3	2											2		
CO3	3	2											2		
CO4	2	2											2		
CO5	2												2		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG & PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
815CHE08	Bioreactor Design	3	0	0	3	50	50	100

Objectives:

- Acquire the basic knowledge of fermentation its kinetics and designing of reactors and agitators
- Understand the concept of mass transfer between two different phases in bioreactors
- Impart the knowledge in various types of bioreactors and its functions

Unit - I Fermentation Kinetics Hours:09

Microbial, plant and animal cell culture - Batch, Continuous and Fed-batch culture. Kinetic relationships - parameters, variables and constraints, simple problems numerical problems.

Unit - II Mass Transfer in Bioreactors Hours:09

Importance of interfacial mass transfer in Biotechnology. Mass Transfer between phases - factors affecting mass transfer between phases. Mass Transfer in porous solids. Oxygen uptake in fermenters. Simple problems on topics.

Unit - III Rheology, Aeration and Agitation in Animal Cell Bioreactors Hours:09

Design, Operation and types of agitators and spargers, power and time requirements for agitation. Effects of agitation on mass transfer, Oxygen delivery system, foam control system, factors affecting antifoam requirements, Antifoam addition system.

Unit - IV Types of Bioreactors and Accessories Hours:09

Description, working, advantages and limitations of stirred tank, Airlift, Bubbledriven, packed bed, fluidized bed, trickle bed and flocculated cell Bioreactors. Description and functions of the following accessories for bioreactors: Pumps, filters, valves, steam traps.

Unit - V Design of a Bioreactor Hours:09

Basic functions of a fermenter for microbial or animal cell culture. Aseptic operation, sterilization and containment, temperature control. Reactor body construction - construction material. Reactor Dynamics. Design calculation for stirred tank Bioreactor. Simple problem on it.

Total Hours: 45

Course Outcomes:

By the end of the course students will be able to

1. Predict fermentation kinetics of growth, product formation, substrate utilization kinetics of bacteria
2. Design a bioreactor considering mass transfer between different phases
3. Analyze differences between reactor types and modes of operation, and exploit these differences for various design goals.
4. Design all accessories and internals like agitator, sterilizer, controllers etc.
5. Design of a bioreactor considering all its related problems

Text Books:

1. Bailey and Ollis, Biochemical engineering fundamentals, 2nd Ed. McGrawHill, 1986.

2. Michael L. Shuler, Fikret Kargi, Matthew DeLisa, Bioprocess Engineering: Basic Concepts, PHI, 3rd Ed, 2017.
3. Atkinson B, Biochemical Reactors, Law Book Co of Australia, 1974.

References:

1. D.G.Rao, Introduction to Biochemical Engineering, Tata McGrawHill 2005.
2. Van't Riet, K & J,Tramper, Basic Bioreactor Design -Marcel Dekkar Inc. New York 1991.
3. Stanbury, P.F.A., Principles of Fermentation Technology, Whitaker & Hall, 1997. Aditya books.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO 3
CO1	3											2	2		
CO2	2	1	3									2	2	2	
CO3	2	2	2									2	2		
CO4	2	2	3									2	2	2	
CO5	2	1	3									2	2	2	

Chairman, Board of Studies
Faculty of Chemical Engineering (UG & PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
815CHE10	Corrosion Engineering	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objective:

- To study the principles of different forms of corrosion
- To study the testing procedures and protection systems of corrosive materials
- To acquire knowledge regarding predicting corrosion behavior and designing process.

UNIT - I Introduction Hours:09

Corrosion principles - electro-chemical aspects, environmental effects, economical, metallurgical and other aspects

Unit - II Forms of Corrosion Hours:09

Forms of corrosion uniform attack, galvanic, crevice, pitting, Inter granular, selective, leaching, erosion and stress corrosion

Unit - III Corrosion Testing Hours:09

Classification - purpose - materials and specimens - Surface Preparation - Exposure Techniques - Standard Expression for Corrosion Rate - Huey Test for Stainless Steel - Streicher Test for Stainless Steel - Warren Test - NACE Test Methods - Slow - Strain - Rate Tests.

Unit - IV Corrosion Prevention Hours:09

Material Selection - Alteration of Environment - Design - Cathodic and Anodic Protection - Coatings

Unit - V Designing Protection Hours:09

Modern Theory - Principles - Thermodynamics and Electrode Kinetics.
Modern Theory Applications - Predicting Corrosion Behavior - Corrosion Prevention - Corrosion Rate Measurement.

Total Hours: 45

Course Outcomes:

By the end of the course students will be able to

1. Learn the principles of Corrosion and understand the environmental effects.
2. Differentiate possible types of corrosion in a particular situation.
3. Apply different corrosion testing methods for a system.
4. Adopt different corrosion prevention methods.
5. Design and apply modern protection coatings.

Text Books:

1. Fontana, M.G., Corrosion engineering, McGraw Hill, 3rd Ed., 2005.
2. Pierre R. Roberge, Corrosion Engineering Principles and Practice, McGraw Hill, 1stEdition, 2008.

References:

1. R. Winston Revie, Uhlig's Handbook of Corrosion, Wiley, 3rdedition, 2011.
2. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control,Butterworth Heinemann,2006

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO 3
CO1	2						2						3		
CO2	2	2		2		1							2		
CO3	2	1		2		1							2		
CO4	2					1							2		
CO5	1		3									2	1		

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Subject Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
815CHP04	Project Work - Viva voce	0	0	18	9	50	50	100

Objective:

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course. This help to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course.

Evaluation:

Each student is required to submit a Project report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained by the student by way of experiments conducted in the laboratory/industry.

There shall be three assessments during the semester by a review committee. The student shall make three presentations on the progress made before the committee at various stages of the Project work. The Head of the Department shall constitute the review committee. The total marks obtained in the three reviews, shall be taken in to account for continuous assessment. There will be a viva-voce examination at the end of the Project work, conducted by one internal examiner and one external examiner, the assessment marks shall be taken for end assessment.

Course Outcomes:

1 Analysis independently to design experiments
2 Simulate
3 Fabricate and Setup experiments.
4 Demonstrate the application of the chemical engineering principles to particular process variables for optimization of experimental projects.
5 Prepare clear concise project reports with the help of graph, charts, and power point presentations.

Cos	Programme Outcomes												Programme Specific Outcome		
	a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
CO1	3	3	3			1	1	1		2	2				3
CO2	3	3	3	3		3	3			2	2	3	3		3
CO3	2	2	3	3	3				3	2	2	3	3	3	3
CO4				2	3					2	2	2			3
CO5										3	3				3

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
711CHT01	Chemical Engineering Plant Design and Economics	3	0	0	3	50	50	100

Objective:
The course is aimed at training the students to perform economic evaluation of chemical processes and chemical projects & gain familiarity of the professional conventions and formats for representing engineering results.

Unit - I Hours: 09

Introduction to Process Design: Introduction - Process design development, design confederations, Cost and asset accounting, Cash flow for industrial operations, Factors effecting investment, Production cost

Plant Design: Design basis, process selection - selection of equipment, specification and design of equipment's, material of construction, plant location, plant layout and installation, safety, startup, shutdown and operating guidelines

Unit - II Hours: 09

Process industries - Capital and interests, economics and process engineering, value of money, equations for economic studies, equivalence. The bond, capital recovery, depreciation, interest in depreciation capital

Unit - III Hours: 09

Cost indices, equipment cost, the William's six-tenths factor, service facilities, capital requirements for complete plants, total and process investment, the balance sheet, sources of capital, Variable cost, fixed cost, use of cost data, profits and earnings economic production charts

Unit - IV Hours: 09

Annual cost method, present worth method, equivalent alternatives, rate of return method, pay out lime method, effect of source of capital, replacement of existing facilities

Unit - V Hours: 09

Profitability & Optimum Design: Profitability, Alternative investments and replacements, Profitability standards, discounted cash flow, Capitalized cost payout period, Alternative investments, Optimum design, Design strategy, Optimum condition, and Optimum production rates fluid dynamics,

Total Hours: 45

Course Outcome:

1. Able to calculate various costs involved in a process industry and Compute break even period for rate of return. Calculate the taxes by different methods
2. Able to estimate profitability of a company, how to work with balance sheets, understand relationship between demand & supply
3. Acquire the concept of management and also personnel management, labour management relations.

Text Books:

1. Plant Design and Economics for Chemical Engineering; by M.S.Peters and K.D.Timmerhaus, Mc Graw Hill, 4th Ed.,1991.
2. Schweyer.H.E. "Process Engineering Economics "-McGraw-Hill, (ISE) 1995.

References:

1. Chemical Process Engineering - Design & Economics by Harry Silla
2. Perry, Robert H. and Green, Don W. (1984). Perry's Chemical Engineers' Handbook (6th Edition ed.). McGraw-Hill. ISBN 0-07-049479-7

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHT02	Transport Phenomena	L	T	P	C	CA	EA	Total
		3	1	0	4	50	50	100

Objectives:

Different types of Fluids, their flow characteristics and different mathematical models are analyzed and applied to actual situations. This subject helps the students to understand the mechanism of fluids in motion under different conditions.

Prerequisite: Basic knowledge of momentum, heat and mass transfer is required. Basics of numerical solutions of ODE and PDE are necessary.

Unit - I Momentum transport in laminar flow (shell balance) Hours: 09+03

Newton's law of viscosity ; Newtonian and non Newtonian fluids; rheological models; General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus

Unit - II Heat and mass transport in laminar flow (shell Balance) Hours: 09+03

Fourier's law of heat conduction; Definitions of concentrations, velocities, and mass fluxes, Fick's law of diffusion. Heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection

Unit - III Equations of Change and Their Applications Hours: 09+03

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multi components systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up

Unit - IV Transport in Turbulent and Boundary Layer Flow Hours: 09+03

Turbulent phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface

Unit - V Analogies between Transport Processes Hours: 09+03

Importance of analogy; development and applications of analogies between momentum heat and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

Total Hours: 60

Course Outcomes:

1. Able to develop mathematical models of momentum, heat and mass transport to determine respective fluxes and velocity, temperature and concentration distribution.
2. Able to apply equations of change to determine the velocity, temperature and concentration profile of complex transport processes.
3. Able to understand the turbulence and boundary layer concept and analogy between transport processes.

Text Books:

1. R.B. Bird, W.E. Stewart and E.W. Lighfoot, "Transport Phenomena", John Wiley, 1978
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn. 1988.
3. B.M.Suryavanshi and L.R..Dongre, "Transport Phenomena", Nirali Prakashan ,First Edison

References:

1. L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.
2. R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, "Fundamentals of Momentum Heat and Mass Transfer", 2nd Edn. John Wiley, New York, 1973

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
711CHT03	Chemical Reaction Engineering - II	3	1	0	3	50	50	100

Objectives:

1. To understand the non-isothermal effects in reactor design
2. To study the kinetics and different regimes in heterogeneous non catalytic reactions
3. To understand the properties of catalysts, catalyst preparation and mechanism of

Catalytic reactions and diffusion effects in porous catalysts

Prerequisite: Students should have the knowledge of ideal reactors and different types of chemical reactions.

Unit - I Hours: 09+03

Temperature and Pressure Effects: Energy balance equations for batch, PFR and CSTR under non-isothermal conditions, Equilibrium conversion under adiabatic conditions, Design of the homogeneous reactors under adiabatic conditions and optimum temperature progression

Unit - II Hours: 09+03

Fluid-solid non-catalytic reactions - shrinking core model, determination of the rate controlling step, conversion in reactors with constant fluid composition, conversion in reactors with variable fluid composition - fixed bed reactor, moving bed reactor

Unit - III Hours: 09+03

Gas-liquid non-catalytic reactions - models for transfer at gas-liquid interface, enhancement factor, Hatta number, Derivation of overall rate equation for first order irreversible reaction and instantaneous reaction, design of packed bed reactors for gas-liquid non-catalytic reactions (simple cases).

Unit - IV Hours: 09+03

Catalysis: catalysts, classification of catalysts, catalyst properties, steps in catalyst reaction, adsorption and desorption isotherms (singe site and dual site mechanism) , synthesizing a rate law, mechanism and rate limiting step

Solid Catalysts: Determination of surface area, void volume, solid density, pore volume distribution, Mercury - penetration method, catalyst preparation, promoters, inhibitors, catalyst deactivation

Unit - V Hours: 09+03

Reaction and diffusion in porous catalysts - effectiveness factor, Thiele modulus, non-isothermal effectiveness factor, Global rate equations, estimation of diffusion - and reaction limited regions (Weisz - Prater criterion for internal diffusion and Mears'

Criterion for external diffusion).
Heterogeneous catalytic reactors - Fixed bed reactors, fluidized bed reactors, slurry reactors, Trickle bed reactors, design aspects with some simple examples

Total Hours: 60

Course Outcomes:

1. Able to evaluate the temperature and pressure effects in ideal reactors
2. Able to understand the nature of fluid - solid and gas - liquid non catalytic reactions and selection of reactors
3. Acquire knowledge on the catalysis process, mechanism, pore diffusion in catalyst, and operation of heterogeneous catalytic reactors

Text Books:

1. Fogler. H.S., "Elements of Chemical Reaction Engineering" 4th Edition, Prentice Hall of India Pvt. Ltd., 2004
2. Levenspiel. O; "Chemical Reaction Engineering", 3rd Edition, Wiley India Pvt Ltd, 2010.

Reference:

1. Smith, J.M., "Chemical Engineering Kinetics", 3rd edition, McGraw-Hill Education India Pvt. Ltd, 2014.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

epartment of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHT04	Biochemical Engineering	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objective:

- To impart knowledge on the role of micro organism in different types of Bio-chemical reaction
- To design Bio-chemical reactors with proper knowledge on Enzyme Engineering

Prerequisite: Kinetics and Design knowledge of various types of reactors and basic fundamentals on biological science.

Unit - I Conventional Chemical Processes and Biochemical Process and Role of Microorganisms Hours: 09

An overview of Industrial Biochemical Processes with typical examples, comparing Chemical and Biochemical Processes, Development and Scope of Biochemical Engineering as a discipline, Typical examples of microbial synthesis of biological.

Introduction to Microbiology: Classification and Industrial uses of Microorganisms.

Structure and functions of Bio Molecules: Carbohydrates, Lipids, Nucleotides to Nucleic Acids - RNA and DNA, Amino acids to Proteins - the building blocks of biochemical life.

Unit - II Microbial Kinetics Hours: 09

Typical growth characteristics of microbial cells; Factors affecting Growth; Monod model; Kinetics for Balanced and Transient Growth, Structured and Un-structured Kinetic Models.

Immobilized cells systems, Methods of Preparation, Characteristics, Applications of Immobilized Cell Biocatalysts- Various Immobilized Cell Reactors; Typical Industrial Examples; Transport in Cells.

Unit - III Enzymes and Enzyme Kinetics Hours: 09

Enzymes- Classification with typical industrially important examples, Applications of Enzymes in Food, Medicine and Industry, Types of Immobilization of Enzymes.

Mechanism and Kinetics of Enzymatic Reactions, Evaluation of Kinetic Parameters, Enzyme Inhibition, Factors affecting the Enzyme Activity.

Unit - IV Bioreactors Hours: 09

Batch and Continuous Reactors for Biomass Production, Reactors in Series with and without Recycle, Types of Bioreactors, Sterilization Reactors, Design of Reactors and Scale-Up with an example.

Unit - V Downstream Processes Hours: 09

Different unit operations in Down Streaming with special reference to Membrane Separations; Extractive Fermentation; Typical Industrial examples for Downstream Processing. Application of biochemical engineering principles (advanced) in treatment of Industrial Effluents.

Total Hours: 45

Course Outcome:

- Able to implement the knowledge of micro organisms and enzymes to study different biochemical reactions and rate equations.
- Able to understand transport mechanisms including mass transfer and heat transfer and sterilization concepts to design and analyze bioreactors.
- Acquire knowledge on various downstream processing for product recovery and purification and design of industrial bioreactors.

Text Books:

1. Bailey J.E., Ollis, D.F. Biochemical Engineering Fundamentals, McGraw-Hill, International Edition, 2nd Edition, New York, 1986.
2. Shuler M. L., Kargi. F., "Bioprocess Engineering: Basic Concepts", 2nd ed. Prentice Hall, 2001.
3. Michael L. Shuler , Fikret Kargi, " Bioprocess Engineering Basic Concepts", Prentice Hall India Pvt Ltd, 2nd Ed.,2001.

Reference:

1. Aiba, S; Humphrey, A.E., Milli, N.R., Biochemical Engineering 2nd ed., Academic Press, 1973.
2. Web, F.C., Biochemical Engineering, Van Nostrand, 1964.
3. Atkinson, B., Biochemical Reactors, Pion Ltd., 1974.
4. Syed Tanveer Ahmed Inamadar, "Biochemical Engineering Principles And Concepts, 2nd Ed., 2008.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHP07	Chemical Process Equipment Design & Drawing Lab - II	L	T	P	C	CA	EA	Total
		0	0	3	2	50	50	100

Objectives:

1. To acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. double pipe heat exchanger, shell and tube heat exchanger, evaporator and packet column, supports etc.).
2. To understand the application of the equipment for the desired conditions.
3. To enhance the skill of design and drawing of process equipment.

All Tables/ Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.

Prerequisite: knowledge of Heat exchange equipment and Distillation

List of experiments:

1. Design and drawing of Double Pipe Heat Exchanger
2. Design and drawing of Shell and Tube Heat Exchanger
3. Design and drawing of Packed Column
4. Design and drawing of Plate Column
5. Design and drawing of Evaporators
6. Rotary Dryer

Total Hours: 45

Course Outcome:

1. Knowledge of basics of process equipment design and important parameters of equipment design and drawing.
2. Ability to design and draw heat exchange equipment and mass transfer equipment
   (e. g. Double pipe heat exchanger).
3. Ability to design and draw various parts of vessels (e.g. heads)

Text Books:

1. V.V. Mahajani, "Joshi's Process Equipment Design", 5th Ed., Trinity Press, 2014.
2. L.E. Brownell and E. Young, "Process equipment design" John Wiley, New York, 2009.

References:

1. S.D. Dawande, "Process Design of Equipments", Vol. 1&2, 6th Ed., Central Techno Publications, Nagpur, 2009.
2. Don W. Green, Robert H. Perry, "Perry's Chemical Engineers' Handbook", 8th Ed., McGraw-Hill, 2007.

3. Kern D.Q., Process Heat Transfer, McGraw Hill, 2001.
4. Robert E Treybal, "Mass Transfer Operations", 3rd Ed., McGraw-Hill, 2012.
5. J.M. Coulson J. F. Richardson, R.K. Sinnott "Chemical Engineering Design Vol. 6, 3rd Ed., Butter worth - Heinemann, 1999.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHP08	Chemical Reaction Engineering Lab	L	T	P	C	CA	EA	Total
		0	0	3	2	50	50	100

Objectives:

1. To determine experimentally the kinetics and rate constants of reactions in different types of reactors
2. To evaluate the parameters (order, rate constant, Activation energy) and mode of a reactor (Plug flow, mixed flow) for optimum performance
3. To provides a practical knowledge to students about the different chemical reactors used in chemical engineering industries

Prerequisite: Chemical Reaction Engineering - I

List of Experiments:

1	To study the kinetics of liquid phase reaction in a batch reactor - Equimolar feed.
2	To study the kinetics of liquid phase reaction in a batch reactor - Non-Equimolar feed.
3	Kinetic studies in Plug Flow Reactor- Coiled tube
4	Kinetic studies in Plug Flow Reactor- Straight tube
5	Kinetic studies in Continuous Stirred Tank Reactor
6	To study residence time distribution (RTD) in a PFR- coiled tube.
7	To study residence time distribution (RTD) in a Continuous Stirred Tank Reactor
8	Kinetics studies in cascade Continuous Stirred Tank Reactor setup
9	Kinetic studies in semi batch Continuous Stirred Tank Reactor
10	Kinetic studies in Packed Bed Reactor

List of Equipment

1. Batch Reactor Setup (2 No's)
2. PFR Setup (Straight and Coiled)
3. CSTR Setup
4. RTD in PFR setup
5. RTD in CSTR Setup
6. CSTR's in Series Setup
7. Packed Bed Reactor

Total Hours: 45

Course Outcome:

1. Able to find rate constant in different types of reactors.
2. Able to carry out kinetic studies in different reactors and to calculate conversion, rate constant.
3. Able to analyze the performance of PFR, PBR, CSTR and RTD in reactors and kinetics studies.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHP09	Technical Seminar & Report Writing	L	T	P	C	CA	EA	Total
		0	0	3	2	50	50	100

Objectives: To assess the ability of the student to study, present and submit a report on a given topic of chemical engineering or allied areas

It enables the students to gain knowledge in any of the technically relevant topics and acquire the confidence in presentation. The student will undertake a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences. Each student has to submit a report, based on the literature/ collected information; the report must not be reproduction of any published material.

The student shall give at least one seminar for about thirty minutes before a committee consisting of three faculty members of the department.

Evaluation: Total Marks (Internal) -100

Method of Evaluation for Continuous assessment: Evaluation through periodical seminar/viva/report submission

Method of Evaluation for End assessment: The student should give a presentation based on their submitted technical report

Total Hours: 45

Course Outcomes:

1. Ability to study and present a seminar on a topic of current relevance in chemical engineering or allied areas.
2. Able to do a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences to prepare one own report.
3. Able to apply knowledge acquired during the academic program to real-life problems by comprehension test.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG & PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHE05	Modern Separation Techniques	L	T	P	C	CA	EA	Total
		3	1	0	3	50	50	100

Objective: To understand the recent advances in separation techniques and their applications in different chemical processes.

Unit I Introductionto separation techniques Hours: 9+3

Review of conventional processes, recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electrofiltration, dual functional filter, Surface based solid - liquid separations involving a second liquid, Sirofloc filter.

Unit II Membrane Separations Hours: 9+3

Types and choice of membranes: Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commerical, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes

Unit III Separations By Adsorption Techniques Hours: 9+3

Mechanism, Types and choice of adsorbents: Normal adsorption techniques, Affinity chromatography and immuno Chromatography, Types of equipment and commercial process, Recent advances and process economics.

Unit IV Ionic Separations Hours: 9+3

Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography and electrodialysis, Commercial processes.

Unit V Other Techniques Hours: 9+3

Separations involving Lyophilisation, Pervaporation and permeation techniques for solids, liquids and gases, Industrial viability and examples, zone melting, Addluctive crystallization, Other separation processes, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

Total Hours: 60

Course Outcome:

1. Explain different types of separation techniques based on size, surface properties, cross flow filtration and derive the equations for the same.
2. Develop design equations for membrane separation processes such as RO&UF. Design the affinity and immuno chromatographic columns.
3. Understand type of equipment employed for electrophoresis, design the ion exchange chromatography and industrial effluent treatment by modern techniques.

Text Books

1. Lacey, R.E. and S.Looeb - Industrial Processing with Membranes Wiley - Inter Science, N.Y.1972.
2. King, C.J. Separation Processes, Tata McGraw-Hill Publishing Co. Ltd., 1982.

References

1. Schoew, H.M. - New Chemical Engineering Separation Techniques, Interscience Publishers, 1972.
2. Ronald W. Roussel - Handbook of Separation Process Technology, John Wiley, New York, 1987.
3. Kestory, R.E. - Synthetic polymeric membranes, Wiley. Interscience, N.Y. 1985.
4. Osadar, Varid Nakagawal - Membrane Science and Technology, Marcel Dekkar (1992).

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
711CHE06	Membrane Technology	3	1	0	3	50	50	100

Objective:

1. To understand the membrane technology concept and principles, various technologies available to achieve effective separation
2. To understand about different separation processes
3. To create an awareness about the different model and modules of separation technologies.

UNIT-I Hours: 09+03

Introduction to separation processes, salient features of membrane separation processes,
history, definition of a membrane, various membrane separation processes and their separation. Material, Membrane Preparation and Characterization: Introduction to polymers, inorganic and ceramic membranes. Preparation of synthetic membranes, phase inversion membranes. Preparation technique for immersion precipitation, preparation technique for composite membranes, Influence of various parameters on membrane morphology. Characterization of porous membranes, characterization of ionic membranes, characterization of non porous membranes

UNIT-II Hours: 09+03

Pressure driven processes: Reverse Osmosis, Ultra Filtration, Membrane Filtration, Nano Filtration, Gas Separation: Introduction, transport equations, process parameters and its effect on them and rejection. Concentration driven and Electrical driven processes: Dialysis, perevoparation and electro dialysis: introduction, variants, transport equations, process parameters.

UNIT-III Hours: 09+03

Polarization phenomenon and fouling: Introduction, concentration polarization, turbulence promoters, pressure drop, gel layer, model osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, temperature polarization, membrane fouling, methods to reduce fouling, compaction.

UNIT-IV Hours: 09+03

Introduction, plate and frame model, spiral wound module, tubular module, capillary module, hollow fiber-model, comparison of module configurations, system design, hollow fiber-module, hybrid dead end cross flow system, cascade operations.

UNIT-V Hours: 09+03

Aspects and advances in Membrane Separation Process: Applications of Reverse Osmosis, Ultra Filtration, Gas separation, Pressure Vessels, Electro Dialysis in chemical and biotechnology and food separation. Instruments in membrane systems, hybrid separators and liquid membranes.

Total Hours: 60

Course Outcome:

1. Able to understand the purpose of membrane filtration process.
2. Acquire knowledge on different types of membrane process.
3. Able to design various membrane process.

Text Books:

1. Mulder. M. H.V., "Basic Principles of Membrane Technology", Kluwer Academic Publications, 2nd ed., 1996.
2. Noble. R. D., Stern. S. A., "Membrane Separation Technology: Principles and Applications", Elsevier, 1st ed., 1995.

References:

1. Crespo. J.G., Boddekes. K.W., "Membrane Process in Separation and Purification", Kluwer Academic Publications, 1994.
2. Baker. R. W., "Membrane Technology and Applications", Wiley, 3rd ed., 2012.
3. Singh. R., "Membrane Technology and Engineering for Water Purification", Butterworth-Heinemann, 2nd ed., 2014.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHE08	Food Technology	L	T	P	C	CA	EA	Total
		3	0	0	2	50	50	100

Objective:

1. To create awareness on the need for processing and preservatives of Foods
2. To design processing equipments for Food Industries

Unit - I An Overview of Food Industry, Food Constituents Quality and Derivative Factor Hours: 09

General aspects of food industry, world food needs and Indian situation. Constituents of food, quality and nutritive aspects, food additives, standards, deteriorative factors and their control.

Unit - II General Engineering Aspects in Food Microbiology and Processing Methods Hours: 09

Food and microorganisms, Preliminary processing methods, Conversion and preservation operations.

Unit - III Heat Preservation and Processing Hours: 09

Degrees of preservation, Selection of Heat treatments, Heat resistance of microorganisms, heat transfer, protective effects of Food constituents, Inoculated Pack studies, Temperature-Time combinations, Heating before or After packaging, Government regulations.

Unit - IV Cold Preservation and Processing Hours: 09

Preservation by Refrigeration and cool storage, Freezing and Frozen storage, dehydration, concentration, drying irradiation, microwave heating, sterilization and pasteurization, fermentation and pickling, packing methods.

Unit - V Production and Utilization of Food Products Hours: 09

Cereal grains, pulses, vegetables, fruits, spices, fats and oils, bakery, confectionery and chocolate products, soft and alcoholic beverages, dairy products, meat, poultry and fish products

Total Hours: 45

Course Outcome:

1. Acquire knowledge about food industry, problems related to food and study about properties related to food.
2. Able to get basic skills about heat preservation, cold preservation with processing and various methods followed for that.
3. Acquire knowledge in aspects of food micro biology, production and utilization of various food products and the processing

Text Books:

1. Potter N.N., Food Science, 5th Ed., Cbs Publishers, 2007.

2. Frazier W.C. Westhoff D.C., Food Microbiology, 5th Ed., McGraw Hill Publishing Co., 2013
3. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967
4. Sivasankar.B., "Food Processing and Preservation", PHI publications, 2002.

Reference:

1. Heldman D.R., Food Process Engineering, The AVI publishing co., 1981.
2. Charm S.E., The Fundamentals of Foods Engineering, 2nd Edition, The AVI Publishing Co., Westport, 1971.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
711CHE11	Fertilizer Technology	L	T	P	C	CA	EA	Total
		3	0	0	2	50	50	100

Objective:
To familiarize with different types of fertilizers, their manufacturing processes. To study the applications of various fertilizers.

Unit - I Nitrogenous Fertilizers Hours: 09
Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling

Unit - II Phosphatic Fertilizers Hours: 09
Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

Unit - III Potassic Fertilizers Hours: 09
Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications

Unit - IV Complex and NPK Fertilizers Hours: 09
Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitro-phosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

Unit - V Miscellaneous Fertilizers Hours: 09
Mixed fertilizers and granulated mixtures; bio-fertilizers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

Total Hours: 45

Course Outcome:
1. Understanding the production, characteristics, storage and handling of nitrogenous fertilizers.
2. Understanding the production, characteristics, storage and handling of phosphatic and potassic fertilizers.
3. Understanding the production, characteristics, storage and handling of complex and miscellaneous fertilizers

Text Books:
1. "Handbook of fertilizer technology", Association of India, New Delhi, 2001.
2. Menno M.G., "Fertilizer Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

Reference:

1. Sauchelli, V, "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, "United Nations Industrial Development Organisation", United Nations, New York, 1998.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1967.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Subject Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
811CHP04	Project Work - Viva voce	0	0	12	9	100	100	200

Objective:

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course. This help to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course.

Evaluation:

Each student is required to submit a Project report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained by the student by way of experiments conducted in the laboratory/industry.

There shall be three assessments during the semester by a review committee. The student shall make three presentations on the progress made before the committee at various stages of the Project work. The Head of the Department shall constitute the review committee. The total marks obtained in the three reviews, shall be taken in to account for continuous assessment. There will be a viva-voce examination at the end of the Project work, conducted by one internal examiner and one external examiner, the assessment marks shall be taken for end assessment.

Course Outcomes:

1 Analysis independently to design experiments and setup experiments.

2 Demonstrate the application of the chemical engineering principles to particular process variables for optimization of experimental projects.

3 Prepare clear concise project reports with the help of graph, charts, and power point presentations.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
811CHT01	Total Quality Management	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To understand the Total Quality Management concept and principles, various tools available to achieve Total Quality Management.
- To understand the statistical approach for quality control.
- To create an awareness about ISO and QS certification process and its need for the industries.

Unit - I Introduction Hours: 09

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership - Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

Unit - II TQM Principles Hours: 09

Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure.

Unit - III Statistical Process Control (SPC) Hours: 09

The seven tools of quality, Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

Unit - IV TQM Tools Hours: 09

Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA

Unit - V Quality Systems Hours: 09

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 - Concept, Requirements and Benefits.

Total Hour: 45

Course Outcomes:

1. Knows the definition of quality, analysis techniques for quality costs, role of senior management and its functions.

2. Understands the principles of TQM, importance of seven tools of quality.
3. Ability to explain importance of benchmarking, quality systems and need of quality systems.

Text Books:

1. Dale H. Besterfield, Hemant Urdhwareshe, Mary Besterfield-Sacre, Carol Besterfield-Michna, Rashmi Urdhwareshe, Glen H. Besterfield"Total Quality Management", Pearson Education Asia, 3rd Edition, 2010.
2. James R.Evans & William M.Lidsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2004.

References:

1. Feigenbaum.A.V., Total Quality Management, McGraw Hill, 1991.
2. Oakland.J.S. Total Quality Management, Butterworth - Heinemann Ltd., Oxford, 1989.
3. Narayana V and Sreenivasan, N.S., Quality Management - Concepts and Tasks, New Age International, 2007.
4. Zeiri. Total Quality Management for Engineers, Wood Head Publishers, 1991.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
811CHE02	Oil and Natural Gas Engineering	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To know about various types and compositions of crude
- To know steps and considerations in the exploration of natural gas
- To gain knowledge in the field of storage, handling, and transportation of oil-gas systems

Unit - I Production of Petroleum, Crude- types and characterization Hours: 09

Origin, Exploration and production of petroleum, Availability Versus Demands, Future outlook, Types of crudes, composition, characteristics, products pattern and characteristics, indigenous and imported crudes

Unit - II Natural Gas Hours: 09

Development of Natural Gas- types of Natural Gas Accumulations: Conventional Natural Gas- Gas in Tight Sands- Gas in Tight Shales- Methane gas occluded in coal- Natural Gas from Geo-pressurized reservoirs

Unit - III Properties of Natural Gas and Condensate Systems Hours: 09

Composition of Natural Gas- Phase behavior- The Ideal Gas- Properties of Gaseous mixtures- Behavior of Real Gas- Compressibility of Natural Gas- Viscosity of Natural Gas- Gas formation volume factor and expansion factor- Water vapour content of Natural Gas - Two phase systems

Unit - IV Separation, processing and Compression of Natural Gas Hours: 09

Gas and Liquid separation- Dehydration of Natural Gas- Types of Compressors- Reciprocating Compressors- Centrifugal Compressors- Rotary Blowers

Unit - V Environmental Aspects of Gas Processing and Use Hours: 09

Environmental Impacts of Natural Gas processing: Air pollutants- Emissions: Gas Flare Emissions- Methane Emissions- Water pollutions- Soil pollution- pollution prevention- Emissions from Natural Gas Use- Combustion Emissions- Acid rain formation- Smog Formation- Greenhouse gas emission- Industrial and Electrical Generation Emissions- protocols and Environment Programs- Environmental Management System

Total Hours: 45

Course outcomes:

1. Understand the properties and composition of cure oil and production of natural gas
2. Learn the properties processing of natural gas
3. Assess the environmental aspects of gas processing

Text Books:

1. Ikoku, Chi. U "Natural Gas Production Engineering", Krieger Publishing Company- Malabar Florida, 1992.

2. Saied Mokhatab, Poe, W. A, Speight, J. G "Handbook of Natural Gas Transmission and Processing", Gulf Professional Publishing imprint of Elsevier, Jordan Hill- Oxford, UK, 2006.

References:

1. Katz Donald L. and Lee Robert L., "Natural Gas Engineering", Mc Graw - Hill Publishing Company, NY, 1990
2. Lyons William C., "Standard Handbook of Oil and Natural Gas Engineering", Gulf Professional Publishing - an imprint of Butterworth - Heinmann, Vol. 1 & 2, 1996.
3. Nelson, W.L "Petroleum Refinery Engineering" McGraw Hill Publishing Company Limited, 1985.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri-Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
811CHE05	Pollution Control in Process Industries	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objectives:

- To know about the different types of pollutants and their effects
- To understand the techniques available to control pollution
- To design a air pollution control equipment

Unit - I Industrial Pollution Hours:09

Introduction, categorization of pollutants and pollution, environmental pollutants, Air pollutants and their sources, classification of water pollutants, thermal pollution, noise pollution, soil pollution, effects of industrial pollutants

Unit - II Air Pollution Control Hours:09

Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Origin, control methods, and equipment used in typical industries - Thermal power plants, metallurgical industries, and cement industries

Unit - III Water Pollution Control Hours:09

Sources of water pollution, characteristics of wastewater, wastewater treatment methods: sedimentation, accelerated gravity separation, flotation, chemical precipitation, Adsorption and biosorption, advanced oxidation techniques

Unit - IV Solid Waste Management Hours:09

Sources and types of solid wastes- Processing techniques --Recovery of Resources,- incineration with heat recovery-principle- site selection and plant layout of an incinerator - sanitary landfill- methods of operation - advantages and disadvantages of sanitary land fill - site selection-need for hazardous waste management-Sources of hazardous wastes-management of nuclear and e wastes-biomedical wastes- management and handling

Unit - V Design of Air Pollution Control Equipments Hours:09

Control of air pollution by equipment: settling chambers, cyclones, filters, electrostatic precipitators, scrubbers or wet scrubbers. General design procedure of cyclone, wet scrubbers, Bag filter

Total Hours: 45

Course Outcomes:

1. Able to classify the different types of pollutants and control of air pollution
2. Understand the treatment methods of wastewater and solid wastes
3. Design air pollution control equipment

Text Books:

1 Mahajan S.P., Pollution control in Process Industries, 1st Edition, Tata McGraw Hill, New Delhi, 1995.

2 Rao C S., Environmental Pollution Control Engineering, 3rd ed., Wiley Eastern Ltd. New Age International Pvt.Ltd. 1995.

3 Techobanoglous Thiesen Ellasen, Solid waste engineering principles and management, McGraw - Hill, 1997.
4 Bhatia S. C., "Environmental Pollution and Control in Chemical Process Industries," Khanna Publishers, Delhi, 2001

Reference:

1. Stern A.C., Boubce R.W and Lowry W.P., Fundamentals of Air Pollution, Academic Press, 1973.
2. John C., Mycock, McKenna J. D and Louis Theodore "Handbook of air pollution control engineering and technology". CRC Press, 1995.
3. Metcalf and Eddy, Wastewater Engineering, Treatment and reuse, Tata McGraw Hill Education, 4th Edition , 2003

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
811CHE10	Corrosion Engineering	L	T	P	C	CA	EA	Total
		3	0	0	3	50	50	100

Objective: To study the principles of corrosion forms of corrosion, testing procedures and to study the protection systems from corrosion and predicting corrosion behavior

UNIT - I **Introduction** Hours:09

Corrosion principles - electro-chemical aspects, environmental effects, metallurgical and other aspects

Unit - II **Forms of Corrosion** Hours:09

Forms of corrosion uniform attack, galvanic, crevice, pitting, Inter granular, selective, leaching, erosion and stress corrosion

Unit - III **Corrosion Testing** Hours:09

Classification - purpose - materials and specimens - Surface Preparation - Exposure Techniques - Standard Expression for Corrosion Rate - Huey Test for Stainless Steel - Streicher Test for Stainless Steel - Warren Test - NACE Test Methods - Slow - Strain - Rate Tests.

Unit - IV **Corrosion Prevention** Hours:09

Material Selection - Alteration of Environment - Design - Cathodic and Anodic Protection - Coatings

Unit - V **Designing Protection** Hours:09

Modern Theory - Principles - Thermodynamics and Electrode Kinetics.
Modern Theory Applications - Predicting Corrosion Behavior - Corrosion Prevention - Corrosion Rate Measurment.

Total Hours: 45

Course Outcomes:

1. Learn the principles of Corrosion and understand the environmental effects.
2. Understand the different types of corrosion and corrosion testing methods.
3. Design and apply modern protection coatings.

Text Books:

1. Fontana, M.G., Corrosion engineering, McGraw Hill, 3rd Ed., 2005.
2. Pierre R. Roberge, Corrosion Engineering Principles and Practice, McGraw Hill, 1st Edition, 2008.

Reference:

1. R. Winston Revie, Uhlig's Handbook of Corrosion, Wiley, 3rd edition, 2011.
2. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control, Butterworth Heinemann, 2006.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri Dt, Tamil Nadu.

Department of Chemical Engineering								
Course Code	Course Title	Hours/week			Credits	Maximum Marks		
		L	T	P	C	CA	EA	Total
811CHE12	Piping Engineering	3	0	0	3	50	50	100

Objectives:

- To understand the design of pipe line system for various industries
- To know about the piping maintenance and operation

Unit - I Single phase incompressible and Compressible flow of Newtonian fluids Hours:09

Single phase incompressible flow of Newtonian and Non-Newtonian liquids-velocity, flow equation. Complex piping system -pipe in series and parallel. Pipe network. Single phase compressible flow-flow analysis for ideal and non-ideal gas. Work, energy and power required for compression of gas

Unit - II Piping design Hours:09

Types of pipe - metallic and non - metallic pipe, piping and pipeline codes. Economic diameter, equivalent length estimation. Fitting number and types. Gravity flow, Sizing economics. Steam line -optimum diameter, temperature (low and high) considerations, and vacuum considerations. Pressure design calculation for plant piping, slurry piping and plastic piping

Unit - III Pipeline design Hours:09

Pipeline design -waste water system, compressed air system, oil piping system, slurry system and Non-Newtonian fluid system

Unit - IV Pipeline Operation Hours:09

Friction reduction, cleaning, coating, war, freezing prevention of by bleeding, leak detection, leak detection using supervisory control and data acquisition (SCADA)

Unit - V Pipeline failure and maintenance Hours:09

Pipeline failure- outside force damage, internal pressure, subsidence strains, Rupture. Pipeline economics and cost. Piping insulations and repair techniques

Total Hours: 45

Course outcomes:

1. Able to understand the nature of compressible and incompressible fluids and basis of piping design
2. Able to Design and operation of pipeline for different fluid systems
3. Learn the maintenance of pipe lines

TEXT BOOKS

1. John J.Mcketta, "Piping Design Handbook", Marcel Dekker Publication, 1992.
2. Henry Liu, "Pipeline Engineering", Lewis Publishers, 2003.

REFERENCE BOOK

1. George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity and Repair", Marcel Dekker Publication, 2003.

Chairman, Board of Studies
Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.