118CYT04	ENGINEERING CHEMISTRY	L T P C 3 0 0 3

COURSE OBJECTIVES

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques
- To recall the terminologies of electrochemistry and explain the function of batteries and fuel cells with its electrochemical reactions
- To understand the fundamentals of corrosion, its types and polymers with its applications
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels

UNIT – I **09**

Hardness of water - types - expression of hardness - units - estimation of hardness of water by EDTA - numerical problems -Alkalinity-types of alkalinity-determination of alkaninity-boiler troubles (scale and sludge) - treatment of boiler feed water - Internal treatment (carbonate, colloidal, phosphate and calgon conditioning) external treatment Ion exchange process, zeolite process - desalination of brackish water - Reverse Osmosis

UNIT – II **09**

Electrochemical cell-single electrode potential-standard electrode potential-electrochemical series and its significance-EMF of a cell- Nernst equation -Electrodes-Reference electrodes-hydrogen, calomel, quinhydrone and glass electrodes. Determination of pH of a solution using a glass electrode. Batteries - primary and secondary cells, dry cell, alkaline, lead acid storage cell, Ni-Cd battery and lithium nano battery. Clean energy fuel cells - H_2-O_2 fuel cell

UNIT – III **09**

Corrosion: definition - types of corrosion: chemical and electrochemical corrosion - Pilling Bedworth ratio - types of oxide layer (stable, unstable, volatile, porous) - hydrogen evolution and oxygen absorption mechanism for electrochemical corrosion - mechanism for rusting of iron. Types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, waterline and pipeline). Galvanic series - applications. Factors influencing corrosion: nature of metal and environment. Corrosion control methods: sacrificial anode method - impressed current Cathodic protection method - electroplating - electroless plating

UNIT – IV **09**

Monomers - polymers - polymerization - functionality - degree of polymerization - classification of polymers based on source and applications - Molecular weight determination. Types of polymerization: addition, condensation and copolymerization - mechanism of free radical polymerization. Preparation, properties and applications of PE, PVC, Teflon, terylene, Nylon and Bakelite. Rubber-drawbacks of natural rubber-Vulcanization-Compounding of plastics - injection and blow moulding methods

UNIT – V **09**

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. **Combustion of fuels:** Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method)

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications
- CO2 Construct an electrochemical cell and Identify the components and processes in batteries and infer the selection criteria for commercial battery systems with respect to different applications
- CO3 Utilize electrochemical data to formulate an electrochemical half-cell and cell reactions for corrosion control processes
- CO4 Differentiate the polymers used in day to day life based on its source, properties and applications
- CO5 Analyse the three types of fuels based on calorific value for selected application

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015

2. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications	3	2													
CO2	Construct an electrochemical cell and Identify the components and processes in batteries and infer the selection criteria for commercial battery systems with respect to different applications	3	2		2											
CO3	Utilize electrochemical data to formulate an electrochemical half-cell and cell reactions for corrosion control processes	3	2		3											
CO4	Differentiate the polymers used in daytodaylife based on its source, properties and applications	3	2		3											
CO5	Analyse the three types of fuels based on calorific value for selected application	2	3		3											

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118EGT05	ENGINEERING GRAPHICS (Common to all Non-Circuit Branches)	L T P C 2 0 4 4

COURSE OBJECTIVES

- To understand the graphical skills for drawing the object and the principle of free-hand sketching techniques
- To understand the principle of orthographic projection of points, lines and plane surfaces
- To study the principle of simple solids
- To understand the principle of section and development of solids
- To understand the principle of Isometric and Perspective projections.

UNIT – I **09**

Curves used in engineering practices:

Conics - Construction of ellipse, Parabola and hyperbola by Eccentricity method - Construction of cycloid - Construction of involutes of square and circle - Drawing of tangents and normal to the above curves.

Free hand sketching:

Representation of Three Dimensional objects - General principles of orthographic projection - Need for importance of multiple views and their placement - First angle projection - layout views - Developing visualization skills through free hand sketching of multiple views from pictorial views of objects

UNIT – II **09**

Projection of points and straight lines located in the first quadrant - Determination of true lengths and true inclinations - Projection of polygonal surface and circular lamina inclined to both reference planes

UNIT – III **09**

Projection of simple solids like prisms, pyramids, cylinders and cones when the axis is inclined to one reference plane by change of position method

UNIT – IV **09**

Sectioning of simple solids like prisms, pyramids, cylinders and cones in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other - Obtaining true shape of section.

Development of lateral surfaces of simple and truncated solids - Prisms, pyramids, cylinders and cones - Development of lateral surfaces of solids with cylindrical cutouts, perpendicular to the axis

UNIT – V **09**

Principles of isometric projection - isometric scale - isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.

Perspective projection of prisms, pyramids and cylinders by visual ray method.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Recognize the conventions and apply dimensioning concepts while drafting simple objects

CO2 Draw the orthographic projection of points, line, and plane surfaces

CO3 Draw the orthographic projection of simple solids

CO4 Draw the section of solid drawings and development of surfaces of the given objects

CO5 Apply the concepts of isometric and perspective projection in engineering practice.

TEXT BOOKS:

1. Ranganath G, Channankaiah and Halesh Koti, "Engineering Graphics", Second Edition, Sahana Publishers, 2015
2. Bhatt. N.D., "Engineering Drawing" Charotar Publishing House, 53th Edition, 2014

REFERENCES:

1. Dhananjay A.Jolhe, "Engineering Drawing with an introduction to AutoCAD" Tata McGraw Hill Publishing Company Limited, 2017
2. Gopalakrishnana. K. R, "Engineering Drawing" (Vol. I & II), Subhas Publications, 2014.
3. Basant Agarwal and C.M.Agarwal, "Engineering Drawing", Tata McGraw Hill, 2013
4. Natrajan K. V, "A Text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2012.
5. M.B.Shaw and B.C.Rana, "Engineering Drawing", Pearson Education India, 2011.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Recognize the conventions and apply dimensioning concepts while drafting simple objects	3	2											3		2
CO2	Draw the orthographic projection of points, line, and plane surfaces	3	3									1			2	1
CO3	Draw the orthographic projection of simple solids	3	3									2		1		
CO4	Draw the section of solid drawings and development of surfaces of the given objects	3	3											3	2	1
CO5	Apply the concepts of isometric and perspective projection in engineering practice	3														

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118ESE01 **BASIC CIVIL AND MECHANICAL ENGINEERING** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To gain the knowledge on civil works like masonry, roofing, flooring and plastering.
- To gain the knowledge on stress, strain of various building and foundations.
- The students should familiar with foundry, welding and forging processes.
- The students should familiar working principle of IC engines and its types.
- To gain the knowledge about various energy recourses and refrigeration air condition systems

A – CIVIL ENGINEERING

UNIT – I **SURVEYING AND CIVIL ENGINEERING MATERIALS** **09**

Surveying: Objects, types, classification, principles, measurements of distances, angles, leveling, determination of areas, illustrative examples. **Civil Engineering Materials:** Bricks, stones, sand, cement, concrete, steel sections.

UNIT – II **BUILDING COMPONENTS AND STRUCTURES** **09**

Foundations: Types, Bearing capacity, Requirement of good foundations. **Superstructure:** Brick masonry, stone masonry, beams, columns, lintels, roofing, flooring, plastering, Mechanics, Internal and external forces, Stress, Strain, Elasticity, Types of Bridges and Dams, Basics of Interior Design and Landscaping

B – MECHANICAL ENGINEERING

UNIT – III **FOUNDRY WELDING AND FORGING** **09**

Foundry: Introduction - Patterns -materials. Types of pattern and pattern allowances. Molding sand, types and properties, Molding procedure. **Welding:** Definition and Classification, Gas welding, Oxy Acetylene welding, Types of flames, advantages and disadvantages of gas welding. Resistance welding - Classification, Spot welding and Seam welding. Soldering, Definition and Classification. Brazing - Definition and Classification. **Forging:** Types of Forging, Differences between Hot working and Cold working processes

UNIT – IV **I C ENGINES& BOILERS** **09**

Internal combustion engines, Working principle of Petrol and Diesel Engines, Four stroke and Two stroke cycles, Comparison of four stroke and two stroke engines, Boilers: Introduction of boilers, classification, Lancashire boiler, Babcock and Wilcox boiler, list of boiler mountings and accessories and applications (no sketches).

UNIT – V **SOURCE OF ENERGY&REFRIGERATION** **09**

Sources of energy: Introduction, conventional and non-conventional sources of energy, examples, solar energy, hydro power plant. Introduction to refrigeration and air-conditioning, COP, properties of refrigerants and types of refrigerants, working principle of vapour compression & vapour absorption refrigeration system, Layout of typical domestic refrigerator, Window and Split type room Air conditioner

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 The usage of surveying and properties of construction materials.
- CO2 The stress strain of various building and material such as substructure, road transport and bridge.
- CO3 The concept of manufacturing methods encountered in engineering practice such as foundry, welding and forging processes.
- CO4 The working of internal combustion engines and its types.
- CO5 The concept of energy conservation in practical, power plant refrigeration air condition and its types.

TEXT BOOKS:

1. Ranganath G and Channankaiah, "Basic Engineering Civil & Mechanical", S.S.Publishers, 2014.
2. Shanmugam G and Palanichamy M S, "Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi, 3rd Edition, 2012.

REFERENCES:

1. Venugopal.K and PrabhuRaja.V, "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam, 2015.
2. Ramamrutham. S, "Basic Civil Engineering", Dhanpat Rai Publishing Co. (P) Ltd, 3rd Edition reprint, 2013.
3. Shanmugasundaram. S and Mylsamy. K, "Basics of Civil and Mechanical Engineering", Cenage Learning India Pvt.Ltd, NewDelhi, 2012.
4. Khanna O.P, Foundry Technology, Dhanpat Rai Publishing Co. (P) Ltd, 2011.
5. Shanmugam G., "Basic Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi, 2010.
6. Gopalakrishna K R, "Elements of Mechanical Engineering", Subhas Publications, Bangalore, 2008.
7. Shantha Kumar S R J, "Basic Mechanical Engineering", Hi-Tech Publications, Mayiladuthurai, 2001.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	The usage of surveying and properties of construction materials	3											2		3	2
CO2	The stress strain of various building and material such as substructure, road transport and bridge	3	2			2		1						3		
CO3	The concept of manufacturing methods encountered in engineering practice such as foundry, welding and forging processes	3	2										2	3	2	1
CO4	The working of internal combustion engines and its types	3	2			2		1					2	2	1	
CO5	The concept of energy conservation in practical, power plant refrigeration air condition and its types	3											2	1		1

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218PPT05	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures -- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT – I **ALGORITHMIC PROBLEM SOLVING** **09**

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT – II **DATA, EXPRESSIONS, STATEMENTS** **09**

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT – III **CONTROL FLOW, FUNCTIONS** **09**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT – IV **LISTS, TUPLES, DICTIONARIES** **09**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT – V **FILES, MODULES, PACKAGES** **09**

Files and exception: text files, reading and writing files, format operator; command line arguments, date and time, errors and exceptions, handling exceptions, debugging, modules, packages; Illustrative programs: word count, copy file

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Develop algorithmic solutions to simple computational problems

CO2 Read, write, execute by hand simple Python programs.

CO3 Structure simple Python programs for solving problems.

CO4 Decompose a Python program into functions.

CO5 Represent compound data using Python lists, tuples, dictionaries and read and write data from/to files in Python Programs

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, ¯An Introduction to Python - Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press, 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-Disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.
4. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
5. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Develop algorithmic solutions to simple computational problems		3			2					2		2			
CO2	Read, write, execute by hand simple Python programs			2							2		2			1
CO3	Structure simple Python programs for solving problems			2							2		2		2	
CO4	Decompose a Python program into functions	3	3	2		2					2		2			1
CO5	Represent compound data using Python lists, tuples, dictionaries			2							2		2		2	

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218BSE03 **CHEMISTRY FOR TECHNOLOGISTS** **L T P C**
2 0 0 2

COURSE OBJECTIVES

- To get ample knowledge about gaseous properties.
- To acquire knowledge about the properties of solutions.
- To apply the basic concepts of thermodynamics for engineering stream
- To understand the mechanistic pathway of chemical reactions.
- To impart an adequate knowledge about dyes and drugs

UNIT – I **09**

Measurable properties of gases, Gas Laws-Boyles law, Charle's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure, Absolute scale of temperature, Ideal gas equation. Postulates of Kinetic theory of gases-average-root mean square and most probable velocities-real gases-deviation from ideal behaviour-Compressibility factor-Vander walls equation.
Properties of Liquids-Vapour Pressure-Viscosity-surface tension and effect of temperature on various properties.

UNIT – II **09**

Different methods for expressing concentration of solution - molality, molarity, mole fraction, percentage (by volume and mass both), vapour pressure of solutions and Raoult's Law - Ideal and non-ideal solutions, vapour pressure - composition, plots for ideal and non-ideal solutions; Colligative properties- Determination of molecular mass using colligative properties; Abnormal value of molar mass, van't Hoff factor and its significance

UNIT – III **09**

Terminologies- System, Surroundings-First law of Thermodynamics-Internal energy and enthalpy of System-Second law of Thermodynamics-entropy of a system-entropy change for an ideal gas-entropy change accompanying change of Phase-Gibbs Helmholtz equation-Clausius -clapeyron equation-Applications-Maxwell relation-Chemical potential; Gibbs-Duhem equation - variation of chemical potential with temperature and pressure.

UNIT – IV **09**

Introduction-kinetics, equilibria and energetics of reaction-nucleophilic substitution-addition-elimination-electrophilic substitution in aromatic systems. Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes, nitrenes ylides and enamines

UNIT – V **09**

Classification and properties of drugs. Penicillin sulpha drugs, mode of action, synthesis of sulphanilamide, chloroquine and chloramphenicol. Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing. Synthesis of dyes. Malachite green, methyl orange, Congo red, phenolphthalein

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply gas laws in various real life situations.
CO2 Able to explain the characteristic properties and behaviour of solutions
CO3 Apply the basic concepts of thermodynamics for engineering stream.
CO4 Familiar in reaction pathways
CO5 Able to understand the chemistry behind dyes and drugs

TEXT BOOKS:

1. Jerry March Organic Reaction Mechanism John Weily Ed, 5 2002.
2. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013

REFERENCES:

1. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015
2. Puri BR, Sharma LR, Patha nia S, "Principles of Physical Chemistry", 42nd Edition, 2008, Vishal Publishing Co., Jalandhar
3. Morrison RT, Boyd RN, Bhattacharjee SK, "Organic Chemistry", 7Th Edition, Pearson India, 2011.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply gas laws in various real life situations	3	2											1		
CO2	Able to explain the characteristic properties and behaviour of solutions	3	3	1		2				2				2	2	
CO3	Apply the basic concepts of thermodynamics for engineering stream	3	2											2	2	1
CO4	Familiar in reaction pathways	3	2											2	2	
CO5	Able to understand the chemistry behind dyes and drugs	3	1												2	1

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218PPP08 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY **L T P C**

0 0 4 2

COURSE OBJECTIVES

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF EXPERIMENTS

1. To Implement python scripts using Variables and operators
2. To Demonstrate Operator precedence to evaluate an expression
3. Display grade of a student using elif statement
4. Implement Floyd triangle using for loop
5. Checks the given number is prime or not using while loop
6. Compute the GCD of Numbers using functions
7. Finding factorial of a given number using recursive function.
8. Takes a list of words and returns the length of longest one using strings
9. To perform linear and binary search using strings
10. To implement list as arrays (multiply 2 matrices)
11. To demonstrate use of list & related functions
12. To demonstrate use of tuple, set& related functions
13. To demonstrate use of Dictionary& related functions
14. Finding most frequent words in a text read from a file
15. Programs that take command line arguments (word count)

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Write, test, and debug simple Python programs.
CO2 Implement Python programs with conditionals and loops.
CO3 Develop Python programs step-wise by defining functions and calling them.
CO4 Use Python lists, tuples, dictionaries for representing compound data.
CO5 Read and write data from/to files in Python.

Course Articulation Matrix:

Cos	Course outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Write, test, and debug simple Python programs		3			2					2		2			
CO2	Implement Python programs with conditionals and loops			2							2		2		2	
CO3	Develop Python programs step-wise by defining functions and calling them			2							2		2		2	
CO4	Use Python lists, tuples, dictionaries for representing compound data	3	3	2		2					2		2			
CO5	Read and write data from/to files in Python			2							2		2			

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318CHT02	ORGANIC CHEMISTRY	L T P C 3 0 0 3

COURSE 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

UNIT – I ORGANIC REACTION MECHANISM **09**

Electrophilic reactions-Friedel crafts reaction, Riemer Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions-aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation -using N-Bromo Succinamide (NBS), thermal halogenation of alkene CH_3-CH = CH_2

UNIT – II SOLVENTS AND REAGENTS **09**

Synthesis, properties and uses of Dimethyl-formamide (DMF), Dimethyl sulfoxide (DMSO), Tetrahydrofuran (THF), Diethyl ether, Dichloromethane and Carbon tetrachloride.

Reagents of Synthetic Importance: oxidizing agents - $KMnO_4$, $K_2Cr_2O_7$, Lead tetra acetate, Osmium Tetroxide. Reducing agents - $LiAlH_4$, Na/liquid ammonia, DCC, Aluminium isopropoxide

UNIT – III HETEROCYCLIC COMPOUNDS **09**

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

UNIT – IV AMINO ACIDS AND PROTEINS **09**

Classification, preparation (Strecker, Skraup, Gabriel phthalimide) and properties of Amino acids. Composition and classification of proteins. Structure of proteins -tests for proteins -general properties and relations of proteins -hydrolysis of proteins

UNIT – V CARBOHYDRATES **09**

Carbohydrates - classification. Monosaccharides- reaction of Glucose and fructose, open chain and cyclic structures of glucose and fructose, mutarotation, epimerzation, Killiani- Fisher synthesis, Ruff degradation, conversion of aldoses to ketoses and Ketoses to aldoses. Disaccharides - properties and structure of sucrose. Polysaccharides - properties and structure of starch and cellulose

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understanding organic reactions mechanism and rearrangements

CO2 Learn and understand synthetic utilityof solvents and reagents

CO3 Learn the synthetic and biological importance of heterocycles

CO4 Learn the basics chemistry principles behind amino acids and proteins

CO5 Understand chemistry of 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
3. Arun Bhal and B.S. Bhal, "A text book of Organic chemistry", S.Chand & Co., New Delhi, 2008

REFERENCES:

1. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition Prentice Hall Inc (2004)USA
2. I.L. Finar, "Organic chemistry (Vol.1)", 6th Edition, Pearson Education, New Delhi, 2006
3. I.L. Finar, "Organic Chemistry (Vol.2)", 5th edition, Pearson Education, New Delhi, 2006

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understanding organic reactions mechanism and rearrangements	3		2	2	3		1						3		
CO2	Learn and understand synthetic utilityof solvents and reagents	3		2	2	3		1						3		
CO3	Learn the synthetic and biological importance of heterocycles	3		2	2	3		1				1		3		
CO4	Learn the basics chemistry principles behind amino acids and proteins	3		2	2	3		1				1		3		
CO5	Understand chemistry of carbohydrates	3		2	2	3		1				1		3		

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318CHT03 **CHEMICAL PROCESS CALCULATIONS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To become familiar with different systems of units and conversions, different ways of expression of composition and behaviour of ideal gases.
- To understand the concepts and behaviour of vapour gas mixtures and principles of stoichiometry.
- To understand the concept of material balance and techniques to solve the problems involving simple unit operations.
- To apply material balance concepts to problems involving reactions.
- To understand the concept of energy balance and its application to simple problems

UNIT – I **UNITS, DIMENSIONS AND BASIC CALCULATIONS** **09**

Basic Chemical Calculations: Fundamentals and derived units. Conversion of units. Dimensional consistency of equations. Dimensionless groups and constants. Conversion of equations. Concept of mole, mole fraction etc. Compositions of mixtures of solids and liquids and gases. Density and Specific gravity; Concept of molarity, molality, normality and ppm.

UNIT – II **BEHAVIOUR OF IDEAL GASES AND VAPOUR-GAS CONCEPTS** **09**

Behaviour of Ideal Gases: Applications of the Ideal gas law - Gaseous mixtures - Dalton's law and Amagat's Law

Vapour-Gas Concepts: Ideal gas law calculations, Vapour pressure concepts and calculations different systems. Problems using semi-log and log-log graphs.

Psychrometry: Humidity related terms, humidity chart, and humidification & dehumidification operations: Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity; Wet bulb Temperature and Dew point calculations

UNIT – III **MATERIAL BALANCE** **09**

General material balance equation: Steady and unsteady state: Block Diagrams-Process Flow Sheet-Material Balances-Different Models: Linear, Matrix, Graphical;

Application of material balance to unit operations: Mixing Tank, Dissolution, Drying, Evaporation, Distillation, Absorption, Extraction, Crystallisation; Recycle and bypass;

Material balance with reaction: Principles of stoichiometry, Concept of limiting and excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, Selectivity related Problems.

UNIT – IV **ENERGY BALANCE** **09**

Thermophysics and Thermochemistry Principles: Heat Capacity, Enthalpy, Heat of Formation, Heat of Reaction, Heat of Combustion and Calorific Value. Heat of Solution, Heat of Mixing, Heat of Crystallization. Sensible and latent heat calculations

Application of General Steady State Energy Balance equation: Determination of ΔH_R at standard and elevated temperature. Theoretical, flame and adiabatic flame temperature calculations.

Energy balance of simple unit operations viz. double pipe heat exchanger, evaporator

UNIT – V **FUELS AND COMBUSTION** **09**

Fuels and Combustion: Types of Fuels: Solid, Liquid & Gas; Ultimate and Proximate analysis of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, Air - fuel ratio calculations. Orsat analysis;

Numerical Problems on sulphur & sulphur burning compounds, Recycle, Bypass and Purge calculations

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other and able to find the equations for fitting data.
- CO2 Develop strategy for solving problems involving gases, vapours etc.
- CO3 Adopt the tools learned from the course to solve numerical problems which contain one or more unit operations.
- CO4 Ability to solve material balance problems involving reactions.
- CO5 Develop mathematical relations for both mass and energy balances for different processes

TEXT BOOKS:

1. Bhatt.B.I and Thakore.S.B., "Stoichiometry", Fifth Edition, McGraw-Hill Education (India) Private Limited, 2017.
2. Narayanan, K. V. and Lakshmikutty, B, "Stoichiometry and Process Calculations" 1st Edition, Prentice Hall of India, 2013.

REFERENCES:

1. Venkataramani, V and Anantharaman, N. "Process Calculations",2 nd Edition, Prentice Hall of India, 2011.
2. O.A. Hougen, K. M. Watson, and R. A. Ragatz, "Chemical Process Principles. Part I. Material and Energy Balances", 1st e-book Edition, CBS Publishers, 2018.
3. David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", Eighth Edition, PearsonIndia, 2015.
4. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 4thEdition., John Wiley & Sons, New York, 2018.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other and able to find the equations for fitting data.	3	3	3	3	2	2					2	2	2	3	
CO2	Develop strategy for solving problems involving gases, vapours etc.	3	3	3	3	2	2					2	2	2	3	
CO3	Adopt the tools learned from the course to solve numerical problems which contain one or more unit operations.	3	3	3	3	2	2					2	2	2	3	
CO4	Ability to solve material balance problems involving reactions.	3	3	3	3	2	2					2	2	2	3	
CO5	Develop mathematical relations for both mass and energy balances for different processes	3	3	3	3	3	3					2	2	2	3	

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318CHT04	INSTRUMENTATION METHODS AND ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To recognize the importance of electromagnetic spectrum
- To Extrapolate Beer-Lambert law to quantitative analysis
- To compare IR and Raman spectroscopy
- To imbibe the chromatography based separation techniques

UNIT – I **INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS** **09**

Electromagnetic radiation-Electromagnetic spectrum Errors, Precision and Accuracy: Definitions, Significant figures, Types of errors, Methodsof expressing accuracy and precision, mean, median, mode, standard deviation.

Definition &Types of spectroscopy, Absorption spectrum, Emission spectra, Wave length and Wave number, Electromagnetic radiation, Visible spectrum, Stokes's shift, Hypochromicity, transmittance

UNIT – II **UV-VIS SPECTROPHOTOMETRY AND COLORIMETRY** **09**

Theory, Deviations from Beer's Law. Colorimetry-Instrumentation (Line diagram alone) and application, estimation of inorganic ions such as Fe,Ni.

Ultra violetspectroscopy - Theory, instrumentation and application - Quantum description,Instrumentation, Chemical shift, applications and limitations.Different shifts of absorption peaks (Bathochromic, hypsochromic, hypochromic)

UNIT – III **IR SPECTROCOPY AND THERMAL ANALYSIS** **09**

Theory of IR spectroscopy, various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (near, mid, finger print and far), Instrumentation (sources and detectors).Difference between Raman spectra and IR spectra.

Thermal methods - TGA, DTA,Thermometrictitrations and their applications.

UNIT – IV **SEPARATION METHODS** **09**

TLC: Stationary phase, mobile phase, sample application, development techniques - evaluation and documentation, advantages and disadvantages of TLC.

Gas Chromatography: Principle, carrier gas, stationery phase, instrumentation, sample injection, column detectors (TCD, FID, ECD), effect of temperature on retention.

HPLC: Principle, instrumentation, column, sample injection, detectors (absorbance, refractive index, electrochemical), mobile phase selection, ion pair chromatography.

UNIT – V **FLAME SPECTROSCOPYAND XRD** **09**

Principle and Instrumentation for Flame Spectrometric Methods, FlameEmission Spectrometry, Atomic Absorption Spectrometry, InterferenceAssociated with Flame and Furnaces, Applications, Comparison of FESand AAS.

XRD-Principle, Braggs equation, Laue photographic method and Powder method, Applications of XRD

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Understanding the basics of electromagnetic spectrum.
- CO2 Learning analysis using UV-Visible spectroscopy
- CO3 Learning analysis through IR spectroscopy
- CO4 Understanding various separation techniques.
- CO5 Learning analysis using Flame spectroscopy and XRD

TEXT BOOKS:

1. Sivasankar B., "Instrumental Methods of Analysis", Oxford University Press, 2012.
2. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007.

REFERENCES:

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis, CENGAGE Learning, India, 7th Edition, 2007.
2. Willard H.H, Merritt L.L, Dean J.A and Settle F.A, Instrumental method of analysis, 7thedition, Wadsworth Publishing Company, 1988.
3. Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of Chemical Analysis, Himalaya Publishers, New Delhi, 2014.
4. John R Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prenticehall of India Pvt. Ltd., 2012.
5. Robert M. Silverstein, Francis X. Webstrer, David Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8th Edition, 2010

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understanding the basics of electromagnetic spectrum.	3	3	3	2	2	2	3						3	3	
CO2	Learning analysis using UV-Visible spectroscopy	3	3	3	2	2	2	3						3	3	
CO3	Learning analysis through IR spectroscopy	3	3	3	2	2	2	3						3	3	
CO4	Understanding various separation techniques	3	3	3	2	2	2	3						3	3	
CO5	Learning analysis using Flame spectroscopy and XRD	3	3	3	2	2	2	3						3	3	

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318EET05 PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING **L T P C**
3 0 0 3

COURSE 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 **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 **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 – III ELECTRICAL MACHINES **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 **`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 **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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Acquired good understanding of basics of DC electrical circuits
CO2 Acquired good understanding of basics of AC fundamentals
CO3 Capable of understanding the construction, working principle of electrical machines
CO4 Gained knowledge on construction and characteristics of various semiconductor devices
CO5 Learnt about the steady state behavior of electrical 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

REFERENCES:

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)

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Acquired good understanding of basics of DC electrical circuits	3	3	2	2	1	1							1	3	
CO2	Acquired good understanding of basics of AC fundamentals	3	3	2	3	2	3							1	3	
CO3	Capable of understanding the construction, working principle of electrical machines	3	3	2	3	2	3							3	3	
CO4	Gained knowledge on construction and characteristics of various semiconductor devices	3	3	2	3	2	3							3	3	
CO5	Learnt about the steady state behavior of electrical drive	3	3	2	2	1	1							1	3	

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318CHE04 **MATERIAL TECHNOLOGY** **L T P C**
3 0 0 3

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** **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** **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** **09**

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

UNIT – IV **COMPOSITES AND ADHESIVES** **`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** **09**

Cement-types-portlandcement-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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the properties of materials and criteria for selecting the material
CO2 Apply the principles of metallurgy and phase equilibrium
CO3 Predict the properties, manufacture and the applications of building materials
CO4 Describethe importance of the chemistry of ferrous metal and non-ferrous metals in industries
CO5 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

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the properties of materials and criteria for selecting the material	3	3	3	2	2		2						3	3	
CO2	Apply the principles of metallurgy and phase equilibrium	3	3	3	2	2		2						3	3	
CO3	Predict the properties, manufacture and the applications of building materials	3	3	3	2	2		2						3	3	
CO4	Describe the importance of the chemistry of ferrous metal and non-ferrous metals in industries	3	3	3	2	2		2						3	3	
CO5	Describe the composite materials, its importance and the different applications	3	3	3	2	2		2						3	3	

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318CHP07	ORGANIC CHEMISTRY LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

- To learn basic principles involved in analysis and synthesis of different organic derivative

LIST OF EXPERIMENTS

1. Quantitative analysis of organic compounds - Identification of aliphatic/aromatic, saturated/unsaturatedcompounds.
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 and h) nitro compounds.

3. Analysis of an unknown organic compound and preparation of suitable solidderivatives (Benzoic acid from Benzaldehyde, hydrolysis of ester and meta- dinitrobenzene from nitrobenzene).
4. Analysis of carbohydrates.
5. Analysis ofproteins.
6. Methodology of filtration andrecrystallization.
7. Introduction to organic synthetic procedures:
   i. Acetylation - Preparation of acetanilide fromaniline.
   ii. Hydrolysis - Preparation of salycilic acid from methylsalyciliate.
   iii. Substitution - Conversion of acetone toiodoform.
   iv. Nitration - Preparation of m-dinitrobenzene fromnitrobenzene.
   v. Oxidation - Preparation of benzoic acid from benzaldehyde/ benzylalcohol

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 The student is able to identify what distinguishes a strong and weak nucleophile and recall the rules of reactions.

CO2 The student shows their mastery of nomenclature since ethyl bromide is not drawn out

CO3 The student analyses a list of compounds and determines their reactivity.

REFERENCES

1. Vogels's Text Book of Practical Organic Chemistry, Fifth Edition, Longman Singapore Publishers Pte. Ltd., Singapore, 2001.

Course Articulation Matrix:

os	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	The student is able to identify what distinguishes a strong and weak nucleophile and recall the rules of reactions.	3		2	2	3		1						3		
CO2	The student shows their mastery of nomenclature since ethyl bromide is not drawn out	3		2	2	3		1						3		
CO3	The student analyses a list of compounds and determines their reactivity.	3		2	2	3		1						3		

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318CHP08	TECHNICAL ANALYSIS LABORATORY	L T P C 0 0 2 1

COURSE OBJECTIVES

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

LIST OF EXPERIMENTS

1. Determination of Redwood / Say bolt numbers, kinematic viscosity and viscosity index of Lubricating oils.
2. Determination of flash point, fire point, cloud and pour point of oils.
3. Determination of acid value and iodine value of oils.
4. Determination of COD of water samples.
5. Cement Analysis (a) Estimation of silica content (b) Estimation of mixed oxide content (c) Estimation of calcium oxide content (d) Estimation of calcium oxide by rapid method.
6. Coal Analysis (a) Estimation of sulphur present in coal (b) Ultimate analysis of coal (c) Proximate analysis of coal.
7. Soap Analysis (a) Estimation of total fatty acid (b) Estimation of percentage alkali content.
8. Flue gas analysis by Orsat's apparatus.
9. Estimation of phenol.
10. Determination of calorific value using bomb calorimeter.
11. Determination of nitrite in water.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Familiarization with equipment like viscometers, flash and fire point apparatus, etc.

CO2 Familiarization of methods for determining COD.

CO3 Familiarization of a few simple synthetic techniques for soap.

REFERENCES

1. Environmental pollution analysis, S.M. Khopkar, New age international.2011
2. Manual of environmental analysis, N.C Aery, Ane books.2010
3. Text book of quantitative chemical analysis, J.Mendham, Pearson education2008

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Familiarization with equipment like viscometers, flash and fire point apparatus, etc.	3	2	1	2	1					2	2		3	3	
CO2	Familiarization of methods for determining COD.	3	3	3	2	2	1				2	2		3	3	
CO3	Familiarization of a few simple synthetic techniques for soap.	3	2	3	2	1	2							2	3	

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318CHP09	ELECTRICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

- 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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Analyze the characteristics of DC generators
CO2 Analyze and test different DC motors
CO3 Test and analyze the different AC motors & transformers

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Analyze the characteristics of DC generators	3	3	2	2	1	1							1	3	
CO2	Analyze and test different DC motors	3	3	2	3	2	3							1	3	
CO3	Test and analyze the different AC motors & transformers	3	3	2	3	2	3							3	3	

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418NMT01 **NUMERICAL METHODS** **L T P C**
3 1 0 4

COURSE 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 **12**

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 **12**

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 **12**

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 **12**

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 **12**

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: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Apply numerical methods such as direct and iterative methods to solve algebraic or transcendental equations and system of equations
- CO2 Use the concept of interpolation and apply to real life situations.
- CO3 Appreciate numerical solutions for differential and integral calculus as a handy tool to solve problems.
- CO4 Implement numerical algorithms to find solutions for intial value problems for ordinary differential equations.
- CO5 Demonstrate algorithms using finite differences to obtain solutions to boundary value problems

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply numerical methods such as direct and iterative methods to solve algebraic or transcendental equations and system of equations	3	3	3	3	2								3	3	
CO2	Use the concept of interpolation and apply to real life situations.	3	2	3	3	3								3	3	
CO3	Appreciate numerical solutions for differential and integral calculus as a handy tool to solve problems.	3	3	3	2	3								3	2	
CO4	Implement numerical algorithms to find solutions for intial value problems for ordinary differential equations.	3	2	3	3	3								3	3	
CO5	Demonstrate algorithms using finite differences to obtain solutions to boundary value problems	3	3	3	2	3								3	2	

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418CHT03 **CHEMICAL PROCESS INDUSTRIES** **L T P C**
3 0 0 3

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** **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 FERTILIZER INDUSTRIES** **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** **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** **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** **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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Acquire knowledge about basics of various aspects of process industries and understands the methods of production of different chemicals.
- CO2 Get fundamental knowledge about plant and equipment design
- CO3 Apply knowledge about sulphur, nitrogen and fertilizer industry.
- CO4 Acquire knowledge about the Manufacturing and processing of paper and pulp, Sugar, by products of sugar and starch and oil, fat products.
- CO5 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.

REFERENCES:

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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Acquire knowledge about basics of various aspects of process industries and understands the methods of production of different chemicals	3	3	3	2	2	3	2			1	1		3	3	
CO2	Get fundamental knowledge about plant and equipment design	3	3	3	2	2	3	2			1	1		3	3	
CO3	Apply knowledge about sulphur, nitrogen and fertilizer industry.	3	3	3	2	2	3	2			1	1		3	3	
CO4	Acquire knowledge about the Manufacturing and processing of paper and pulp, Sugar, byproducts of sugar and starch and oil, fat products.	3	3	3	2	2	3	2			1	1		3	3	
CO5	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.	3	3	3	2	2	3	2			1	1		3	3	

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418CHT04 **CHEMICAL ENGINEERING FLUID MECHANICS** **L T P C**
2 2 0 3

COURSE 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** **09**

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** **09**

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** **09**

Reynolds number regimes- internal versus viscous flow - laminar flow in pipes and annular pipe - Newtonian fluids - Hagen Poiseuelle's equation - laminar flow of non - Newtonian fluids - turbulent flow in pipes and channels head losses in fittings and valves

UNIT – IV **FLOW THROUGH PACKED AND FLUIDIZED BEDS** **09**

Flow past immersed bodies - skin and form drag - drag coefficients - fluid flow through packed bed - Ergun's 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** **09**

Metering of fluids - orifice meter - Venturi 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, reciprocating and rotatory pumps - air lift and diaphragm pumps - fans - blowers - compressors - steam jet ejector - selector and specifications

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Students can get the knowledge about the unit and dimensions and also about the role of pressure in the fluid flow and pressure measurement.
- CO2 Students can get the knowledge about the types of fluid flow and also on the discharge measurement by using different equipment at different conditions.
- CO3 Students would have knowledge on Fluid properties, their characteristics while static and during flow through ducts, pipes and porous medium.
- CO4 Students get the idea about different types of forces, losses and their effects in the fluid flow
- CO5 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:

Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Second Edition, McGraw-Hill,
1. 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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Students can get the knowledge about the unit and dimensions and also about the role of pressure in the fluid flow and pressure measurement.	3	3	3	3	3	3	2				1		3	3	
CO2	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	3	3	3	3	3	2				1		3	3	
CO3	Students would have knowledge on Fluid properties, their characteristics while static and during flow through ducts, pipes and porous medium.	3	3	3	3	3	3	2				1		3	3	
CO4	Students get the idea about different types of forces, losses and their effects in the fluid flow	3	3	3	3	3	3	2				1		3	3	
CO5	Students get the knowledge about several machineries used to transport the fluid and their performance	3	3	3	3	3	3	2				1		3	3	

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418CHT05 **MECHANICAL OPERATIONS** **L T P C**
3 0 0 3

COURSE 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 **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 **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 **09**

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

UNIT – IV FILTRATION **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 **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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Decide the usage of equipment for industrial application with respect to size reduction.
CO2 Decide the necessary equipment to screen different particles.
CO3 Apply the knowledge of different blends and mixing techniques to liquids and solids.
CO4 Students will be able to understand the concept of filtration techniques.
CO5 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. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Seventh Edition, 2005.
3. G.G.Brown, "Unit Operations", CBS publishers, 2005.

REFERENCES:

1. Coulson, J.M and Richardson, J.F., "Chemical Engineering", Volume 2, Fourth Edition, Butterworth-Heineman, 2004.
2. Badger, Walter L. and Banchero, Julius T., "Introduction to Chemical Engineering", Tata McGraw Hill Publishers, New Delhi, 1998.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Decide the usage of equipment for industrial application with respect to size reduction.	3	3	3	3	2	3	2				1		3	3	3
CO2	Decide the necessary equipment to screen different particles.	3	3	3	3	3	3	2				1		3	3	3
CO3	Apply the knowledge of different blends and mixing techniques to liquids and solids.	3	3	3	3	2	3	2				1		3	3	3
CO4	Students will be able to understand the concept of filtration techniques.	3	3	3	2	3	3	2				1		3	3	3
CO5	Apply the usage of various filtration equipments and thickeners.	3	3	2	3	3	3	2				1		3	3	3

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418CHE03 **RENEWABLE ENERGY TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- 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 **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 **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 **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 **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 **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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Recognize the renewable energy sources with their situation and exploration in detail.

CO2 Understand the different types of energy conversion systems in wind and geothermal energy.

CO3 Understand the various energy conversion systems for solar and ocean energy harnessing.

CO4 Familiarize multiple methods in biomass and biogas conversion and its application

CO5 Familiar with principle 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.

REFERENCES:

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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Recognize the renewable energy sources with their situation and exploration in detail.	2	3	2	3	2	2							3	2	
CO2	Understand the different types of energy conversion systems in wind and geothermal energy.	3	3	2	3	2	2							3	3	
CO3	Understand the various energy conversion systems for solar and ocean energy harnessing.	3	3	2	3	2	2							3	3	
CO4	Familiarize multiple methods in biomass and biogas conversion and its application	3	3	2	3	2	2							3	3	
CO5	Familiar with principle operation and application of energy produced from Fuel and MHD in industries.	3	3	2	3	2	2							3	2	

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Krishnagiri -Dt, Tamil Nadu.

418CHP07 **FLUID MECHANICS LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To determine experimentally the flow characteristics of fluids and also to determine the efficiency of the flow measuring devices and fluid transport machineries.
- 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 (Open) orifice
12. Determination of friction factor in flow through straight pipe
13. Evaluation of head loss coefficients in pipe fittings
14. Calibration of Variable area meter

LIST OF EXPERIMENTS

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Conduct experiments for fluid flow in circular pipes, orifice and venture meters.
- CO2 Estimate the coefficient of rectangular and triangular notches.
- CO3 Estimate head loss in pipe fittings.
- CO4 Estimate coefficient of discharge for flow through open and closed channels, show relationship between Reynolds number and friction factor
- CO5 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.

REFERNCES

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. Yunus Cengel 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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Conduct experiments for fluid flow in circular pipes, orifice and venture meters.	3	3	3	3	3	3	2				1		3	3	
CO2	Estimate the coefficient of rectangular and triangular notches.	3	3	3	3	3	3	2				1		3	3	
CO3	Estimate head loss in pipe fittings.	3	3	3	3	3	3	2				1		3	3	
CO4	Estimate coefficient of discharge for flow through open and closed channels, show relationship between Reynolds number and friction factor	3	3	3	3	3	3	2				1		3	3	
CO5	Perform characteristic studies of submersible and centrifugal pump	3	3	3	3	3	3	2				1		3	3	

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418CHP08	PHYSICAL CHEMISTRY LABORATORY	L T P C 0 0 4 2

COURSE 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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the principles, properties and characteristics of solvents and mixtures
CO2 Determine the molecular weight of solute using different methods
CO3 Determine the Critical Micelle Concentration (CMC) of a metal salt
CO4 Apply the kinetics to hydrolysis of ester
CO5 Determine the molecular weight of a polymer

REFERENCES

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the principles, properties and characteristics of solvents and mixtures	2	2	3	3	2	1	2						3	1	
CO2	Determine the molecular weight of solute using different methods	2	2	3	2	2								3	1	
CO3	Determine the Critical Micelle Concentration (CMC) of a metal salt	2	2	3	2	2	1							3	1	
CO4	Apply the kinetics to hydrolysis of ester	3	2	3	2	3								3	1	
CO5	Determine the molecular weight of a polymer	3	2	3	2	3	1							3	1	

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418CHP09	MECHANICAL OPERATIONS LABORATORY	L T P C 0 0 4 2

COURSE OBJECTIVES

- 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 EQUIPMENTS

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
12. Baum Jig

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Determine work index, average particle size through experiments by crushers, ball mill, rod mill and conducting size analysis by various size sieves.

CO2 Design size separation equipments such as cyclone separator, pressure and vacuum filters

CO3 Determine thickener area from batch sedimentation experiment

TEXTBOOK

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Determine work index, average particle size through experiments by crushers, ball mill, rod mill and conducting size analysis by various size sieves.	3	3	3	2	2	1							3	3	
CO2	Design size separation equipments such as cyclone separator, pressure and vacuum filters	3	3	3	2	2	1							3	3	
CO3	Determine thickener area from batch sedimentation experiment	3	3	3	2	2	1							3	3	

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518PST01	PROBABILITY AND STATISTICS	L T P C 3 0 0 3

COURSE OBJECTIVES

- To impart the knowledge of basic probabilistic theory.
- To learn one dimensional discrete and continuous probability distributions occurring in natural phenomena.
- To extend the probability theory to two dimensional random variables and to study the statistical measures.
- To introduce the notion of sampling distributions and have acquired knowledge of statistical techniques useful in making rational decision in management problems.
- To expose to statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.

UNIT – I PROBABILITY AND RANDOM VARIABLE **12**

Axioms of probability - Conditional probability - Total probability - Baye's theorem- Random variable - Probability mass function - Probability density function - Properties - Moments - Moment generating functions and their properties.

UNIT – II PROBABILITY DISTRIBUTIONS **12**

Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions and their properties - Functions of a random variable-simple applications.

UNIT – III TWO-DIMENSIONAL RANDOM VARIABLES **12**

Joint distributions - Marginal and Conditional distributions - Covariance - Correlation and Linear regression - Central limit theorem (Statement and applications only for independent and identically distributed random variables).

UNIT – IV TESTING OF HYPOTHESIS **12**

Sampling distributions - Tests for single mean, Proportion, Difference of means (large and small samples) - Tests for single variance and equality of variances - Chi-square test for goodness of fit - Independence of attributes.

UNIT – V DESIGN OF EXPERIMENTS **12**

Analysis of variance - Completely Randomized Design (CRD) -one way classification - Randomized Block Design (RBD) -two way classification - Latin Square Design (LSD) - Factorial Designs- 2^2 Factorial designs- Control charts for measurements - $\bar{x}$ chart, R-chart, p - chart and np - chart.

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Imbibing the knowledge of basic probability improves the quality of interpretation and decision making in real time problems of uncertainty.

CO2 Understanding the real time application of probability distributions.

CO3 Learning the concept of two dimensional random variables helps to understand and analyse the Statistical measures which describe an outcome of a random experiment.

CO4 Drawing inference & decision making through hypothesis testing.

CO5 Acquainting the knowledge of analysis of variance and control limits.

TEXT BOOKS:

1. Miller and Freund., "Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, 2012.

REFERENCES:

1. Spiegel, M.R, Schiller,J and Alu Srinivasan, R, "Schaum's Outlines Probability and Statistics", Tata McGraw-Hill Publishing Company Ltd. New Delhi , 2010.
2. Gupta.S.C., & Kapoor,V.K., "Fundamentals of mathematical statistics", 11th edition, Sultan Chand & Sons publishers, New Delhi, 2013.
3. Ibe, O.C.,"Fundamentals of Applied Probability and Random Processes", Elsevier, U.P., 1st Indian Reprint, 2007.
4. Veerarajan.T., "Probability, Statistics and Random Processes", Tata McGraw-Hill publishing company Limited, New Delhi, 2014.
5. Kandasamy.P,Thilagavathy,K.,&Gunavathi.K., "Probability, Statistics and Queueing Theory"., S.Chand & Company Ltd., New Delhi, 2014.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Imbibing the knowledge of basic probability improves the quality of interpretation and decision making in real time problems of uncertainty.	3	1	2	3	1								2		
CO2	Understanding the real time application of probability distributions.	3	3	3		2	1							2		2
CO3	Learning the concept of two dimensional random variables helps to understand and analyse the Statistical measures which describe an outcome of a random experiment.	2	2	2	2	3								2		2
CO4	Drawing inference & decision making through hypothesis testing.	3	3	3	2	3							2	3		3
CO5	Acquainting the knowledge of analysis of variance and control limits.	3	2	3	1	2								3		2

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518CHT02 **CHEMICAL ENGINEERING THERMODYNAMICS** **L T P C**
3 0 0 3

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** **12**

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** **12**

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** **12**

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

UNIT – IV **CHEMICAL REACTION EQUILLIBRIA** **12**

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

UNIT – V **APPLICATION OF LAWS OF THERMODYNAMICS** **12**

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

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 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.

CO2 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.

CO3 Predict the changes in the properties of real fluids undergoing changes in process plant equipment.

CO4 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.

CO5 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.

REFERENCES:

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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	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.	3	2	2									2	3		1
CO2	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	3	3	2		1	2	1				1		1	
CO3	Predict the changes in the properties of real fluids undergoing changes in process plant equipment.	2	2	3	1				1				2			2
CO4	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.	1	2	2	1		2				2		2	2		1
CO5	Determine equilibrium constants, standard enthalpy, Gibbs free energy and equilibrium compositions for single and multiple reaction systems.	2	2	3	2		1	1	2	1			1	3		2

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518CHT03 **HEAT TRANSFER** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To provide an overall view of different modes of heat transfer applicable to process industries
- To learn the path of heat transfer when different phases are involved.
- To impart the concept and functioning of different heat exchangers.

UNIT – I CONDUCTION **12**

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 **12**

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 **12**

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 **12**

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 **12**

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: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Distinguish different modes of heat transfer
CO2 Find the rate of heat transfer with and without change of phase
CO3 Evaluate film coefficients in convection under different situations (forced, natural convection, Boiling and Condensation Heat)
CO4 Decide the type of evaporator required for a specific purpose
CO5 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

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Distinguish different modes of heat transfer		1	2	1	1		1					2	1	2	
CO2	Find the rate of heat transfer with and without change of phase	1	1	1		2	1		1		1			3		1
CO3	Evaluate film coefficients in convection under different situations (forced, natural convection, Boiling and Condensation Heat)	1	2	3	2	2	1	2	1		1	2	1	3	2	1
CO4	Decide the type of evaporator required for a specific purpose	3	2		3	3	2	2	2	3	3	2	1	3	1	1
CO5	Analyze the concepts of heat exchangers	2	2	2	1	1		1	1	1			1	1	1	1

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518CHT04	MASS TRANSFER – I	L T P C 3 0 0 3

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 **12**

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 **12**

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, 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 **12**

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

UNIT – IV DRYING **12**

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 **12**

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

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Write rate equations for mass transfer operations
- CO2 Apply the diffusion principles in mass transfer calculations
- CO3 Apply the concepts of inter phase mass transfer in gas- liquid, liquid-liquid and solid - liquid mass transfer operations
- CO4 Design Cooling towers, dryers and crystallizers
- CO5 Acquire knowledge about crystal formation and industrial 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. Narayanan KV ,"Mass Transfer Theory and applications", CBSPublishers & Distributors, 2014.

REFERENCES:

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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Write rate equations for mass transfer operations	1		2	1									1		
CO2	Apply the diffusion principles in mass transfer calculations	1	2	1	1		1	1	1	1	1		1	1		
CO3	Apply the concepts of inter phase mass transfer in gas- liquid, liquid-liquid and solid - liquid mass transfer operations	2	3	3	3	2	2	1	2	1			2	2	1	1
CO4	Design Cooling towers, dryers and crystallizers	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	Acquire knowledge about crystal formation and industrial crystallizers.	2	2	1	2	2	1	1	1					1		

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518CHE04 **OIL AND NATURAL GAS ENGINEERING** **L T P C**
3 0 0 3

COURSE 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** **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** **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** **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** **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** **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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understand the properties and composition of cure oil and production of natural gas

CO2 Learn the properties processing of natural gas
CO3 Assess the environmental aspects of gas processing
CO4 Acquire knowledge about compressors
CO5 Acquire knowledge about emissions and environmental management systems

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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the properties and composition of cure oil and production of natural gas	1	1					1	1	1				2		
CO2	Learn the properties processing of natural gas	1		1			1	1				1	1			
CO3	Assess the environmental aspects of gas processing	1	1	1	1		1	1					1	2		
CO4	Acquire knowledge about compressors	1	1	1	1				1		1			2		1
CO5	Acquire knowledge about emissions and environmental management systems	1	1	1	1		1	1	1		1	1	1	2		1

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518MEO01 **FINITE ELEMENT ANALYSIS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To interpret the mathematical and physical principles underlying the Finite Element Analysis.
- To acquire knowledge about the characteristics of various one dimensional elements for the problems being solved.
- To explain about the finite element equations for simple and complex elements.
- To learn how the finite element method is implemented in vibration analysis.
- To develop finite element formulations of engineering problems from a variety of application areas including heat transfer and fluid flow analysis

PREREQUESTIE

Knowledge of Engineering Mathematics, Strength of Materials, Engineering Thermodynamics, Dynamics of Machinery are required

INTRODUCTION (Not for examination) **04**

Solution to engineering problems - Mathematical modeling - Discrete and Continuum modeling - need for numerical methods of solution - Relevance and scope of finite element methods - engineering applications of FEA

UNIT – I **FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROBLEMS** **08**

Weighted residual methods -Cieneral weighted residual statement - Weak formulation of the weighted residual statement - Piecewise continuous irial functions- Principle of stationary tolal potential - Rayleigh Ritz method - Piecewise continuous trial functions – Solution of equilibrium problems – Gaussian elimination method – Rayleigh Ritz method – Galerkin method.

UNIT – II **ONE DIMENSIONAL FINITE ELEMENT ANALYSIS** **08**

General form of total potential for 1 D applications - Generic form of finite element equations - linear bar element – Quadratic bar element -Nodal approximation - Development of shape functionsElement matrices and vectors - Example problems - Extension to plane truss- Development of Element equations - assembly - Element connectivity - Global equations - Solution methods - Beam element - Nodal approximation - Shape functions - Element matrices and vectors - A.ssembly - solution - Example problems.

UNIT – III **TWO DIMENSIONAL FINITE ELEMENT ANALYSIS** **09**

Introduction - Approximation of geometry and field variable - S noded triangular elements - four noded rectangular elements - Higher order elements - Natural coordinates and coordinate transformations - Triangular and quadrilateral elements - Iso-parametric elements - Structural mechanics applications in 2 Dimensions - Elasticity equations - stress strain relations - plane problems of elasticity - Element equations - Assembly - Need for quadrature formule - transformations to natural coordinates - Gaussian quadrature - Example problems in plane stress, Plane strain and Axisymmetric applications

UNIT – IV **DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD** **08**

Introduction - Vibrational Problems - Equations of motion based on weak form - Axial vibration of bars - Transverse vibration of beams - Consistent mass malices and lumped mass matrices- element equations -Solution of eigen value problems - Vector iteration methods.

UNIT – V **APPLICATIONS IN HEAT TRANSFER & FLUID FLOW ANALYSIS** **08**

Basic equation of steady state heat transfer and fluid flow problems – I D finite element formulation – I D heat transfer and fluid flow problems - Scalar variable problems in 2Dimensions - Applications to heat transfer in 2 Dimension

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Identify mathematical model for solution of common engineering problems
CO2 Formulate one dimensional finite element equation for simple problems
CO3 Examine 2-D finite element continuum for structural applications
CO4 Formulate and solve vibration problems using finite element techniques
CO5 Solve 1-D and 2-D heat transfer and fluid flow problems using finite element approach

TEXT BOOKS:

1. Logan D.L., "A First Course in the Finite Element Method", 6" Edition, Thomson Learning. 2016
2. P.Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.

REFERENCES:

1. Rao S.S, "The Finite Element Method in Engineering", Butterworth-Heinemann (An imprint of Elsevier), 6th Edition, 2018.
2. I.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International 3rd Editions, 2017.
3. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition 2017.
4. Chandrupatla T.R. & Belagundu A.D., "Introduction to Finite Elements in Engineering", Pearson Education, New Delhi, 4 Edition, 2014.
5. K.J. Bathe, "Finite Element Procedures", Prentice-Hall India Pvt. Ltd., New Delhi, 2" Edition, 2014.
6. Chennakesava R Alavela, "FEM: Basic Concepts and Applications", Prentice Hall India Pvt. Ltd, New Delhi, 2012
7. Cook R.D., Malkus D.S., Plesha M.E., and Witt R.J., "Concepts and Applications of Finite Element Analysis", Wiley India (P) Ltd., New Delhi, 4 th Edition, 2007.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Identify mathematical model for solution of common engineering problems	3		2			1				1	1				1
CO2	Formulate one dimensional finite element equation for simple problems	3		2			1				1	1			2	
CO3	Examine 2-D finite element continuum for structural applications		2	2		1		1						1		
CO4	Formulate and solve vibration problems using finite element techniques	3		2			2		2			2		1		
CO5	Solve 1-D and 2-D heat transfer and fluid flow problems using finite element approach	3		2			2		2			2		1		

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518CHP07	HEAT TRANSFER LABORATORY	L T P C 0 0 4 2

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 EQUIPMENTS

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

Minimum 10 experiments shall be offered

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Determine the thermal conductivity for various conductors and Stefan Boltzmann constants through experiments.

CO2 Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.

CO3 Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Determine the thermal conductivity for various conductors and Stefan Boltzmann constants through experiments.	3	3	3	3	3	1	1	1	1	1			3		1
CO2	Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.	3	3	3	1	2			1		1	1		2		1
CO3	Use experimental data to evaluate heat transfer co-efficient and evaluate performance of different types of equipment including heat exchangers, condensers.	3	3	3	3	2	3	1		2	1	1	3	2		1

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518CHP08 CHEMICAL ENGINEERING COMPUTATIONAL LABORATORY L T P C

0 0 4 2

COURSE OBJECTIVES

- To give the students in understanding the fundamental concepts in mathematics, problems solving and computer programming.
- To implement numerical techniques developed in the course to problems of engineering interest.
- To implement various numerical methods to solve the equations related to chemical engineering.

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. Numerical 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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Equipped with the software applications and the numerical solutions of chemical engineering problems.
- CO2 Solve the various numerical problems using these tools and commercial packages.
- CO3 Optimize the various factors using the computational techniques

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Equipped with the software applications and the numerical solutions of chemical engineering problems.	2	3	3	3	3	2	2	1	2				2	2	
CO2	Solve the various numerical problems using these tools and commercial packages.	3	3	3	3	3	1		1	2			2	3	3	3
CO3	Optimize the various factors using the computational techniques	2	3	3	3	3	1	1	1	2		2	1	3	3	3

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Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

518CHP09	EMPLOYABILITY SKILLS LAB	L T P C 0 0 4 2

COURSE 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.

LAB REQUIREMENTS:

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

UNIT – I **09**

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

UNIT – II **09**

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

UNIT – III **09**

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.

UNIT – IV **09**

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

UNIT – V **09**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Comprehend the various strategies of listening and its significance.

CO2 Articulate their views clearly and concisely with self-confidence and persuasiveness.

CO3 Understand the prevailing practices of testing in the recruitment process by the corporate and the institutional selection processes.

CO4 Communicate the corporate and social requirements in an impressive written mode.

CO5 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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Comprehend the various strategies of listening and its significance.										3		3			
CO2	Articulate their views clearly and concisely with self-confidence and persuasiveness.										2		3			
CO3	Understand the prevailing practices of testing in the recruitment process by the corporate and the institutional selection processes.										3		2			
CO4	Communicate the corporate and social requirements in an impressive written mode.										2	2	2			1
CO5	Enhance their verbal skills in the screening tests competently both for recruitment and pursuing higher studies as well.										2		2			1

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Adhiyamaan College of Engineering (Autonomous)
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618CHT01	MASS TRANSFER – II	L T P C 3 0 0 3

COURSE 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 **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 **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 **09**

Theory of Ponchon-Savarit method: enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios; (No numerical problems)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply mass transfer and separation principles in several unit operations like absorption, distillation

CO2 Determine the number of theoretical stages in a stage-wise mass transfer processes

CO3 Calculate height requirements of continuous separation columns.

CO4 Apply mass transfer and separation principles in several unit operations like liquid-liquid extraction, leaching and adsorption

CO5 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. Philip C Wankat, "Equilibrium Stage Separations", Prentice Hall,1993

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply mass transfer and separation principles in several unit operations like absorption, distillation	2	2	2	2	2			1				2	3	2	
CO2	Determine the number of theoretical stages in a stage-wise mass transfer processes	3	3	3	3		1		1					3	2	
CO3	Calculate height requirements of continuous separation columns.	2	2	2	2	2			1					3	2	
CO4	Apply mass transfer and separation principles in several unit operations like liquid-liquid extraction, leaching and adsorption	3	3	3	3				1				2	3	3	2
CO5	Understand the principle of ion exchange.	1	1	1	1									1	1	

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618CHT02	CHEMICAL REACTION ENGINEERING-I	L T P C 3 1 0 4

COURSE OBJECTIVES

- 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 KINETICS OF HOMOGENEOUS REACTIONS **12**

Introduction, Chemical kinetics and Thermodynamics/Equilibrium, single and multiple reactions, Rate constant and rate of reaction, Factors affecting rate of reaction, Molecularity and order of reaction, elementary and non-elementary reactions, rate equations, temperature dependence of rate, Arrhenius, Collision and activated complex theories, kinetic models for non-elementary reactions

UNIT – II INTERPRETATION OF BATCH REACTOR DATA **12**

constant volume batch reactor, Analysis of total pressure data obtained in a constant-volume system, Integral method of analysis of data, Differential method of analysis, fractional life method, varying volume batch reactor

UNIT – III DESIGN OF IDEAL REACTORS SINGLE HOMOGENEOUS REACTORS **12**

The general mole balance equation for a reactor, design equations for Ideal batch reactor, ideal steady mixed flow reactor and steady state ideal plug flow reactor. Size comparison of single reactors, optimum reactor size problems

Multiple Reactor Systems: Plug flow reactors in series and/or in parallel-equal sized mixed flow reactors in series-mixed flow reactors of different sizes in series - finding the conversion in a given system - determining the best system for a given conversion - reactors of different types in series-recycle reactor - autocatalytic reactions

UNIT – IV MULTIPLE REACTIONS **12**

Introduction to multiple reactions - Design for parallel reactions- optimum yield, conversion, and selectivity-qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size

Quantitative discussion about product distribution, quantitative treatment in a plug flow or batch reactor, quantitative treatment in a mixed flow reactor, irreversible series-parallel reactions-two step irreversible series-parallel reactions

UNIT – V BASICS OF NON IDEAL FLOW **12**

Introduction to non-ideal flow, concept of micro and macro mixing, residence time distribution functions, C, E and F curves, calculation of mean residence time from E and F curves, interpretation of the response data using the "Dispersion" and "Tanks-in-series" models (for first order reactions)

TOTAL: 60 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Apply the basic principles of reaction kinetics, understand the effect of temperature on the rate of reaction

CO2 Learn and analyze batch reactor data

CO3 Design of single and multiple ideal flow reactors for homogeneous reactions.

CO4 Learn about multiple reactions and analyze the thermal characteristics of reactors and its usage in design procedure.

CO5 Acquire basic knowledge on non-ideal flow reactors

TEXT BOOKS:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd ed., John Wiley & Sons, 2001.
2. Fogler H.S., "Elements of Chemical Reaction Engineering", 4th ed., PHI, 2005

REFERENCES:

1. J.M.Smith, "Chemical Engineering Kinetics", 3 rd ed., McGraw-Hill Education India Pvt. Ltd, 2014.
2. Lanny D. Schmidt, "The Engineering of Chemical Reactions", 2nd Edition, Oxford University Press, 2007

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply the basic principles of reaction kinetics, understand the effect of temperature on the rate of reaction	2	2	2	2					1	2		1			1
CO2	Learn and analyze batch reactor data	1	1	1	1		1		1					1		
CO3	Design of single and multiple ideal flow reactors for homogeneous reactions.	3	3	3	3	1	2	2	1	2			1	2		2
CO4	Learn about multiple reactions and analyze the thermal characteristics of reactors and its usage in design procedure.	1	1	1	1			1								1
CO5	Acquire basic knowledge on non-ideal flow reactors	1	1	1	1		1			1						1

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Krishnagiri -Dt, Tamil Nadu.

618CHT03	PROCESS DYNAMICS AND CONTROL	L T P C 3 0 0 3

COURSE 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 **09**

Incentives for chemical process control, Design elements of a control system, classification of chemical process variables, physical elements (hardware) constituting a control system.
Development of a Mathematical model- Why do we need mathematical modeling for process control - state variables and state equations - additional elements of the mathematical models - concept of dead time - modeling of mixing process - the input - output model - Degrees of Freedom

UNIT – II LOOP CONTROL SYSTEMS **09**

Analysis of the dynamic behavior of chemical processes - linearization of systems with one variable - examples - Laplace transforms - development of Transfer function and the Input/ Output models - poles and zeros of a transfer function - Qualitative analysis of the response of a system - dynamics of first order systems and dynamics of second order systems - Interacting and Non - Interacting systems.

UNIT – III CONTROLLERS & ADVANCED CONTROL TECHNIQUE **09**

Introduction to feedback control - concept of feedback control - types of feedback controllers - transfer function of feedback controllers; Dynamic behavior of feedback controlled processes: Block diagram and the closed loop response - Effect of P, PI, PID controllers on closed loop process.
Advance controlled techniques: Feed forward controller - ratio control - cascade control - selective control - split range control - adaptive control - Introduction to control - characterization.

UNIT – IV STABILITY ANALYSIS AND CONTROLLER TUNING **09**

Stability Analysis of Feedback systems: Routh - Hurwitz Criterion for Stability, Root locus analysis; Design of feedback controllers: Simple performance criteria, Time - Integral performance criteria - selection of the type of feedback controller - Process reaction Curve technique for controller tuning - Ziegler - Nichols Tuning Technique.

UNIT – V FREQUENCY RESPONSE ANALYSIS **09**

Frequency response analysis - response of a first order system to a Sinusoidal input - Frequency Frequency response analysis - response of a first order system to a Sinusoidal input - Frequency response characteristics - Frequency response of a different processes and controllers - Bode Diagram - Nyquist Plots; Design of feedback controllers using frequency response analysis - Bode stability Criterion - Gain and Phase Margins

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Understand the prerequisites of control strategies.
- CO2 Design of process control systems
- CO3 Suggest the suitable controllers for different chemical process
- CO4 Analyze stability and apply different tuning techniques
- CO5 Design control systems using frequency response analysis

TEXT BOOKS:

1. Coughanowr and Koppel, "Process Systems Analysis and Control", McGraw-Hill, New York, 2013
2. George Stephanopolous, "Chemical Process Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.
3. William L.Luyben/Michael L.Luyben, Essentials of Process Control, McGraw - Hill Companies, Inc., 1997.

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the prerequisites of control strategies.	2	2	2	2									1	1	1
CO2	Design of process control systems	3	3	3	3	3	1	1		1				1	3	3
CO3	Suggest the suitable controllers for different chemical process	3	3	3	3	1			1	1	1		1	1	2	2
CO4	Analyze stability and apply different tuning techniques	2	2	2	2	2			2					1	2	1
CO5	Design control systems using frequency response analysis	3	3	3	3	3	1	1	1				1	1	3	

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618CHT04 **CHEMICAL PROCESS PLANT SAFETY** **L T P C**
3 0 0 3

COURSE 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** **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** **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** **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** **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** **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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Impart knowledge on safety management process in chemical process industries.
CO2 Understand the effects of toxicants and safety policies and procedures.
CO3 Identify the sources and consequences of fire and explosion
CO4 Analyze the hazard and can identify the root cause of an accident.
CO5 Understand the concept of failure probabilities, and frequency of accident scenarios.

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.
4. Daniel A. Crowl, Joseph F. Louvar; "Chemical Process Safety Fundamentals with Applications"; Third Edition, Prentice Hall International Series,2011.

REFERENCES:

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

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Impart knowledge on safety management process in chemical process industries.	1			1		2	2	3	1		1		1		2
CO2	Understand the effects of toxicants and safety policies and procedures.	1			1		2	3	3	1		1		1		3
CO3	Identify the sources and consequences of fire and explosion	1			1	1	2	2	3	1		1		1		2
CO4	Analyze the hazard and can identify the root cause of an accident.	2	2	2	2	1	2	2	3	3	1		2			3
CO5	Understand the concept of failure probabilities, and frequency of accident scenarios.	2	2	2	2	1	2	2	3	3	1	1	2			3

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618CHE06	FOOD SCIENCE AND TECHNOLOGY	L T P C 3 0 0 3

COURSE OBJECTIVES

- To create awareness on the need for processing and preservatives of Foods.
- To design processing equipment's for Food Industries.
- To learn about the food microbiology.

UNIT – I AN OVERVIEW OF FOOD INDUSTRY, FOOD CONSTITUENTS QUALITY AND DETERIORATIVE FACTOR **09**

General aspects of food industry, World food needs and Indian situation. Constituents of food - Carbohydrates, Proteins, Lipids and Vitamins, Quality and nutritive aspects, Food additives, Preservatives, Flavours, Food standards, Deteriorative factors and their control.

UNIT – II GENERAL ENGINEERING ASPECTS IN FOOD MICROBIOLOGY AND PROCESSING METHODS **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 **09**

Degrees of preservation, Selection of Heat treatments, Heat resistance of microorganisms, heat transfer, Protective effects of Food constituents, Dehydration, Concentration, Microwave heating, Sterilization and Pasteurization, Drying and Irradiation, Inoculated Pack studies, Temperature-Time combinations, Heating before or after packaging.

UNIT – IV COLD PRESERVATION AND PROCESSING **09**

Preservation by Refrigeration and cool storage, Freezing and Frozen storage, Freeze drying and Cryogenic preservation, Fermentation and pickling, Packing methods.

UNIT – V PRODUCTION AND UTILIZATION OF FOOD PRODUCTS **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 amino acids.

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Understand the problems related to food and food industries by implementing properties related to food
- CO2 Apply the knowledge in aspects of food microbiology, production and utilization of various food products and the processing
- CO3 Apply the basic skills related to heat preservation, with processing and various methods followed in food processing industries.
- CO4 Apply the basic skills related to cold preservation, with processing and various methods followed in food processing industries.
- CO5 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.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understand the problems related to food and food industries by implementing properties related to food	1	1			1	1	2		1			2			1
CO2	Apply the knowledge in aspects of food microbiology, production and utilization of various food products and the processing	2	2		1		1	1	2				2			1
CO3	Apply the basic skills related to heat preservation, with processing and various methods followed in food processing industries.	2	2				2	2	2	1						1
CO4	Apply the basic skills related to cold preservation, with processing and various methods followed in food processing industries.	2					2	2	2	1	2		2			1
CO5	Understand the Production and Utilization of Food Products	2					2	2	1	1	2		1			

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618BTO04 HEALTH & PHARMACEUTICAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To have the basic knowledge of pharmacology
- To gain knowledge in various dosage forms and biopharmaceutics
- To be able to understand in pharmacokinetics and drug discovery

PREREQUESTIE

Biochemistry

UNIT – I INTRODUCTION TO PHARMACOLOGY **09**

Historical outlines of drugs, classifications of drugs, physico-chemical properties of drugs, Routes of administration of drugs, drug metabolism, controlled release drug delivery system, drug stability, Sources: plant, marine and microorganisms

UNIT – II DRUG DISCOVERY AND DEVELOPMENT **09**

Introduction, basic clinical evolution of new drugs, bioavailability of drugs, quantitative and qualitative assay of drugs by biological testing, packing techniques like compression of tablets, wet & dry granulation, direct compression, tablet presses and coating

UNIT – III PHARMACOKINETICS AND BIOTRANSFORMATION **09**

Pharmacokinetics: introduction, absorption, distribution, elimination and metabolism of drugs, site of action, Phase I and Phase II reactions, pro drugs, adverse drug effects, Role of Enzymes in drug metabolism

UNIT – IV PHARMACEUTICAL DOSAGE FORMS AND APPLICATIONS **09**

Oral solid dosage forms, compressed tablets, types, pills, solutions, syrups, juices, nasal solutions, emulsions, lotions and extracts. Applications of various drugs in human body and site of action

UNIT – V BIO PHARMACEUTICALS **09**

Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, common drugs which are abused, antibiotics, human insulin, interferon, somatostatin, somatotropin - its preservation and analytical methods

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Drugs, drugs action, drug metabolism
- CO2 Drug development, bioavailability
- CO3 Various dosage forms of Biopharmaceuticals
- CO4 The recent evolution in pharmaceutical biotechnology
- CO5 Evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market

TEXT BOOKS:

1. Remington, "The science and practice of pharmacy", Lippincott Williams and Wilkins, 20th edition,2001
2. Gareth Thomas, Medicinal Chemistry an Introduction", John Wiley, New Delhi, 2000
3. RamI.Mahato,AjitS.Narang,"PharmaceuticalDosageFormsandDrugDelivery",2nd Edition CRC Press, 2011

REFERENCES:

1. Katzung, B.G. "Basic and Clinical Pharmacology", Prentice Hall of India, New Delhi., 1995
2. Tripathi, K.D. "Essentials of Medical Pharmacology", Jaypee Brothers Medical Publishers (P) Ltd, 6th edition, John Wiley, New Delhi, 2000

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Drugs, drugs action, drug metabolism	3			2						1	1				3
CO2	Drug development, bioavailability		2		2				2			2			2	
CO3	Various dosage forms of Biopharmaceuticals		2	2		2			1			1			2	
CO4	The recent evolution in pharmaceutical biotechnology		2		2				2			2			2	
CO5	Evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market					2		2				2			2	

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Adhiyamaan College of Engineering (Autonomous)
HOSUR-635 109.
Krishnagiri -Dt, Tamil Nadu.

618CHP07	PROCESS CONTROL LABORATORY	L T P C 0 0 4 2

COURSE 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 EQUIPMENTS

1. Control valve characteristics setup
2. Time constant of Thermometer setup
3. Interacting, Non-Interacting setup
4. 10 Computers with MATLAB

Minimum 10 experiments shall be offered

TOTAL: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Understands the importance of dynamics of process in controller design

CO2 Able to design of controller and evaluation of its performance

CO3 Able to use MATLAB Simu-link software in dynamic study of processes, and design of controllers

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Understands the importance of dynamics of process in controller design	3	3	3	3	3			1			1		3	3	3
CO2	Able to design of controller and evaluation of its performance	3	3	3	3	3			1			1	2	3	3	3
CO3	Able to use MATLAB Simu-link software in dynamic study of processes, and design of controllers	3	3	3	3	3			1			1	1	3	3	3

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

618CHP08	MASS TRANSFER LABORATORY	L T P C 0 0 4 2

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

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 EQUIPMENTS

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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

- CO1 Apply the basic principles of mass transfer operations
- CO2 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
- CO3 Choose a mass transfer operation for separation of a mixture into pure components

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Apply the basic principles of mass transfer operations	3	3	3	3	3			1			1		3	3	3
CO2	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	3	3	3	3			1			1	2	3	3	3
CO3	Choose a mass transfer operation for separation of a mixture into pure components	3	3	3	3	3			1			1	1	3	3	3

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

618CHP09 CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING LAB – I

L	T	P	C
0	0	2	1

COURSE 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: 45 PERIODS

COURSE OUTCOMES

By the end of the course students will be able to

CO1 Students understands design and drawing considerations of process equipment
CO2 Students will be able to perform required calculations for the process equipment design
CO3 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. V.V. Mahajani, "Joshi's Process Equipment Design", 5th Ed., Trinity Press, 2014.
3. L.E. Brownell and E. Young, "Process equipment design" John Wiley, New York, 2009

REFERENCES:

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 Standards Institution, New Delhi.
3. Perry, R.H. "Chemical Engineers' Handbook", McGraw-Hill, 8th Ed 2007.
4. McCabeW.L., Smith J.Cand Harriot, P. "Unit Operation of Chemical Engineering", McGraw-Hill, 2001.
5. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.1980
6. J.M. Coulson J. F. Richardson, R.K. Sinnott "Chemical Engineering Design Vol. 6, 3rd Ed., Butter worth - Heinemann, 1999.

Course Articulation Matrix:

Cos	Course Outcomes	Programme Outcomes												Programme Specific Outcome		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	Students understands design and drawing considerations of process equipment	2							2							1
CO2	Students will be able to perform required calculations for the process equipment design	3	3	2			1	1	2	2	2					2
CO3	Students will be able to design and draw process equipments	3	3	2	2		1	1	3	2	1					2

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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		

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Faculty of Chemical Engineering (UG& PG)
Adhiyamaan College of Engineering (Autonomous)
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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

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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	

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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

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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

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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		

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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
715CHP07	Chemical Reaction Engineering Lab	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		
715CHP08	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)
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			

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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
715CHP09	Technical Seminar & Report Writing	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

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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

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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
815CHE02	Petroleum Refinery Engineering	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)
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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		
815CHE06	Drugs and Pharmaceutical Technology	L	T	P	C	CA	EA	Total
		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		
815CHE07	Heterogeneous Catalysis	L	T	P	C	CA	EA	Total
		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)
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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	

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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		

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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

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