C.V. Raman College of Engineering,
(An Autonomous Institute Affiliated to BPUT, Odisha)
Bidyanagar, Mahura, Janla, Bhubaneswar - 752 054 (Orissa)

Second Year B.Tech Course Structure with effect from Academic Year 2015-16 Batch

Department of Chemical Engineering

Semester III

Sl. No.	Code	Subject	Type	Teaching Scheme			Credits
				L	P	T	
S1	**MA21104**	Mathematics-III(B)	Theory – Core	3	-	1	4
S2	**CH20101**	Fluid Flow & Flow Measurement	Theory – Core	3	-	1	4
S3	**CH20102**	Chemical Process Technology	Theory – Core	3	-	-	3
S4	**CH20103**	Mass Transfer-I	Theory – Core	3	-	-	3
S5	**CS21102**	Object Oriented Programming using C++	Theory – MD	3	-	-	2
P1	**CH20301**	Fluid Flow & Flow Measurement Lab	Lab – Core	-	2	-	1
P2	**CH20302**	Chemical Technology Lab	Lab – Core	-	2	-	1
P3	**CS21302**	Object Oriented Programming using C++ Lab	Lab – MD	-	2	-	1
P4	**CH24301**	Introduction to Process Automation	Lab – SD	-	2	-	1
MP	**CH27397**	Mini Proj.	Project	-	4	-	2
	CH27401	Comprehensive Viva Voce based on S2 & S3	Oral	-	-	-	2
P5	**HS27421/ HS27420**	Technical writing / General Seminar	Lab	-	2	-	1
Total				**15**	**14**	**2**	**25**

Second Year B.Tech Course Structure with effect from Academic Year 2015-16 Batch

Department of Chemical Engineering

Semester IV

Sl. No.	Code	Subject	Type	Teaching Scheme			Credits
				L	P	T	
S1	**MA21105**	Mathematics-IV	Theory – Core	3	-	1	4
S2	**CH20104**	Mechanical Operation	Theory – Core	3	-	1	4
S3	**CH20105**	Mass Transfer-II	Theory – Core	3	-	-	3
S4	**CH20106**	Chemical Process Calculations	Theory – Core	3	-	-	3
S5	**EC21161**	Electronics Engineering	Theory – MD	3	-	-	2
P1	**CH20304**	Mechanical Operation Lab	Lab – Core	-	2	-	1
P2	**CH20305**	Mass Transfer Lab	Lab – Core	-	2	-	1
P3	**EC21361**	Electronics Engineering Lab	Lab – MD	-	2	-	1
P4	**CH24302**	General Seminar on Research Methodology	Lab – SD	-	2	-	1
MP	**CH27398**	Mini Proj.	Project	-	4	-	2
	CH27402	Comprehensive Viva Voce based on S2 & S3	Oral	-	-	-	2
P5	**HS27420/ HS27421**	General Seminar / Technical Writing	Lab	-	2	-	1
Total:				**15**	**14**	**2**	**25**

MA21104: Mathematics–III (B) [3-0-0]

Credits: 04 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Elementary idea of Sets, Functions, Trigonometry, Two–dimensional co-ordinate Geometry, Fundamentals of differential and integral calculus, Ordinary Differential Equations.

Objectives:

1. To empower the students with skills to model and solve partial differential equations with comparative ease.
2. To make students aware of Complex Analysis and its applications.

Course Outcomes:

After the completion of the course, the students will be able to:

CO1. Enlighten with the ideas and methods of solving different first and second order partial differential equations.

CO2. Solve various applied problems of partial differential equations such as Wave Equations, Heat Equations, Steady State Heat Equations and Laplace's Equations etc. by separation of variables.

CO3. Find out the roots of complex equations, can say whether a function of complex variable is analytic, can represent a function of complex variables by its power series, and integrate.

Course Details:

Unit 1: Partial Differential Equations (08 Hrs)

U1.1. Introduction to Partial Differential Equations. Partial differential equation of first order, Linear partial differential equation (Lagrange's' Method), Non-linear partial differential equation, Charpit's Method, Homogenous and non-homogeneous partial differential equation with constant co-efficient, Cauchy type differential Equations.

U1.2. Self Study Topics: Finding integral surface of the differential equations.

Unit 2: Some More Techniques to Solve PDEs (08 Hrs)

U2.1. Non – Linear Partial Differential Equations of Second Order [Monge's Method], Solution of Second Order PDE, Some Miscellaneous Cases, Solutions of Partial Differential Equations by Separation of Variables, Solution of Parabolic, Hyperbolic Partial Differential Equations.

U2.2. Self Study Topics: Solutions of PDE by Applying Laplace's Transforms.

Unit 3: Wave, Heat, and Laplace's Equations (08 Hrs)

U3.1. One and two dimensional wave equations and their solutions, one and two dimensional heat equations and their solutions, D'Alembert's Solution of Wave Equation, Solutions of Laplace's Equations in Cartesian, Polar Forms, cylindrical and spherical polar forms.

U3.2. Self Study Topics: Transmission line Equations.

Unit 4: **Complex Analytic Function and Conformal Mapping (08 Hrs)**

U4.1. Complex Numbers, Complex Plane, Polar form of Complex Numbers, Powers and Roots, Analytic function, Cauchy-Riemann equations, Laplace equation, Complex Exponential, Trigonometric, Hyperbolic, and Logarithmic Functions, conformal Mapping and Linear Fractional Transformations.

U4.2. Self Study Topics: Riemann Surfaces.

Unit 5: Complex Integration and Power Series (08 Hrs)

U5.1. Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions. Taylor Series, Laurent's series, Singularities and zeros, Residue integration method.

U5.2. Self Study Topics: Complex Analysis Applied to Problems of Heat and Fluid flow.

Note: Five assignments to be given to the students for self study comprising of one assignment from each unit.

Text Books:

T1. Advanced Engineering Mathematics, Erwin Kreyszig, John Willy and Sons, 8th Edition, 1999. Chapters: 11(11.2 - 11.5, 11.9, 11.11), 12(12.1 – 12.8), 13(13.1 – 13.4), 14(14.1-14.4), 15(15.1 – 15.4).

T2. Higher Engineering Mathematics, B.V. Ramanna, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1st Reprint, 2007. Chapters: 18(18.1 – 18.8).

Reference Books:

R1. Engineering Mathematics, S. Pal and S.C. Bhunia Oxford Publishers, 1st Edition, 2014.

R2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 43rd Edition, 2014.

R3. Advanced Engineering Mathematics. Jain and Iyangar, Narosa Publishing House, 4th, 2014 (Reprint).

R4. Advanced Engineering Mathematics. P. V. O'Neil, CENGAGE Learning, 7th Edition, 2012.

R5. Fundamental of Complex Analysis, E.B. Saff, A. D. Snider, Third Edition, Pearson Education, New Delhi, 2008.

R6. A Course on Ordinary and Partial Differential Equations, J. Sinha Roy and S. Padhy, Kalyani Publishers, Fourth Edition, 2014.

MA21104: Mathematics–III (B) [0-0-1]

Teaching Scheme: Tutorial 01 Hr / Week

Prerequisites: Elementary idea of Sets, Functions, Trigonometry, Two –dimensional co-ordinate Geometry, Fundamentals of differential and integral calculus of 10+2 standard

Objectives:

1. To empower the students with skills to model and solve partial differential equations with comparative ease.

2. To make students aware of Complex Analysis and its applications.

List of Contents:

Tutorial No. 1: Problem solving involving Formation of PDEs and Solving Linear PDE by Lagrange's Method.

Tutorial No. 2: Problem solving involving Non-linear PDE by Charpit's Method.

Tutorial No. 3: Problem solving involving Linear PDE.

Tutorial No. 4: Problem solving involving One Dimensional Wave Equation.

Tutorial No. 5: Problem solving involving Heat Equation.

Tutorial No. 6: Problem solving Involving Laplace's Equation.

Tutorial No.7: Problem solving involving Complex Analytic functions and Cauchy-Rieman Equations.

Tutorial No. 8: Problem solving involving Conformal Mapping.

Tutorial No.9: Problem solving involving Complex Exponential, Trigonometric, Hyperbolic and Logarithmic Functions.

Tutorial No. 10: Some problems for practice involving Complex Integration.

Tutorial No. 11: Some problems for practice on Taylor and Laurent Series.

Tutorial No. 12: Some problems for practice on Residue Integration Method.

Text Books:

T1. Advanced Engineering Mathematics, Erwin Kreyszig, John Willy and Sons, 8th Edition, 1999. Chapters: 11(11.2 - 11.5, 11.9, 11.11), 12(12.1 – 12.8), 13(13.1 – 13.4), 14(14.1-

14.4), 15(15.1 – 15.4).

T2. Higher Engineering Mathematics, B. V. Ramanna, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1st Reprint, 2007. Chapters: 18(18.1 – 18.8).

Reference Books:

R1. Engineering Mathematics, S. Pal and S.C. Bhunia Oxford Publishers, 1st Edition, 2014.

R2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 43rd Edition, 2014.

R3. Advanced Engineering Mathematics. Jain and Iyangar, Narosa Publishing House, 4th, 2014 (Reprint).

R4. Advanced Engineering Mathematics. P. V. O'Neil, CENGAGE Learning, 7th Edition, 2012.

R5. Fundamental of Complex Analysis, E.B. Saff, A. D. Snider, Third Edition, Pearson Education, New Delhi, 2008.

R6. A Course on Ordinary and Partial Differential Equations, J. Sinha Roy and S. Padhy, Kalyani Publishers, Fourth Edition, 2014.

CH20101: Fluid Flow & Flow Measurement [3-0-0]

Credits: 04 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Nil

Objectives: Provide students with a basic knowledge in fluid properties and statics utilizing the principles developed in previous mechanics courses.

Course Outcomes:

After the completion of the course, the students will be able to:

CO1. Apply principles of dimensional analysis to solve simple problems and use dimensionless parameters.

CO2. Know the basic principles and definitions of fundamental concepts of fluid mechanics

CO3. Know the basic equations of fluid statics and mechanics such as Equation of continuity, Navier-Stokes equation, Euler equation and Bernoulli's equation.

CO4. Solve problems related to manometers and centrifugal decanters and to analyze fluid flow problems and use Navier-Stokes equation and Bernoulli's equation and equation of continuity to determine velocities, pressures and flow rate for incompressible and inviscid fluids.

CO5. Understand the concepts of boundary layers, flow in a pipe, skin friction, wall shear, friction factors, and mechanics of viscous flow past immersed bodies, drag coefficient and the concept of terminal velocity.

CO6. Analyze and solve problems in pipe flows as well as fluid machinery like pumps, blowers and fans and to know various flow measuring devices, design aspects and working principles.

Course Details:

Unit 1: Fluid statistics and dimensional analysis (06 Hrs)

U1.1. Units and dimensional analysis, Types of Fluids, Fluid as a continuum, Fluid Static: Hydrostatic Pressure, Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices.

U1.2. Self Study Topics: Problems based on Buckingham's and Rayleigh methods of analysis.

Unit 2: Flow measurements and Fluid kinematics (06 Hrs)

U2.1. Introduction to fluids in motion, Flow in boundary layers, Its formation & growth in tubes & plates, Basic equations of fluid flow continuity, momentum & Bernoulli's equation**,** Navier Stokes equation – specific applications, Flow measuring devices; Venturi, Orifice, Pitot tube & Rotameter.

U2.2. Self Study Topics: Study of various variable head and variable area meters.

Unit 3: Flow of incompressible, compressible flows and immersed bodies (06 Hrs)

U3.1. Flow of incompressible fluid in pipes, Relation between skin friction & wall shear. Laminar flow in pipes, Hagen-Poiuilles equation, Friction factor, Friction from changes in velocity or direction, Flow of compressible fluids, Basic equations. Flow past immersed bodies, Drag Co-efficient, concept of equivalent diameter and sphericity; Ergun equation, Motion of particles through fluids. Its mechanics, terminal Velocity.

U3.2. Self Study Topics: Study of different types of compressible flows.

Unit 4: Fluidization and its applications (06 Hrs)

U4.1. Friction inflow through beds of solids, Fluidization, Mechanism of fluidization, pressure drops in fluidization, Application of fluidization.

U4.2. Self Study Topics: Design of a fluidized and packed bed.

Unit 5: Transportation of fluids (06 Hrs)

U5.1. Transportation of fluids, Reciprocating rotary & centrifugal pump, fans, blowers &

compressors, Characteristics curves & calculation of power & efficiency of pumps, Concept of slip.

U5.2. Self Study Topics: Study of different types of positive displacement pumps.

Note: Five assignments to be given to the students on self study, comprising of one assignment from each unit.

Text Books:

T1. "A textbook of fluid mechanics and hydraulic machines", R. K. Bansal, Laxmi Publications (P) Ltd., 9th Edition, 2014.

T2. "Unit operations of chemical engineering", Smith and Harriott peter, Tata Mc Graw-hill Higher Education, 7th Edition, 2005.

Reference Book:

R1. "Fluid Mechanics", Frank M White, McGraw-Hill Education, 7th Edition, 2010.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

CH20101: FLUID FLOW & FLOW MEASUREMENT [0-0-1]

Teaching Scheme: Tutorial 01 Hr / Week

List of Contents:

Tutorial No. 1: Buckingham's and Rayleigh methods of dimensional analysis also standard unit system used in measurement.

Tutorial No. 2: Analysis of various flow meters used in measurement.

Tutorial No. 3: Bernoulli's equation for real fluids and study of various variable head and variable area meters with its application.

Tutorial No. 4: laminar and turbulent flow description ant its applicability for real systems.

Tutorial No. 5: Study of different types of compressible flows for both adiabatic and isothermal process.

Tutorial No.6: Study of different types of incompressible flows for both adiabatic and isothermal process.

Tutorial No. 7: Mechanism of fluidization and its application**.**

Tutorial No. 8: Design of fluidized bed systems

Tutorial No. 9: Design of a packed bed systems and.

Tutorial No.10: Use of Ergun equations for calculating pressure drop for both laminar and turbulent region.

Tutorial No. 11: Study of flow past immersed bodies.

Tutorial No. 12: Study of different types of positive displacement pumps.

Text Books:

T1. "A textbook of fluid mechanics and hydraulic machines", R. K. Bansal, Laxmi Publications (P) Ltd., 9th Edition, 2014.

T2. "Unit operations of chemical engineering", Smith and Harriott peter, Tata Mc Graw-Hill Higher Education, 7th Edition, 2005.

Reference Book:

R1. "Fluid Mechanics", Frank M White, McGraw-Hill Education, 7th Edition, 2010.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

CH20102: Chemical Process Technology [3-0-0]

Credits: 03 **Teaching Scheme:** Theory 03 Hrs/Week

Prerequisites: The student is expected to have sound knowledge of intermediate level organic chemistry

Objectives: The aim of the course is to study process technologies, availability of raw materials, production trends, preparation of flow sheets, engineering and environmental problems of various chemical industries.

Course outcomes:

After the completion of the course, the students will be able to:

CO1. Explain the basic history, current issues and trends in process industries.

CO2. Understand the process flow diagram and various process parameters.

CO3. Conversant with process technology of important chemical industries.

CO4. Know the developments taking place in the chemical process industry worldwide.

CO5. Appreciate the physico-chemical changes taking place in a process industry.

CO6. Recognize the importance of process economics in the industry.

Course Details:

Unit1: Heavy chemicals: Caustic soda and chlorine, caustic soda and chlorine,

Hydrochloric acid, Soda Ash, Sulphuric acid (06 Hrs)

U1.1. Electrolytic method of production of caustic soda and chlorine, Elemental Sulfur from ores; Sulfur Oxides, Double contact double absorption method of production of Sulphuric acid, Industrial Gases: CO_2, H_2, O_2, N_2 , Water gas, Coke-oven gas and Producer gas. Nitric acid, Hydrochloric acid, phosphoric acid, Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder.

U1.2. Self Study Topics: Electrolytic cell, Acid rain, working of fire extinguisher

Unit 2: Fertilizer Industry Phosphorous Industry (06 Hrs)

U2.1. Urea, Ammonium chloride, Ammonium nitrate, Ammonium phosphate, Ammonium sulfate, Production of white and Red Phosphorus, Pentoxide. Super Phosphate, Triple Super Phosphate, DAP and Biofertilizers.

U2.2. Self Study Topics: Different Fertilizers used today and their environmental impacts.

Unit 3: Petroleum Industry and Edible oils (06 Hrs)

U3.1. Constituents of crude petroleum; Production of ethylene, propylene Extraction and purification of oil from oil seeds, use of byproducts from oil production industry, hydrogenation of oil using various catalysts. Soap industry, Saponification process, Manufacture of soap from vegetable oils, various types of detergents, manufacture of Detergents. Various method of application of dyes on the fabrics

U3.2. Self Study Topics: By-products of petroleum industry

Unit 4: Sugar Industry and Paper Industry (06 Hrs)

U4.1. Sources of sugar, raw material for sugar industry, production of sugar from sugarcane. Manufacture of industrial alcohol from various cellulosic sources, byproducts of sugar industry, Conversion of industrial alcohols to absolute alcohol. Manufacture of pulp from various sources, Production of paper from pulp. Dyes and Pigments trends. Various natural and synthetic dyes used in today.

U4.2. Self Study Topics : Sugar industry in India, trends in liquor industry, Recycling of paper

Unit 5: Polymer industry and Rubber industry (06 Hrs)

U5.1. Polymerization process, types of polymerizations, Polymerization, PVC, LDPE, Polypropylene, Cross linked polymers, Rubber Industries: Natural and synthetic rubber and rubber compounding. Other Industries like: Paints, Pigments, Vanishes, Enamel, Lacquers - White Lead and Zinc oxide, Hydrogen peroxide (H2O2), Silicon carbide (SiC), Glass,

Cement, Chlorine and Fluorine based industries.

U5.2. Self Study Topics: Comparison of synthetic and natural fibers.

Note: Five assignments to be given to the students on self study, comprising of one assignment from each unit.

Text Books:

T1. "Outlines of Chemical Technology", C.E. Dryden, Edited & revised by M. Gopal Rao & M. Sittig, Affiliated East-West Press, third Edition, 2010.

T2. "Shreeve's Chemical Process Industries", George T. Austin, McGraw Hill,5th Edition, 2012.

Reference Book:

R1. "Chemical Process Technology", Jacob A. Moulijn, Michiel Makkee, Annelies E. van Diepen, Wiley, 2nd Edition, 2013.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

CH20103: Mass Transfer–I [3-0-0]

Credits: 03 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Nil

Objectives:

The general objectives of Mass Transfer Operations-I are to discuss the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems. This course will provide an overview of mass transfer operations at basic to an intermediate level. Coverage will be relatively broad. This course applies the concepts of diffusion mass transfer, mass transfer coefficients, convective mass transfer, interphase mass transfer, equipment for gas-liquid operations, absorption, and distillation. Each topic will be covered in logical sequence with relevant examples. The goal is to provide students with the theoretical/analytical background to understand mass transfer operations and to tackle the sort of complex problems.

Course Outcomes:

After the completion of the course, the students will be:

CO1. Define the different processes in mass transfer and molecular diffusion in gases & liquids.

CO2. Study about diffusion coefficients in laminar and turbulent flow.

CO3. Detail study on distillation, VLE, azeotrope and stage efficiency.

CO4. Find out number of stages in distillation column using McCabe-Thiele method & Ponchon-Savarit method.

CO5. Study on efficiency calculation in distillation and absorption & gas absorption.

CO6. Apply the absorption process on packed tower such as HETP, HTU and NTU.

Course Details:

Unit 1: Diffusion in mass transfer (06 Hrs)

U1.1. Introduction to Mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state molecular diffusion in fluids at rest and laminar flow, molecular diffusion in gases, steady state equimolal counter current diffusion, diffusivity of gases, molecular diffusion in liquids, diffusivity in liquids

U1.2. Self Study Topics: Equipment for gas liquid operation and Mass Transfer Coefficient

Unit 2: Application of molecular diffusion in mass transfer (06 Hrs)

U2.1. Application of molecular diffusion, mass transfer coefficients, in laminar and turbulent flow, Film theory, Penetration theory, surface-renewal theories, analogy between mass, heat and momentum transfer

U2.2. Self Study Topics: Dimensional analysis for mass transfer and its applications, Simultaneous mass and heat transfer.

Unit 3: Distillation-I (06 Hrs)

U3.1. Principle of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation, steam distillation, azeotropic and extractive distillation.

U3.2. Self Study Topics: Flooding, weeping, chocking, molecular distillation,

Unit 4: Distillation-II (06 Hrs)

U4.1. Continuous rectification-binary system, the fractionation operation, Ponchon - Savarit method, Continuous distillation: McCabe - Thiele method, feed tray location, increased reflux ratio, total reflux ration, minimum reflux ratio, optimum reflux ratio, Tray efficiencies, introduction to multi component distillation.

U4.2. Self Study Topics: Bubble column, reboiler.

Unit 5: Absorption **(06 Hrs)**

U5.1. Absorption : Equilibrium solubility of gases in liquids, two components system, multi component system, ideal and non - ideal solutions, choice of solvent for absorption, single component absorption material balance, counter current multistage operations, dilute gas mixtures, non - isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU, NTU concepts for single component absorption.

U5.2. Self Study Topics: Tray efficiencies, absorption with chemical reaction.

Textbooks:

T1. Mass Transfer Operations, R. E. Treybal, McGraw Hill, New York, 3rd Edition, 2001.

T2. Unit Operations in Chemical Engineering, Mc-Cabe & Smith., Mc Graw Hill International Edn, 7th Edition, 2009.

T3. Mass Transfer Operations, A. Suryanarayana, New age international publishers, 2009.

Reference Books:

R1. Design of Equilibrium Stage Process, B. D. Smith, Mc Graw Hill.

R2. Chemical Engineering, J. M. Coulson and J. F. Richardson, Vol - II, Asian books private Ltd., 2007.

R3. Perry's Chemical Engineers' Handbook, Don W. Green, Robert H., Eighth Edition.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

CS21102: Object Oriented Programming using C++ [3-0-0]

Credits: 02 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites:

1. Knowledge of any programming language.
2. Knowledge of various control structures
3. Knowledge of functions
4. Knowledge of basic I/O mechanisms.
5. Ability to apply logic.

Objectives:

1. To get a clear understanding of object oriented programming and C++ concept.
2. Be able to explain the difference between OOP and POP.

3. Be able to program using various C++ features such as operator overloading, dynamic memory allocation, inheritance, polymorphism, exception handling and templates.

4. Be able to build C++ classes using appropriate encapsulation and design principles.

5. To improve the problem solving skills by applying OOP techniques to solve bigger computing problems.

Course Outcomes:

After the completion of the course, the students will be:

CO1. Identify the principles and practice of object oriented analysis.

CO2. Apply various object oriented features like inheritance, encapsulation and polymorphism to solve various computing problems using C++ language.

CO3. Apply concepts of operator overloading, constructors and destructors.

CO4. Use additional C++ features such as dynamic memory management, object copying, assignment operator etc. to formulate and solve complex problems.

CO5. Apply exception handling as well as apply template function and template class to write application program

Course Details:

Unit 1: Introduction (06 Hrs)

U1.1. Introduction to object oriented programming, Object Oriented Programming paradigm. Basic concepts of object oriented programming, i.e. Object, Class, polymorphism, encapsulation, data abstraction, inheritance, data hiding and message passing.

Getting started with C++ syntax, Input and Output in C++, C++ tokens: Keywords, Identifiers, Constants, Operators. Data-types: user-defined & derived data-types, Reference variables, Dynamic initialization of variables, Special operators in C++ (i.e. scope resolution, new, delete and other operators), Pointers. Functions: Call by reference, Default parameter values in functions, Inline functions.

U1.2. Self Study: Control structures, arrays, functions returning reference, Manipulators, Operator precedence.

Unit 2: Class & Object: (06Hrs)

U2.1. Abstraction mechanism: Difference between structure and class, Specifying a class, access specifiers, data members, member functions, array of objects, static members, friend functions, constructors, destructors.

U2.2. Self Study: Making an outside function inline, Constructor with default arguments, constant member functions.

Unit 3: Inheritance: (06 Hrs)

U3.1. Inheritance: Class hierarchy, derived classes, single inheritance, multiple, multilevel, hierarchical, hybrid inheritance, role of virtual base class, constructor and destructor in inheritance.

U3.2. Self Study: Initialization list in constructors, Delegation, Nested classes.

Unit 4: Polymorphism: (06 Hrs)

U4.1. Polymorphism: Binding, Static binding, Dynamic binding. Function Overloading, Ambiguity in function overloading. Operator Overloading: Operator function, member and non member operator function, type conversion.

Dynamic polymorphism: Base class pointer, object slicing, late binding, method overriding with virtual functions, pure virtual functions, abstract classes.

U4.2. Self Study: this pointer, applications of this pointer, overloading I/O operators, virtual destructors, typeid operator.

Unit 5: Exception Handling, Template and Namespace (06 Hrs)

U5.1. Exception handling Mechanism: use of try, throw and catch. Generic catch, rethrowing an exception, Specifying exceptions for a function.

Template: Class templates, Function templates, Overloading a function template.

Namespaces: user defined namespaces, namespaces provided by library.

U5.2. Self Study: Exception in inheritance, Non-type Template parameter, Standard Template Library.

Note: Five assignments to be given to the students on self study, comprising of one assignment from each unit.

Text Books:

1. Object Oriented Programming with C++ by E. Balagurusamy, McGraw-Hill Education (India)

2. ANSI and Turbo C++ by Ashoke N. Kamthane, Pearson Education

Reference Books:

1. Big C++ - Wiley India

2. C++: The Complete Reference- Schildt, McGraw-Hill Education (India)

3. C++ and Object Oriented Programming – Jana, PHI Learning.

4. Object Oriented Programming with C++ - Rajiv Sahay, Oxford
5. Mastering C++ - Venugopal, McGraw-Hill Education (India)

CH20301: Fluid Flow & Flow Measurement Lab [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Prerequisites: Nil

Objectives: To acquaint the students with fundamentals of dynamic fluid flow and demonstrate the working details of various fluid flow measurement equipments and pumps.

Course Outcomes:

After the completion of the course, the students will be:

CO1. Know the basic units of measurement, convert units and utilize basic measurement techniques of fluid mechanics.

CO2. Demonstrate practical understanding of equations like Bernoulli, Continuity and Ergun equation along with working of various basic flow measuring devices like Venturi and Orifice meter, Pitot tube, Notches etc.

CO3. Understand the concepts and compare the results of analytical models in the lecture with the practical laboratory experiments by working in a team and develop the ability to write good reports.

CO4. Get an idea about the working and maintenance of various pumps and devices used in industry as well as in general household applications.

Course Details:

List of Practicals: (Any 10**)**

Experiment 1: Fluidized Bed- To determine the minimum fluidization velocity and pressure drop.

Experiment 2: Flow through pipes- To find out the pressure drop.

Experiment 3: Centrifugal Pump - To draw the characteristics curve and find out the efficiency.

Experiment 4: Reciprocating Pump - To draw the characteristics curve and find out the efficiency.

Experiment 5: Venturimeter- To find out the flow rate of fluid inside a pipe.

Experiment 6: Orifice Meter- To find out the flow rate of fluid inside a pipe.

Experiment 7: Reynolds Apparatus – To verify the flow whether it is laminar or turbulent.

Experiment 8: Bernoulli's Apparatus – To verify the Bernoulli's Equation.

Experiment 9: Pitot tube – To find out the point velocity of fluid.

Experiment 10: V-Notch – To measure the flow rate of a fluid by using V–Notch.

Experiment 11: Packed Bed – To find out the pressure drop when a fluid is flowing through a packed bed.

Text Book:

T1. Unit Operations of Chemical Engineering, W. L. McCabe, W. L.Smith, and P. Harriot, McGraw-Hill International Edition, 6th ed., 2001.

Reference Book:

R1. Fluid Mechanics, Frank M. White, Tata McGraw-Hill, 6th Ed., New Delhi, 2008.

CH20302: Chemical Technology Lab [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Prerequisites: Knowledge of intermediate level physical and organic chemistry

Objectives: To acquaint students with Industrial manufacturing processes at laboratory scale

Course Outcomes:

After the completion of the course, the students will be:

CO1. Carry out characterization studies on oil samples to determine properties, namely acid value.

CO2. Perform water quality assessment and management through determination of parameters such as pH, Dissolved oxygen etc.

CO3. Understand the working principle of parameter determination instruments and differentiate between solutions of varying concentration by implementing Snell's law through Refractometer.

CO4. Comprehend the preparation and characterization of some industrially important edible and inedible chemicals like soap, sugar etc.

Course Detailes:

List of Practicals: (Any ten)

Experimetn No.1. Determination of Dissolved oxygen in tap water and waste water using winkler's method.

Experimetn No.2. Selection of an oil sample to be used as lubricating oil by comparing the acid values.

Experimetn No.3. Determination of sugar concentration in a sample using refractometer

Experimetn No.4. To prepare Ammonium phosphate fertilizer and estimate phosphate content of the fertilizer.

Experimetn No.5. To compare Glucose: Fructose of two different sources.

Experimetn No.6. To estimate the total hardness, permanent hardness and temporary hardness of water by using standard EDTA solution.

Experimetn No.7. To study the adsorption of a solute (Oxalic acid) by activated charcoal from an aqueous solution.

Experimetn No.8. To determine the rate constant of the hydrolysis of Ethyl acetate using an acid as a catalyst.

Experimetn No.9. Preparation and characterization of soap.

Experimetn No.10. Determination of molecular weight of a polymer using Ostwald's viscometer.

Experimetn No.11. Determination of pKa Values of Ortho Phosphoric acid using pH meter.

Experimetn No.12. Determination of the rate constant of the hydrolysis of Ethyl acetate using an acid as a catalyst.

Text Books:

T1. "Outlines of Chemical Technology", C.E. Dryden, Edited & revised by M. Gopal Rao & M. Sittig, Affiliated East-West Press, third Edition, 2010.

T2. "Shreeve's Chemical Process Industries", George T. Austin, McGraw Hill, 5th Edition, 2012.

Reference Book:

R1. "Organic Chemistry", Robert T Morrison, Robert N. Boyd, Prentice Hall, 6th Edition, 1992.

CS21302: Object Oriented Programming using C++ Lab [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Prerequisites:

1. Basic C programming concepts.
2. Basic knowledge of various control statements.
3. Basic knowledge of function concepts and the idea of modularity.

4. Basic knowledge of Linux and Window Operating System.

Objectives:

1. To make the student learn an object oriented way of solving problems.
2. To teach the student to write programs in C++ to solve the problems.
3. To make the student to learn C++ programming language and its support for data abstraction and data hiding.
4. Understanding different object oriented features.
5. Understanding advanced program flow and techniques.
6. Understanding pointers, references, pointers to member functions, memory management.
7. Understanding generic programming and exception hanling mechanisms.

Course Outcomes:

After the completion of the course, the students will be:

CO1. Understand basic programming structure and application of function.

CO2. Identify the principles and practice of object oriented analysis.

CO3. Apply various object oriented features like inheritance and polymorphism to solve various computing problems using C++ language.

CO4. Use C++ features such as dynamic memory management, object copying etc to formulate and solve complex problems.

CO5. Apply exception handling and template concept to write robust and generic program.

Course Details:

1. Basic C++ programs, Input and output statements, C++ Programs to implement various control Structures.
2. Study of Function concept in C++.
3. Study of class and objects in C++.
4. Study of static members.
5. Study of friend function and friend class.
6. Study of various types of inheritance.
7. Study of static polymorphism with function overloading.
8. Study of static polymorphism with operator overloading.
9. Study of dynamic polymorphism with virtual functions.
10. Study of exception handling mechanism.
11. Study of generic programming using templates.

List of Practicals:

Experiment No. 1: Basic C++ programs, C++ Programs to Implement Various Control Structures.

a. If statement

b. Switch case statement and do while loop

c. For loop

d. While loop

Experiment No. 2: Programs to Understand Different Function Call Mechanism. Call by reference, Call by Value, Call by Address

a. Implementation of inline functions.

b. Implementation of Function with default arguments

Experiment No. 3: Program to understand class and object.

a. Program to differentiate between structure and class

b. Defining member functions inside and outside the class.

c. Program to implement array of objects.

d. Implementation of static data members and member functions.

Experiment No. 4: Programs to Understand Friend Function & Friend Class.

a. Friend Function

b. Friend class

Experiment No. 5: Program to implement constructors and destructors.

Experiment No. 6: Programs to Implement Inheritance

a. Single Inheritance(private and public mode derivation)

b. Multiple inheritances

c. Hierarchical inheritance

d. Multilevel Inheritance

e. Multipath Inheritance

Experiment No. 7: Understanding static Polymorphism

a. Program to implement function overloading and its ambiguity.

b. overloading unary operator as member and non member function.

c. Programs to Overload Binary Operators as member and non member function.

Experiment No. 8: Program to implement type conversion techniques.

a. basic to class type

b. class to basic type

c. one class type to another class type

Experiment No. 9: Program to implement dynamic polymorphism

a. Implementation of function overriding with virtual function

b. Use of this pointer

Experiment No. 10: a. Program to implement exception handling mechanism

b. Programs on Class Templates and Function Templates.

Text Books:

1. Object Oriented Programming with C++ by E. Balagurusamy, McGraw-Hill Education (India)
2. ANSI and Turbo C++ by Ashoke N. Kamthane, Pearson Education

Reference Books:

1. C++: The Complete Reference- Schildt, McGraw-Hill Education (India)
2. Object Oriented Programming with C++ - Rajiv Sahay, Oxford
3. Mastering C++, Venugopal, McGraw-Hill Education (India)

CH24301: Introduction to Process Automation [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Prerequisites: Basic ideas of engineering operations**.**

Objectives:

1. To get the basic idea of process automation and its need in present industrial scenario.
2. To introduce the various aspects of application of process automation in different chemical industries.
3. To improve the pronunciation, oral communication, expressions and the listening skills of the students.
4. To guide the students for their confidence in front of a group.

Course outcomes:

After the successful completion of the course, the student will be able to

CO1. Identify potential areas for automation, justify need for automation and basic difference between process and factory automation.

CO2. Get knowledge about different automation tools, software and their application in various chemical industries like petrochemical and petroleum refinery engineering, pharmaceuticals and fine chemical industry, paper and pulp industry.

CO3. Demonstrate the various fields of application of process automation in polymer, rubber plastic industry, metal and mineral process industry, cement, glass and ceramic, food and beverages industry.

CO4. Share their know-how through presentation in a group regarding the range of chemical industries, the need and application of process automation in those industries and make one technical report to represent their review on application of process automation in chemical industries.

Specific course scheme:

1. Introduction to basic process automation.
2. Definition of automation.
3. Types of automation.
4. Need of automation.
5. Definition of chemical operation and process (Unit Operation & Unit Process).
6. Different chemical processes and application of automation in process industries.
7. The topic may be defined by the guide.
8. A report is required to submit before the presentation.
9. The presentation may be of minimum 15 minutes duration followed by 10 minutes of interaction.
10. All other nonparticipating students must attend each presentation and take part in the interactive sessions.

Interactive sessions and presentation:

1. Application of process automation in petrochemical and petroleum refinery engineering
2. Application of process automation in pharmaceutical industry
3. Application of process automation in paper and pulp Industry
4. Application of process automation in polymer, rubber, plastic industry
5. Application of process automation in metal and mineral process industries
6. Application of process automation cement, glass, ceramic industries.
7. Application of process automation in food, alcohol and beverages.

CH27397: Mini Project [0-4-0]

Credits: 02 **Teaching Scheme:** 04 Hrs / week

For 3rd semester students a Mini Project is to be carried out considering the following objectives:

1. Scope for creativity
2. Hands on experience
3. Academic occupancy
4. Based on all the subjects in the continuing semester
5. The Mini Project group will be of 3 to 5 students.
6. Head of the Department will appoint Mini Project Guides. 02 credits will be awarded to the candidates after the viva voce and project demonstration at the end of the semester based on the project statement and requirements. The students are advised to utilize the laboratory resources before or after their contact hours as per the prescribed module.

Course Outcomes:

At the completion of the course, the students will be able to:

CO1. Survey literature to know about previous and ongoing researches in various fields and therefore select the particular area to work for based on the gaps and opportunities found from literature survey and to express the findings from literature survey in written form.

CO2. Apply basic engineering fundamentals in the selected domain of practical applications to analyze a concept/system/machine operation/process etc. by working as an individual or in a team and contribute to the development of the project.

CO3. Develop engineering ideas with significant novelty and develop a techno-commercial feasibility model for its implementation.

CO4. Prepare project report and deliver oral presentations at the end of semester.

CH27401: Comprehensive Viva Voce [Oral]

Credits: 02

Compulsory for each student based on the two subjects (S2) CH20101 & (S3) CH20102.

End Semester Examination (Oral): 100 marks

Course outcomes:

After the completion, the students will be able to

CO1. Answer basic questions related to process industries.

CO2. Answer questions related to basic principles in fluid mechanics.

CO3. Acquire additional ideas related to process industries and fluid flow phenomena.

CO4. Communicate confidently to the Engineering community.

HS27420: General Seminar [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 2Hrs / Week

Prerequisites: The students should have reasonable level of proficiency and skills in various languages and are able to understand and communicate an international language such as English.

Course Objectives: The objective of the course is to develop the skill and efficiency of the students for the preparation of seminar presentation and its deliberation impeccably.

Course Outcomes:

After the completion of the course, the students will able to:

CO1. Comprehend the different stages of seminar preparation and deliberation of presentation.

CO2. Obtain tolerable proficiency to communicate efficiently.

CO3. Overcome their stage fright.

CO4. Become successful in making an effective seminar presentation.

Course details

Lab-1: Importance and structure of Seminar Presentations

Lab-2: Types of Seminar Presentations

Lab-3: Good vs. Bad presentations and review of a standard seminar presentation

Lab-4: Changing formal seminar paper to informal seminar presentations

Lab-5: Planning: selection of topics and collection of data, laying down the objective and preparing the outline

Lab-6: Preparing PPTs, referencing and other supporting materials

Lab-7: Handling Question Answer sessions and focusing on language of the Presentations

Lab-8: Voice modulation and delivery of the presentation

Lab-9: Group Presentation

Lab-10: Individual Presentation 1

Lab-11: Individual Presentation 2

Lab-12: Assessment and Rounding off

Text Books:

T1."English for Business Communication "by Sweeney, Simon, CUP, 2003.

T2."Everyone Communicates, Few Connect" by John C. Maxwell, Thomas Nelson; 1 edition, 2010.

HS27421: Technical Writing [0-2-0]

Credit: 01 **Teaching Scheme:** 02 Hrs / Week

Prerequisites: The students should have tolerable proficiency in different language skills. They should be able to understand and write in the second language.

Course Objectives: This course seeks to develop the students' skill of writing formal reports and seminar papers.

Course Outcomes:

After the completion of the course, the students will be able to:

CO1. Understand the process of writing reports in English in a business organization.

CO2. Gain tolerable proficiency in communicating effectively in English.

CO3. Learn to write synopsis, abstract, introductory chapter, research article/ seminar paper with minimum errors.

CO4. Identify common errors in English and rectify them with minimum correction.

Course Details:

Lab-1: Definition and structure of reports.

Lab-2: Types of reports.

Lab-3: References, glossary and bibliography in reports

Lab-4: Charts and illustrations in reports

Lab-5: Report writing techniques - 1

Lab-6: Report writing techniques -2

Lab-7: A detailed study of a report

Lab-8: Writing synopses

Lab-9: Writing abstracts

Lab-10: Writing an introductory chapter

Lab-11: Writing a research article / seminar paper-1

Lab-12: Writing a research article / seminar paper-2

Text Books:

T1."Techniques of writing memos, reports and business letters", Courtland L Bovee, Jaico Publishing house Mumbai, 2005.

T2."Writing: A Problem solving approach", Norman Coe.

Reference Book:

R1."Business communication and report writing", R. C. Sharma and Krishna Mohan, Tata Mc-Graw Hill Publishing Company, 2nd Edition, 2000.

MA21105: Mathematics–IV [3-0-0]

Credits: 04 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Elementary ideas of counting techniques and differential and integral calculus of 10+2 standard.

Objectives:

1. To make students aware of numerical techniques to solve algebraic and transcendental equations.
2. To enlighten the students with the different numerical techniques to interpolate a set of data points to a polynomial (Known as interpolating polynomial).
3. To make students aware Techniques of Numerical Integration.
4. To make students aware of the methods to solve ordinary differential equations numerically.
5. To introduce the fundamental concepts of probability and probability distributions.
6. To make students aware of Sampling and hypothesis testing.
7. To make students aware of the concept of correlation and regression.

Course outcomes:

After the completion of the course, the students will be able to:

CO1. Get enlightened with the ideas and methods of solving algebraic and transcendental equations numerically.

CO2. Learn interpolation methods to estimate polynomials and numerical integration.

CO3. Solve ordinary differential equations by power series and single step numerical methods.

CO4. Solve problems and learn important concepts/characteristics involving probability theory and probability distributions.

CO5. Get enlightened with the concepts of finding statistical measures such as mean and variance of data, sampling, testing of hypotheses, correlation regression.

Course Details:

Unit 1: Numerical solution of Transcendental and Linear System of Equations (08 Hrs)

U1.1. Numerical methods: Approximation and round of errors, Truncation error and Taylor's series. Roots of equation: The bisection method, the false-position method, fixed point iteration, Newton-Raphson method, Muller's method. Solution of System of Linear equations by Gauss-Seidel method.

U1.2. Self Study Topics: Finding multiple roots of algebraic equations.

Unit 2: Interpolation and Numerical Integration (08 Hrs)

U2.1. Interpolation: Newton divided difference interpolation, Lagrange Interpolation, Newton's forward and backward interpolation. Numerical integration: The trapezoidal rule, The Simpson's rules, Gauss quadrature, Romberg Integration Method.

U2.2. Self Study Topics : Numerical Differentiation

Unit 3: Numerical and Power Series Solutions of Ordinary Differential Equations (08 Hrs)

U3.1. Numerical Solutions of Ordinary differential equation: Euler's method, Improvement of Euler's method, Runge-Kutta methods. Power Series Solutions of Ordinary differential equations: Power Series Method to solve ordinary differential equations, Legendre's Equation and Legenre's Polynomials, Bessel's Equations and Bessel's Functions of the first and second kind.

U3.2. Self Study Topics: Picard's Iteration Method and Stability Analysis of Single Step Method.

Unit 4: Probability Theory (08 Hrs)

U4.1. Probability: Probability, Random variables, Probability distributions, Mean and variance of distribution, Binomial, Poisson, Hyper geometric and Normal distributions.

U4.2. Self Study Topics: Distribution of several random variables.

Unit 5: Mathematical Statistics (08 Hrs)

U5.1. Mathematical Statistics: Mean and Variance of a data, Random sampling, Estimation of Parameters, Confidence Intervals, Testing of hypothesis, Acceptance sampling, Chi square test for goodness of fit , Regression Analysis, Fitting Straight Lines, Correlation analysis.

U5.2. Self Study Topics: Nonparametric Tests.

Note: Five assignments to be given to the students on self study, comprising of one assignment from each unit.

Text Books:

T1. Numerical methods for Engineers, Steven C. Chapra and Raymond P. Canale, Tata McGraw-Hill Publishing Company Limited, New Delhi,, Fifth Edition,2007. [Chapters 2, 3(3.1, 3.2), 4(4.2, 4.3), 5 (5.1, 5.2, 5.3), 6 (6.4), 10(10.2), 13(13.1, 13.2, 13.3, 13.5), 16(16.1, 16.2), 17(17.2, 17.3), 20(20.1, 20.2, 20.3)].

T2. Advanced Engineering Mathematics, Erwin Kreyszig, John Willy and Sons, 8th Edition, 1999. [Chapters: 4(4.1, -4.4, 4.6), 22 (22.1 – 22.3, 22.5-22.8), 23(23.1-23.4, 23.6, 23.7, 23.9, 23.10)]

Reference Books:

R1. Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R.K. Jain, New Age International Publishers, Sixth Edition, 2014.

R2. Probability and Statistics for Engineering and Sciences, Jay L. Devore, Thomson/CENGAGE Learning India Pvt. Ltd, Eighth Edition, 2012.

R3. Fundamental of Mathematical Statistics, S. C. Gupta and V.K. Kapoor, Sultan Chand and Company, New Delhi, 11th Edition (reprint), 2014.

R4. Probability & Statistics for Engineers & Scientists, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, Pearson Education Inc., New Delhi, Eighth Edition, 2007.

R5. A Course on Ordinary and Partial Differential Equations, J. Sinha Roy and S. Padhy, Kalyani Publishers, Fourth Edition, 2014.

R6. Higher Engineering Mathematics, B. V. Ramana, TMH, 1st Reprint, 2007.

R7. Engineering Mathematics, S. Pal and S.C. Bhunia Oxford Publishers, 1st Edition, 2014.

R8. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 43rd Edition, 2014.

R9. Introductory Method of Numerical Analysis, S. S. Sastry, PHI Learning PVT LTD, New Delhi, Fourth Edition, 2009.

R10. Numerical Mathematics and Computing, W.Cheney and D. Kincaid, Thomson / CENGAGE Learning, Fifth Edition, 2014.

MA21105: Mathematics–IV [0-0-1]

Teaching Scheme: Tutorial 01 Hr / Week

Prerequisites: Elementary idea of Counting Techniques and differential and integral calculus of 10+2 standard.

Objectives:

1. To make students aware of numerical techniques to solve algebraic and transcendental equations
2. To enlighten the students with the different numerical techniques to interpolate a set of data points to a polynomial (Known as interpolating polynomial).
3. To make students aware Techniques of Numerical Integration.
4. To make students aware of the methods to solve ordinary differential equations numerically.
5. To introduce the fundamental concepts of of probability and probability distributions.
6. To make students aware of Sampling and hypothesis testing.
7. To make students aware of the concept of correlation and regression.

List of Contents:

Tutorial No. 1: Problem solving involving roots of algebraic and transcendental equations.

Tutorial No. 2: Problem solving involving Interpolation.

Tutorial No. 3: Some problems for practice on Numerical Integration.

Tutorial No.4: Some problems for practice on Numerical solutions of ordinary differential equations.

Tutorial No. 5: Some problems for practice on power series solution of ordinary differential equations.

Tutorial No. 6: Some problems for practice on Probability Theory.

Tutorial No. 7: Some problems for practice on Random Variables and probability functions.

Tutorial No. 8: Some problems for practice on Binomial, Poisson, Hyper Geometric and Normal distributions

Tutorial No. 9: Some Problems for practice on Mean and Variance.

Tutorial No. 10: Some problems for practice involving Estimation of Parameters and Hypothesis testing.

Tutorial No. 11: Some problems for practice on Acceptance Sampling and Chi square test.

Tutorial No. 12: Some problems for practice on Regression and Correlation Analysis.

Text Books:

T1. Numerical methods for Engineers, Steven C. Chapra and Raymond P. Canale, Tata McGraw-Hill Publishing Company Limited, New Delhi,, Fifth Edition,2007. [Chapters 2, 3(3.1, 3.2), 4(4.2, 4.3), 5 (5.1, 5.2, 5.3), 6 (6.4), 10(10.2), 13(13.1, 13.2, 13.3, 13.5), 16(16.1, 16.2), 17(17.2, 17.3), 20(20.1, 20.2, 20.3)].

T2. Advanced Engineering Mathematics, Erwin Kreyszig, John Willy and Sons, 8th Edition, 1999. [Chapters: 4(4.1, -4.4, 4.6), 22 (22.1, 22.5-22.8), 23(23.1-23.4, 23.6, 23.7, 23.9, 23.10)].

Reference Books:

R1. Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R.K. Jain, New Age International Publishers, Sixth Edition, 2014.

R2. Probability and Statistics for Engineering and Sciences, Jay L. Devore, Thomson/CENGAGE Learning India Pvt. Ltd, Eighth Edition, 2012.

R3. Fundamental of Mathematical Statistics, S. C. Gupta and V.K.Kapoor, Sultan Chand and Company, New Delhi, 11th Edition (reprint), 2014.

R4. Probability & Statistics for Engineers & Scientists, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, Pearson Education Inc., New Delhi, Eighth Edition, 2007.

R5. A Course on Ordinary and Partial Differential Equations, J. Sinha Roy and S. Padhy, Kalyani Publishers, Fourth Edition, 2014.

R6. Higher Engineering Mathematics, B. V. Ramana, TMH, 1st Reprint, 2007.

R7. Engineering Mathematics, S. Pal and S.C. Bhunia, Oxford Publishers, 1st Edition, 2014.

R8. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 43rd Edition, 2014.

R9. Introductory Method of Numerical Analysis, S. S. Sastry, PHI Learning PVT LTD, New Delhi, Fourth Edition, 2009.

R10. Numerical Mathematics and Computing, W. Cheney and D. Kincaid, Thomson/CENGAGE Learning, Fifth Edition, 2014.

CH20104: MECHANICAL OPERATION [3-0-0]

Credits: 04 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Nil

Objectives: Graduate will demonstrate on understanding the unit operation and their role in Chemical Engineering industries considering the following points:

1. Characteristics of particulate solids, Principles of size reduction, crushing and grinding equipment.
2. Mixing of solids and separation methods for different types of mixtures like solid-solid, solid-gas, solid-liquid
3. Size enlargement: scope and applications, size enlargement techniques
4. Conveying of bulk solids, classification and selection of conveyors for chemical process industries.

Course outcomes:

After the completion of the course, the students will be able to:

CO1. Build basic knowledge of various mechanical operations, screen analysis and applications.

CO2. Review the practical importance and relevance of laws used for crushing, grinding and size separation in chemical industry.

CO3. Utilize the technological methods related to unit operations in process plant regarding comminution and equipment related to it.

CO4. Study a detailed overview of equipment used to perform various mechanical operations and problems associated during the implementation and applications.

CO5. Build a clear concept on filtration theory and techniques.

CO6. Familiarize with the process and equipment associated with different floatation, centrifugation, and sedimentation process.

Course Details:

Unit 1: Particles and Particulates (06 Hrs)

U1.1. Determination, characterization and analysis of particles, size, shape, specific surface area and analysis of average particles.

U1.2. Self study: Study of the physical and chemical properties of particles.

Unit 2: Screening and separation (06 Hrs)

U2.1. Types and capacity of different screens, Determination of screen effectiveness, Screen

capacity and screening equipments, Differential and cumulative methods of analysis.

U2.2. Analysis of different types of screening equipments.

Unit 3: Size reduction equipments (06 Hrs)

U3.1. Comminuting and Size Reduction Equipments, Laws of grinding- Kick's law, Rittinger's Law and Bond's law and their limitations, Grinding, crushing efficiency and power consumption, Size Separation- Magnetic and Electrostatic Separators

U3.2. Study of different size reduction equipments.

Unit 4: Flow of particles and laws of settling (06 Hrs)

U4.1. Motion of particles through fluid, Drag Coefficient, Free and hindered settling, Stoke's law & Newton's law regimes of settling, Thickeners, Cyclones etc.

U4.2. Flow past submerged bodies.

Unit 5: Filtration theories and Mixing (06 Hrs)

U5.1. Sink & float method, Jigging, Tabling, Filtration, Theory, Plate & Frame filter press, Leaf filter, Rotary filter, Mixing & Agitation, Power consumption of mixer mixing equipment, Forth flotation, Conveying, Different types of Conveyers: Belt, Screw, Apron, Flight, Pneumatic conveyor and elevators

U5.2. Study of different types of filtration techniques.

Note: Five assignments to be given to the students on self study, comprising of one assignment from each unit.

Text Book:

T1. "Particle technology and separation process", J R Backhurst , J F Richardson , J H Harker, Elsevier, 5th Edition, 2006.

Reference Book:

R1. "Unit operations of chemical engineering", Smith and Harriott peter, Tata Mc Graw-hill Higher Education, 7th Edition, 2005.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

CH20104: MECHANICAL OPERATION [0-0-1]

Teaching Scheme: Tutorial 01 Hr / Week

Prerequisites: Nil

Objectives:

1. Graduate will grasp the understanding of unit operation, characteristics of particulate solids, principles of size reduction, crushing and grinding equipment.
2. Mixing of solids and separation methods for different types of mixtures like solid-solid, solid-gas, solid-liquid.
3. Size enlargement: scope and applications, size enlargement techniques.
4. Conveying of bulk solids, classification and selection of conveyors for chemical process industries.

Course Details:

List of Contents

Tutorial No. 1: Study of the physical and chemical properties of particles.

Tutorial No. 2: Analysis of different types of screening equipments.

Tutorial No. 3: Study of different size reduction equipments and their application in industry.

Tutorial No. 4: Flow past submerged bodies of various shapes.

Tutorial No. 5: Study of different types of filtration techniques.

Tutorial No. 6: Selective problems on laws of grinding-I.

Tutorial No. 7: Selective problems on laws of grinding-II.

Tutorial No. 8: Drag Coefficient.

Tutorial No. 9: Problems on free and hindered settling.

Tutorial No. 10: Power consumption of mixer.

Tutorial No. 11: Study on forth flotation.

Tutorial No. 12: Selective problems on pneumatic conveying system.

Text Book:

T1. Particle technology and separation process", J R Backhurst, J F Richardson, J H Harker, Elsevier, 5th Edition, 2006.

Reference Book:

R1. Unit Operations of Chemical Engineering, Smith and Harriott peter, Tata Mc Graw-hill Higher Education, 7th Edition, 2005.

CH20105: Mass Transfer–II [3-0-0]

Credits: 03 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Knowledge of Chemical Process Calculations and Mass Transfer-I

Objectives:

The general objectives of Mass Transfer Operations-II are to discuss the concept of humidification, drying, leaching and adsorption. Each topic will be covered in logical sequence with relevant examples. The goal is to provide students with the theoretical/analytical background to understand mass transfer operations and to tackle the sort of complex problems.

Course Outcomes:

After the completion of the course, students will be able to:

CO1. Humidification, dehumidification, cooling towers, DBT and WBT.

CO2. Psychometric chart preparation, quantity of Psychrometric chart, measuring instruments for humidification.

CO3. Equipments used in extraction, the number of stages in extraction, different between leaching and extraction.

CO4. Different equipments used for extraction processes, leaching of minerals or components from different ores, drying and different types of drying.

CO5. Rate kinetic study on leaching of different minerals and materials, rate of drying calculation for different materials.

Application of processes using different driers, define adsorption, desorption, adsorption process and utility of Lagmuir and Freundlich equation in adsorption, problem solving of adsorption

Course Details:

Unit 1: Humidification Operations (06 Hrs)

U1.1. Definition of fundamental terms, Psychometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, Gas liquid contact, Dehumidification, Adiabatic Humidification. Equipments: Natural Circulation, Natural draft, Mechanical draft, Spray tower, Spray chamber, Spray pond.

U1.2. Self Study Topics: Some problems on dry-bulb and wet-bulb temperatures, spray tower.

Unit 2: Humidity Measurement (06 Hrs)

U2.1. Direct chemical method, Methods of humidification and Dehumidification, Hygrometer method, Sling psychrometer, Dew point method, Mirror method.

U2.2. Self Study Topics: Psychrometric chart, methods of humidification and Dehumidification, equipment like cooling tower, spray dryer, fluidized bed and spouted bed dryer, pneumatic dryer and vacuum dryer.

Unit 3: Liquid - liquid Operations (06 Hrs)

U3.1. Extraction : Introduction, liquid - liquid equilibria, analytical and graphical solutions for single and multistage operations, continuous, counter current operation without and with reflux, fractional extraction, equipment for liquid contacting operations, single stage, multistage and continuous contacting equipments.

U3.2 Self Study Topics: Selective problems on liquid - liquid equilibria, single and multistage operations under different conditions.

Unit 4: Leaching & **Adsorption (06 Hrs)**

U4.1. Theory of adsorption, Industrial adsorbents, adsorption equilibria, Freundlich equation, single and multistage operations, Ion - Exchange. Operation of solid, steady and unsteady state operation, equipment, analytical methods for single and multistage operations.

U4.2. Self Study Topics: Leaching of iron, aluminum, silica, copper etc. different types of adsorber.

Unit 5: Drying (06 Hrs)

U5.1. Equilibria, Drying rate curve, Batch and continuous drying, Time of drying and calculations, Mechanism of batch drying, Equipments for batch and continuous drying operations, Design of dryers.

U5.2 Self Study Topics: Industrial dryers Kiln, Selective problems on different types of drying under variable conditions.

Textbooks:

T1. Mass Transfer Operations, R. E. Treybal, McGraw Hill, New York, 3rd Edition, 2000.

T2. Unit Operations in Chemical Engineering Mc Cabe & Smith., Mc Graw Hill International Edn, 7th Edition, 2007.

T3. Mass Transfer Operations, A. Suryanarayana, New age international publishers, 2009.

T4. "Chemical Engineering – Vol. I & II", Coulson J. M.; Richardson, J. F., 6th Edition, Butterworth-Heinemann, 1999.

Reference Books:

R1. Deisgn of Equilibrium Stage Process, B. D. Smith, Mc Graw Hill.

R2. J. M. Coulson and J. F. Richardson, Chemical Engineering, Vol - II, Asian books private Ltd., 2006.

R3. Perry, Perry's Chemical Engineer's Handbook, Don W. Green, Robert H., Eight Edition, 2007.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

CH20106: Chemical Process Calculations [3-0-0]

Credits: 03 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Knowledge of 10+2 standard of Chemistry

Objectives:

1. Understanding the fundamental concept of chemical process calculations.
2. Detailed idea of material balance considering with and without chemical reaction.
3. Detailed idea of energy balance following the fundamental rules process calculations.
4. Understanding the concept of steady state and unsteady state for material and energy balance calculations.
5. To understand the concept of recycle, by-pass, purge adiabatic, isothermal, operations.

Course outcomes:

After the completion of the course, students will be able to:

CO1. Convert quantities from one set of units to another quickly and accurately.

CO2. Use log-log and semi-log and other types of graphs and diagrams for plotting and extraction of data.

CO3. Define and determine the composition of steam in-terms of mass, volume, weight and mole fractions and understand the concepts of dew point, bubble point, boiling point, humidity. dry bulb and wet bulb temperatures.

CO4. Solve for the unknown variables using fundamental laws, empirical relationships and Write simple phase equilibrium relationships (e.g. Raoult's and Henry's Laws) and various gas laws. (e.g. Vander-Waal's, Dalton's, Amagat's laws)

CO5. Perform material balance for both unit operations (e.g. Distillation, Drying, Mixing, Crystallization) and unit processes. (e.g. Chemical reacting systems)

CO6. Understand the concepts of enthalpy, heat capacity, heats of reaction, mixing, solution, vaporization and Hess law and perform calculations and energy balance using them.

Course Details:

Unit 1: Basic Concepts of Industrial Stoichiometry (05 Hrs)

U1.1. Units and types of dimensions. Dimensional analysis: Rayleigh's method and Bucking Pi theorem. Dimensional homogeneity. Conversion of units and equations. Uses of log-log and semi-log graph papers. Basic concepts of graphical differentiation, graphical integration and triangular diagram.

U1.2. Self study topics: Problems solving by using different methods of dimensional analysis and dimensional homogeneity.

Unit 2: Introduction to Chemical Process Calculations (05 Hrs)

U2.1. Mass fraction and mass percent. Volume fraction and volume percent. Mole fraction and mole percent. Weight fraction and weight percent. Limiting and excess reactants. Percentage and degrees of conversion. Degree of completion. Selectivity. Yield and yield percent. Dew point, bubble point and boiling point. Humidity and saturation. Dry-bulb and wet-bulb temperatures.

U2.2. Self study topics: Problems solving using the concepts of mole fraction and percent, limiting and excess reactants, selectivity, yield percent, dry-bulb and wet-bulb temperatures.

Unit 3: Calculations of Gas Laws and Equations of States (04 Hrs)

U3.1. Behaviour of ideal gases and laws. Van der-Waal's law, Dalton's law, Amagat's law, Raoult's law, Henry's law, Antoine's equation. Effect of temperature on vapour pressures. Liquefaction and vaporization.

U3.2. Self study topics: Solving problems based on the concepts of various gas laws and equations of states.

Unit 4: Material Balance and Stoichiometry (08 Hrs)

U4.1. Basic ideas of material balance. Material balance with and without chemical reactions for different unit operations and unit processes: Distillation, Drying, Evaporation, Adsorption, Mixing, Crystallization. Material balance for steady and unsteady state systems. Calculations of systems with recycle, by-pass and purge.

U4.2. Self study topics: Problems solving using the concepts of material balance for steady and unsteady state systems considering with reaction and without reaction mechanisms.

Unit 5: Energy Balance and Stoichiometry (08 Hrs)

U5.1. Basic ideas of energy balance. Energy balance with and without chemical reactions. Basic ideas of thermophysics and thermochemistry. Calculation of enthalpy, heat capacity, specific heat capacity, heat and standard heat of reaction and formation, heat of combustion, heat of solution, heat of mixing, heat of vaporization and condensation. Hess's law. Adiabatic and theoretical flame temperatures.

U5.2. Self-Study topics: Solving the problems of energy balance considering the concepts of thermophysics and thermochemistry.

Five assignments to be given to the students based on Self-Study, comprising of one assignment from each unit.

Text Books:

1. Chemical Process Principles, Hougan D. A., Watson K.M. and Ragatz R. A., Asia Publishing House, Vol. 1, 1962.
2. Basic Principles and Calculations in Chemical Engineering, Himmelblau D.M., Prentice Hall, 6th ed., 1996.
3. Stoichiometry, Bhatt B.I. and Vora S.M., Tata McGraw-Hill Publishing Company Ltd.,, 4th edition, 2001.

Reference Book:

1. Elementary Principles of Chemical Processes, Felder R.M. and Rousseau R.W., 3rd ed., John Wiley, 1999.

Open source learning:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

EC21161: Electronics Engineering [3-0-0]

Credits: 02 **Teaching Scheme:** Theory 03 Hrs / Week

Prerequisites: Physics

Course Outcomes:

CO1: Define and identify the different electrical signals.

CO2: Apply the knowledge of semiconductors in different electronics circuits.

CO3: Illustrate the knowledge to understand and identify amplifiers and oscillators.

CO4: Demonstrate the basic knowledge of digital electronics, Boolean algebra and combo circuits.

CO5: Explain and demonstrate the knowledge of microcomputer and sensors.

CO6: Read voluntarily to enhance the knowledge in electronics engineering domain.

Course Details:

Unit 1: Signals and Semiconductor Diodes (08 Hrs)

U1.1. Introduction to Electronics: Signals, Classification of signals. Semiconductor Diodes: Introduction, Physical operation of p-n junction diodes, Characteristics of p-n junction diodes, Zener diode. Diode applications: Rectifier circuits (half-wave, full-wave).

U1.2. Equivalent circuit of diode, Light emitting diode and Photo diode.

Unit 2: **Bipolar Junction Transistors (08 Hrs)**

U2.1. Bipolar Junction Transistors (BJTs): Construction and physical operation of n-p-n and p-n-p transistors in the active region, Types of BJT configuration and current-voltage characteristics. BJT Circuits at DC: Biasing in BJT amplifier circuits.

U2.2. BJT as a switch, Load line analysis, Stability of BJT biasing circuits.

Unit 3: **Op-Amp and Its Applications (08 Hrs)**

U3.1. The Operational Amplifier (Op-Amp): Introduction to Op-Amp, The ideal Op-Amp, Characteristics of Ideal Op-Amp. Applications of Op-Amp: Inverting and non-inverting configurations, Summing amplifier, Integrator, Instrumentation amplifier.

Feedback Amplifiers and Oscillators: Introduction to feedback, Amplifier with negative feedback, Basic principles of sinusoidal oscillators, Op-Amp Oscillator circuits (Wien-Bridge oscillator and Crystal oscillator).

U3.2. Difference amplifier, Differentiator, Properties and advantages of negative feedback,

Unit 4: **Digital Electronics (08 Hrs)**

U4.1. Digital Electronic Principles: Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic.

Logic Gates and Boolean Algebra: The inverter, The AND, OR, NAND NOR, Exclusive-OR and Exclusive-NOR gate, Boolean operations and expressions, Laws and Rules of Boolean algebra, DeMorgan's theorem, Boolean analysis of logic circuits.

U4.2. Octal and Hexadecimal number system, Implementation using universal logic gates.

Unit 5: **Microprocessors and Sensors (08 Hrs)**

U5.1. Microprocessor and Microcontroller: Architectural advancement of microprocessor, Features of microprocessors (8085, 8086), Features of microcontroller (8051), Comparison between microprocessor and microcontroller.

Sensors: Capacitive and inductive pressure sensor, piezo-electric pressure sensor, IR sensor, Temperature sensor, piezo-electric accelerometer.

U5.2. Tristate devices, Memory and Input Output Interfacing devices, Tactile sensor, Gyroscope, Tachometer.

Text Books:

T1. "Electronic Devices and Circuits", Anil K. Maini and Varsha Agrawal, Wiley India Pvt Ltd, 1st Edition, 2009.

T2. "Digital Fundamentals", Thomas L. Floyd, Pearson Education, 8th Edition, 2005.

T3. "Fundamentals of Microprocessors and Microcomputers", B. Ram, Dhanpat Rai Publication Limited, 8th Edition, 2012.

T4. "Principles of Industrial instrumentation and control", D. Patranabis, Mcgraw Hill Education, 3rd edition, 2010.

Reference Books:

R1. "Microelectronic Circuits", Adel S. Sedra and Kenneth C. Smith, Oxford University Press, 6th Edition, 2013.

R2. "Integrated Electronics: Analog and Digital Circuit", Jacob Millman, Christos Halkias and Chetan D Parikh, Mcgraw Hill Education, 2nd Edition, 2011.

R3. "Electronic Devices and Circuit Theory", Robert L. Boylestad and Louis Nashelsky, Pearson Education, 10th Edition, 2009.

R4. "Introduction to Measurements and Instrumentation", A.K.Ghosh, PHI Learning PVT. LTD, 3rd Edition, 2012.

CH20304: Mechanical Operation Lab [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Objectives: This lab will provide the understanding of unit operations such as characteristics of particulate solids, principles of size reduction, crushing and grinding equipment, size separation, settling and their role in mineral processing industries.

Course Outcomes:

After completing this laboratory, the students will be able to:

CO1. Apply the knowledge to find out the average particle size of a material by surface – volumes mean diameter method and also to find out the effectiveness of a hand screening method of a screen and efficiency of Wilfley Table.

CO2. Visualize practically the application of sink and float method and floatation technique to separate mixture of coal into two fractions.

CO3. Determine the batch sedimentation data under specified conditions.

CO4. Gain hand on experience in plate and frame filter press to calculate the specific cake resistance and filter medium resistance of slurry in the filter press.

Course Details:

List of Practicals: (Any 10**)**

Experiment No. 1: To find out the average size of particles in a sample (Volume - surface mean diameter).

Experiment No. 2: To determine the Grindability Index of coal by Hard Groove machine.

Experiment No. 3: To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen.

Experiment No. 4: To separate a mixture of coal into two fractions using sink and float method.

Experiment No. 5: To separate a mixture of coal into two fractions using flotation technique.

Experiment No. 6: To determine the Optimum time of sieving for a given sample of material.

Experiment No. 7: To verify the Rittinger's and Kick's law using crushing rolls and to find out the Work Index of the coal.

Experiment No. 8: To find out the effectiveness of hand screening of a given screen.

Experiment No. 9: To determine the batch sedimentation data and to calculate the minimum thickener area under given conditions.

Experiment No. 10: To determine the specific cake resistance and filter medium resistance of slurry in Plate - and - frame filter press.

Experiment No. 11: To verify the laws of size reduction using a vibrating mill.

Experiment No. 12: To find the effectiveness of a Trammel.

Experiment No.13: To find the size analysis of a given fine sample using Beaker decantation method.

Experiment No.14: To compare open circuit and closed circuit grinding by means of a ball mill.

Experiment No. 15: To concentrate a given material by means of Tabling.

Text Books:

T1. "Unit Operations of Chemical Engineering", McCabe W. L. & Smith J. C, Tata McGraw Hill Publications, 5th edition

T2. "Stoichiometry", Bhatt B. I. and Vora S. M, Tata McGraw Hill Publications, 4th Edition, 2004.

T3. "Chemical Engineering Vol. 2", Coulson J.M. & Richardson J.F, Pergamon Press, 5th ed., 2002. "Title of the book", Authors Name, Publishers Name, Edition, Year of Publication.

Reference Books:

R1. "Principles of Unit Operations", Foust A.S., John Wiley & Sons, 1965.

R2. "Heat Transfer", Holman J. P., McGraw Hill, 7th edition, 1993.

R3. "Principles & Calculations in Chemical Engineering", Himmelblau D. M., Tata McGraw-Hill, 7th Edition, 2004. "Title of the book", Authors Name, Publishers Name, Edition, Year of Publication.

CH20305: Mass Transfer Lab [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Prerequisites: Nil

Objectives:

1. To provide hands-on experience in performance of mass transfer, separations related processes and equipment.
2. To familiarize students with various methods of data gathering, analysis and reduction.

Course Outcomes:

After completing the laboratory, the students will be able to:

CO1. Understand and demonstrate mass transfer operations and models.

CO2. Formulate and validate different types of interface reactions in diffusion.

CO3. Apply the principles of mass transfer operation such as diffusivity, HETP, etc. and calculate theoretical plates in chemical process industries.

CO4. Determine the performance and efficiencies of mass transfer equipment such as crystalliser, distillation column, dryers etc. and able to explain through graphical approach.

List of Practicals: (Any 10**)**

Experiment No.1: To verify Rayleigh's equation through simple distillation for binary mixture of water and ethanol.

Experiment No.2: To determine vaporization and thermal efficiencies in steam distillation of the given organic liquid i.e. nitrobenzene or aniline etc.

Experiment No.3: To study the height equivalent to a theoretical plate (HETP) of packed column at total reflux for a binary system of ethanol and water using Fenske's equation.

Experiment No.4: To study the phenomenon of surface evaporation and determine the constants of Himus equation.

Experiment No.5: To determine the vapour – liquid equilibrium curve for carbon tetrachloride-air system. ,

Experiment No.6: To determine the diffusivity coefficient for carbon tetrachloride- air system.

Experiment No.7: Performance of lab scale bubble cap distillation column at different reflux ratios.

Experiment No.8: Drying of solids in a tray drier under forced draft condition.

Experiment No.9: A rotary dryer consists of a cylindrical shell, set with its axis at a right angle to the horizontal and mounted on rollers so that it can be rotated.

Experiment No.10: To determine that mass transfer coefficients for the given system using the experimental setup. ,

Experiment No.11: To study the performance of a Swenson walker Crystallizer and to determine the crystal yield and the efficiency of crystallizer. ,

Experiment No.12: To conduct extraction of oil from a sample mustard cake. ,

Text Books:

T1. Mass Transfer Operations, Treybal, R.E., McGraw Hill, 3rd edition, 1980.

T2. Chemical Engineering–Vol. I & II, Coulson, J. M.; Richardson, J. F., Butterworth-Heinemann, 6^{th} edition, 1999.

Reference Books:

R1. Unit Operations of Chemical Engineering, McCabe, W. L.; Smith, J. C.;Harriott, P., McGraw-Hill, 4th ed., 1985.

R2. "Perry's Chemical Engineer's Handbook", Perry, Robert H.; Green, Don W., McGraw-Hill, 6thEdition, 1984.

EC21361: Electronics Engineering Lab [0-2-0]

Credit: 01 **Teaching Scheme: -** Laboratory 02 Hrs / Week

Prerequisites: Physics Lab.

Course Outcomes:

After completing the laboratory, the students will be able to:

CO1: Recognize various types of electronics components and demonstrate their parameters.

CO2: Demonstrate the knowledge of different electronics instruments like DSO/CRO, function generator, multimeter etc.

CO3: Apply the knowledge of electronic components to imitate basic electronics circuits.

CO4: Identify different types of digital logic gates and observe their characteristics.

CO5: Practice various arithmetic and logic operations with the help of 8085 microprocessor.

CO6: Recognize different types of sensors and observe their functioning.

Course Details:

List of Practicals: (Any 10**)**

Experiment No. 1: Study of electronic components, operation and use of oscilloscope and function generator to measure different parameters of a given waveform.

Experiment No. 2: V-I characteristics of semiconductor diode and determining its DC and AC resistances.

Experiment No. 3: Implementation of half-wave and full-wave rectifier circuits without and with capacitor filter and measurement of their ripple factor values.

Experiment No. 4: Design, assemble and test of voltage divider biasing circuit using common emitter BJT.

Experiment No. 5: Design and implement Op-Amp applications (Inverting, non-inverting).

Experiment No. 6: R.C phase shift oscillator/Wien-Bridge oscillator using OP-Amp/Crystal oscillator.

Experiment No. 7: Digital Logic Gates: Truth table verification of AND, OR, NAND, NOR, EX-OR, EX-NOR, NOT gates.

Experiment No. 8: Temperature measurement using Thermocouple, Thermister, RTD and LM35.

Experiment No. 9: Introduction to microcomputer system and programming using 8085 (Addition, subtraction).

Experiment No.10: To find largest and smallest number in a given data array using 8085 microprocessor.

Experiment No.11: Voltage-Current characteristics of common emitter n-p-n transistor.

Experiment No.12: Flow control using P.I.D controller.

Text Books:

T1. "Electronic Devices and Circuits", Anil K. Maini and Varsha Agrawal, Wiley India Pvt Ltd, 1st Edition, 2009.

T2. "Digital Fundamentals", Thomas L. Floyd, Pearson Education, 8th Edition, 2005.

T3. "Fundamentals of Microprocessors and Microcomputers", B. Ram, Dhanpat Rai Publication Limited, 8th Edition, 2012.

T4. "Electrical and Electronics Measurements and Instrumentation", A.K.Sawhney, Dhanpat Rai Publications, 9th Edition, 2011.

Reference Books:

R1. "Electronic Instrumentation", H. S. Kalsi, Mcgraw Hill Education, 3rd Edition, 2010.

R2. "Principles of Industrial instrumentation and control", D. Patranabis, Mcgraw Hill Education, 3rd edition, 2010.

CH24302: General Seminar on Research Methodology [0-2-0]

Credit: 01 **Teaching Scheme:** Laboratory 02 Hrs / Week

Prerequisites: The students should have tolerable proficiency in language skills – listening, speaking, reading, writing and Grammar of English as envisaged in the syllabus of 10+2 standard.

Objectives:

1. By the end of the course the students will have understood the process of conducting research in their respective fields with tolerable proficiency.

2. They will have learnt about different parts of a technical dissertation.

Course outcomes:

After the completion of the course, the students will be able to:

CO1. Research Initiation methods with particular emphasis on literature survey, gap analysis and generation of problem statements

CO2. Formulation of the project followed by analysis and learning of data through various statistical techniques

CO3. Structuring of thesis and understanding of mode of presentation of various essential component of the thesis

CO4. Identification of various arenas of research publications and understanding of basic essential steps for each case

Course Details:

Lab–1: Objectives and types of research: Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Lab–2: Research Formulation – Defining and formulating the research problem. Importance of literature review in defining a problem. Identifying gap areas from literature review. Development of working hypothesis. Thesis statement / Statement of the problem – Introduction

Lab–3: Research design and methods – Basic Principles- Need of research design. Important concepts relating to research design. Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan

Lab–4: Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection, sampling Methods, Data Processing and Analysis strategies - Data Analysis with Statistical Packages, hypothesis-testing, generalization and Interpretation.

Lab–5: Reporting and thesis writing – Structure and components of scientific reports - Types of report. Technical reports and thesis. Significance, different steps in the preparation, Layout, structure and Language of typical reports.

Lab–6: Illustrations and tables - Bibliography, referencing and footnotes. Oral presentation: Planning, Preparation, Practice, making presentation, Use of visual aids and Importance of effective communication.

Lab–7: Application of results and ethics, Environmental impacts, Ethical issues - ethical committees. Intellectual property rights and patent law. Reproduction of published material –

Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

Text Books:

1. Wisker, Gina, The Postgraduate Research Handbook**,** 2nd edition, 2007, Palgrave Macmillan.
2. Modern Language Association of America. 2009. MLA handbook for writers of research papers. 7th ed. New York: Modern Language Association of America.

Reference Book:

1. Walliman, N. 2011. Research methods: the basics. Oxon: Routledge.

CH27398: Mini Project [0-4-0]

Credits: 02 **Teaching Scheme:** 04 Hrs / Week

For 4th semester students, a Mini Project is to be carried out considering the following objectives:

1. Scope for creativity
2. Hands on experience
3. Academic occupancy
4. Based on all the subjects in the continuing semester
5. The Mini Project group will be of 3 to 5 students.
6. Head of the Department will appoint Mini Project Guides. 02 credits will be awarded to the candidates after the viva voce and project demonstration at the end of the semester based on the project statement and requirements. The students are advised to utilize the laboratory resources before or after their contact hours as per the prescribed module.

Course outcomes:

After the completion of the course, the students will be able to:

CO1. Survey literature to know about previous and ongoing researches in various fields and therefore select the particular area to work for based on the gaps and opportunities found from literature survey and to express the findings from literature survey in written form.

CO2. Apply basic engineering fundamentals in the selected domain of practical applications to analyze a concept/system/machine operation/process etc. by working as an individual or in a team and contribute to the development of the project.

CO3. Develop engineering ideas with significant novelty and develop a techno-commercial feasibility model for its implementation.

CO4. Prepare project report and deliver oral presentations at the end of semester.

CH27402: Comprehensive Viva Voce [Oral]

Credits: 02

Compulsory for each student based on the two subjects (S2) CH20104 & (S3) CH20105.

End Semester Examination (Oral): 100 marks.

Course outcomes:

After the completion of the course, the students will be able to:

CO1. Answer basic questions related to unit operations.

CO2. Answer questions related to basic principles in mass transfer.

CO3. Acquire additional ideas related to unit operations and mass transfer phenomena.

CO4. Communicate confidently to the Engineering community.