Choice Based Credit System (CBCS)

Name of the Programme (UG): B.Tech

Syllabus for III - Semester and IV - Semester

With effect from 2017 - 2018

Specialization /Branch: Chemical Engineering

Chaitanya Bharathi Institute of Technology (A)
Chaitanya Bharathi (P.O), Gandipet
Hyderabad-500075, Telangana State.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

Choice Based Credit System

B.Tech (Chemical Engineering)

SEMESTER – III

S.No.	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of See in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	16MT C03	Engineering Mathematics-III	3	-	3	30	70	3
2	16CH C01	Chemical Technology	3	-	3	30	70	3
3	16CH C02	Fluid Mechanics	3	-	3	30	70	3
4	16CH C03	Material and Energy Balance	3	-	3	30	70	3
5	16CY C07	Physical Chemistry	3	-	3	30	70	3
6	16MB C01	Engineering Economics and Accountancy	3	-	3	30	70	3
PRACTICALS								
7	16CH CO4	Chemical Technology Lab	-	3	3	25	50	2
8	16CY C08	Physical Chemistry Lab	-	3	3	25	50	2
9	16ME C13 /16EE C05	Basics of Mechanical and Electrical Engg. Lab	-	3	3	25	50	2
Total			**18**	**9**	**-**	**255**	**570**	**24**

L: Lecture T: Tutorial D: Drawing P: Practical

CIE - Continuous Internal Evaluation SEE - Semester and Examination

AssessmentProcedures for Awarding Marks

The distribution of marks is based on CIE by concerned teacher and the Semester end examination shall be as follows:

Course (in terms of credits)	CIE	Semester end Examination(Marks)	Remarks	Duration of SemesterEnd Examination
Three(3) Credits/ Four(4) Credits	30*	70**	Theory Course/ Engg.Graphics	3 Hours
Two(2) Credits	20*	50***	Theory	2 Hours
Two(2) Credits	25	50	Lab Course/ Workshop	3 Hours
One(1) Credit	15	35	Lab Course	2 Hours
Two(2) Credits	50	—-	Project Seminar/ Seminar	——
Six(6) Credits	50	100	Project	Viva-Voce
One(1) Credit	—-	50***	Environmental Studies,Professional Ethics and Human values	2 Hours
One(1) Credit	50		Mini Project	——-

CIE: Continuous Internal Evaluation

*Out of 30/20 sessional marks(CIE), 10/5 marks are allotted for slip-tests (Three slips test will be conducted, each of 10/5 marks, best two average is considered) and the remaining 20/15 marks are based on the average of two tests, weightage for each test is 20/15 marks.

**The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 20 marks. Part-B carries 50 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

***The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 15 marks. Part-B carries 35 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

Note: A course that has CIE (sessional marks) but no semester end examination as per scheme, is treated as Pass/Fail for which pass marks are 50% of CIE.

A candidate has earned the credits of a particular course, if he/she secures not less than the minimum marks/grade as prescribed. Minimum pass marks for theory course is 40% of total marks i.e., CIE plus semester end examinations where as for the lab course/project is 50%.

16MT C05

ENGINEERING MATHEMATICS-III

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives:

1. To study the expansion of functions in various intervals.
2. To form P.D.E and to find its solution.
3. To solve Wave, Heat & Laplace equations.
4. To learn Differentiation and Integration of complex valued functions.
5. To evaluate Complex Integration.
6. To evaluate Real definite integrals.

Course outcomes: On the successful completion of this course the student will be able to

1. Expand functions in the given intervals.
2. Solve linear and non linear PDEs.
3. Solve one-dimension, two-dimension, Heat steady state equations and also one-dimension wave equation.
4. Solve problems on Analytic functions, Cauchy's theorem and Cauchy's integral formula.
5. Expand functions by using Taylor's and Laurent's series.
6. Solve Real and Complex integrals by using Cauchy Theorems.

UNIT – I

Fourier series: Definition of Periodic, Single valued, finite maxima and minima of functions. Euler's Formulae, Dirichlets Conditions for Fourier expansion, Functions having points of discontinuity, Change of interval, Expansion of odd and even functions, Half-range sine series and cosine series.

UNIT-II:

Partial differential equations: Formation of partial differential equations by eliminating the arbitrary constants or arbitrary functions, solutions of linear partial differential equation of first order by using Lagrange's Method, solution of Non-linear partial differential equations of first order by using standard types, Charpit's Method.

UNIT - III

Applications of Partial differential equations: Solution of partial differential equations by using method of separation of variables, solution of vibration of a stretched string (1D-Wave equation), one dimensional heat equation, Two dimensional heat equation under steady state conditions.

UNIT - IV

Theory of Complex variables: Analytic functions, Cauchy Riemann equations (Cartesian and polar forms), construction of Analytic functions by using Milne-Thomson's method. Harmonic function. Complex line integrals, Cauchy's theorem, Cauchy's Integral formula and its derivatives and problems related to the above theorems.

UNIT - V

Expansion of functions, Singularities & Residues: Taylor's and Laurent's series Expansions (Only statements). Zeros, types of singularities, Residues and Cauchy's Residue theorem, Evaluation of real integrals by Cauchy's residue theorem. Evaluation of improper real integrals of the type: $\int_{-\infty}^{\infty} f(x)dx$ Where f(x) has no poles on real axis and $\int_0^{2\pi} f(\sin\theta, \cos\theta)d\theta$.

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, 2015.
2. M.D. Raisinghania, "Advanced Differential equations", 7th edition, S Chand publishers, 2013.
3. J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th edition, McGraw Hill publishers, 2003.

Suggested Reading:

1. N P Bali and Manish Goyal, "A Text Book of Engineering Mathematics", 9th Edition, Laxmi publishers, 2016.
2. Alan Jeffrey, "Mathematics for Engineers and Scientists", 6th Edition, Chapman & Hall/CRC publishers, 2013.
3. A R Vasisthaand R K Gupta, , "Integral transforms", Krishna prakashan publishers , 2004.
4. R.K.Jain&S.R.K.Iyenger, "Advanced Engineering Mathematics", 3rd edition, Narosa Publications, 2007.

16CH C01

CHEMICAL TECHNOLOGY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course helps the students to understand the:

1. Concept of unit operations and unit processes in chemical process industry.
2. Flow diagrams that explain the conversion of raw materials to finished products.
3. Exposure to organic and inorganic processes.
4. Understanding process limitations and scale-up information.

Course Outcomes: At the end of the course, the students will be able to:

1. Estimate the chemical industry growth and opportunities.
2. Differentiate between unit operation and unit processes.
3. Develop flowdiagrams of different processes.
4. Classify between inorganic and organic processes.
5. Design processes based on conditions, space time, yield, conversion, recycle methods, temperature, pressure.
6. Predict the process limitations and propose a model to overcome the limitations.

UNIT – I

Classification of Indian Chemical Industry, Introduction to unit operations and unit processes. Metallurgical Industry overview – classification of metals, manufacturing of pig Iron by blast furnace, methods of steel making – steel alloys. Manufacturing of copper and types of copper alloys, Manufacturing of Aluminum and types of alloys, Manufacturing of graphite and its applications.

UNIT – II

Manufacturing of H_2 by steam reforming of hydrocarbons. NH_3 Synthesis - methods and manufacturing. Urea manufacturing by total recycle.

Manufacturing of Diammonium Phosphate. Manufacturing of Triple super Phosphate, Mixed and Bio Fertilizers.

UNIT – III

Ceramic industry overview, ceramic raw materials manufacturing of porcelain ware. Manufacturing of refractory's & applications, Cement: Raw materials, Manufacturing of Portland cement, Cement types and composition. Glass: Raw materials - Manufacturing – Types of glasses – uses.

UNIT – IV

Classification of plastics, Manufacturing of Phenol formaldehyde resin, PVC, PVA, Synthetic fibers Manufacturing of Nylon–6-6, Polyester Fiber Classification of rubbers and Manufacturing of SBR.

UNIT – V

Pulp and Paper Industry: Methods of pulping production. Recovery of chemicals from black liquor.Production of paper. Oils, Soaps, Detergents: Definitions, constituents of oils, Extraction and expression of vegetable oil. Refining and Hydrogenation of oils. Continuous process for the production of Fatty acids and Soap.

Text Books:

1. Shreve, R. N, "Chemical Process Industries", 4th Ed., McGraw Hill Book Company Inc., New York, U.S.A., 1977.
2. Rao, M. G. and Sittig, M., "Dryden's Outlines of Chemical Technology for the 21st Century, 3rdEd., Affiliated East-West Press, New Delhi, 1998.

Suggested Reading:

1. Andreas Jess and Peter Wasserscheid, "Chemical Technology: An Integral Textbook", John Wiley and Sons, Inc., New York, 2000.
2. Faith, W. L., Keys, D. B. and Clark, R. L., "Industrial Chemicals", 4th Ed., John Wiley, 1980.
3. Fertilizer Association of India, "Handbook of Fertilizer Technology", 2nd Ed.,Scientific Publisher, NewDelhi, 2009.

16CH C02

FLUID MECHANICS

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: This course helps the students to understand the:

1. Fluid flow phenomena for incompressible and compressible fluids.
2. Conservation of momentum principles to fluid flow.
3. Flow in Pipes, Channels and flow past immersed bodies.
4. Fluidization phenomena and methods for transporting the fluids

Course Outcomes: At the end of the course, the students will be able to:

1. Differentiate different types of fluids.
2. Identifyequipments to be used to measure fluid flow based on their properties.
3. Design the piping for flow of fluids under different conditions useful for industry.
4. Apply the phenomena of fluidization applications in petroleum, chemical and allied industries.
5. Calculate the energy losses during the transport of fluids through pipes.
6. Deicide the types of pumps for different fluids under different conditions such as toxic, acidic, slurry type.

UNIT – I

Fluid Flow Phenomena and Fluid Statics: Definition of fluid, shear rate and shear stress, Newtonian and Non-Newtonian fluids, Time dependent flow, viscosity and momentum flux, compressible, incompressible, real and ideal fluids, viscosities of gases and liquids, Laminar and Turbulent flows, Reynolds experiment, Boundary layers, Hydrostatic equilibrium, U-tube manometer, inclined manometer and two fluid manometer and inverted manometer.

UNIT – II

Basic Equations of Fluid Flow: path lines, stream lines and stream tube, mass balance–equation of continuity, one dimensional flow, mass velocity, differential momentum balance- equations of motion, coquette flow, macroscopic momentum balances, momentum of stream and momentum correction factor, layer flow with free surface. Mechanical energy equation- Bernoulli equation- corrections for effects of solid boundaries, kinetic energy correction factor, corrections for fluid friction, pump work in Bernoulli equation.

UNIT – III

Incompressible Flow in Pipes and Channels and Frictional Losses: Shear stresses and skin friction, fanning friction factor, flow in noncircular channels, laminar flow of Newtonian and Non-Newtonian fluids, velocity distribution, Hagen-Poiseuille equation, Turbulent flow, universal velocity distribution, Roughness, Moody's friction factor chart. Pipes and valves, fittings.Friction losses due to sudden expansion and contraction, Effects of fittings and valves, form frictional losses in the Bernoulli Equation.Dimensional analysis and Buckingham π -theorem and Rayleigh theorem– its applications and limitations.

UNIT – IV

Compressible Fluids and Non Newtonian fluids (with Differential Pressure estimation) Flow past immersed bodies and Fluidization: Motion of particles through fluids – Free settling and hindered settling, Drag and drag coefficient, Flow through packed beds of solids – Kozeny-Carman equation, Burke-Plummer equation and Ergun equation. Fluidization and conditions for fluidization, Minimum fluidization velocity, particulate and bubbling fluidizations, Expansion of fluidized beds, Applications of fluidization.

UNIT – V

Transportation and Metering of Fluids: Centrifugal and Positive Displacement Pumps, Characteristics of pumps, suction lift and cavitation, NPSH, Flow meters- Venturi meter, orifice meters, Pitot tube, Rota meters and Notches and Weirs, Compressors and blowers.

Text Books:

1. W. L. McCabe, J. C. Smith and P.Harriott , Unit Operations of Chemical Engineering, 7th Ed., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. C.J.Geankopolis, "Transport processes and unit operations", 3rd Ed., Prentice Hall Publishers, USA, 1993.

Suggested Reading:

1. James O. Wilkes, "**Fluid Mechanics for Chemical Engineers with Microfluids and CFD", 2nd Ed.**, University of Michigan, Prentice Hall Intl., 2006.
2. Kurmi, R.S., "Hydraulics, Fluid Mechanics and Hydraulic Machines", 20th Ed., S. Chand and Company Pvt.Ltd., New Delhi, 2014.

16CH C03

MATERIAL AND ENERGY BALANCES

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course objectives: This course helps the students to understand the:

1. fundamental aspects of chemical engineering problem solving.
2. mass and energy balance relations for chemical processes.
3. mass balance of unit operations and processes without and with chemical reactions.
4. energy balance over different unit operations.

Course Outcomes: At the end of the course, the students will be able to:

1. differentiate between mass and volume relations.
2. develop material balance equations for the processes involving unit operations.
3. write material balance equations for the process involving chemical reactions.
4. develop material balance equations for recycle and bypass operations.
5. write energy balance equations for chemical processes.
6. apply this knowledge to solve advanced chemical engineering problems.

UNIT – I

Basic concepts - Mass and volume relations, Stoichiometric and composition relations - Ideal gas law, partial pressure - Vaporpressures of pure components, Raoult's law and Henry's law, Vapor pressure of miscible and immiscible liquids and solutions.

UNIT – II

Material Balance Without Chemical Reaction Solubility and crystallization (single solute systems) – Material balance in Unit Operations like absorption, distillation, evaporation, crystallization, leaching, extraction, drying and mixing units under steady state conditions.

UNIT – III

Material Balance With Chemical Reaction Material balances over units involving reactions including combustion- Proximate and ultimate analysis of coal and analysis of flue gas.

UNIT – IV

Material balances for by-pass, recycle and purge Operations.

UNIT-V

Energy Balances Heat capacity, sensible and latent heat – Heat balances in operations involving phase change – Heat balance over heat exchangers, dryers and simple evaporation systems / Heat balances calculation in processes without chemical reaction- Heat of reaction, Heat of formation, Heat of combustion- Heat balance in reactions, Adiabatic reaction, temperature of products-Heating values of fuels.

Text Books:

1. O.A.Hougen, K.M Watson and R.A Ragatz, Chemical Process Principles, 2nd Ed, John Wiley and Sons, 2004.
2. Felder, M. Richard, Ronald, W. R., Newell, A. J., "Elementary Principles of Chemical Processes", 4th Ed., John Wiley and Sons, U.S.A., 2016.

Suggested Reading:

1. David M.Himmelbleauand James B Riqqs, Basic Principles and Calculations in Chemical Engineering", 7th Ed, PHI Learning, New Delhi, 2003.
2. K.V.Narayananand B.Lakshmikutty, Stoichiometry and Process calculations, Prentice Hall of India, New Delhi, 2006.
3. B.I Bhatt and S.B.Thakone, "Stoichiometry", 5th Ed. Tata Mc.Graw Hill, New Delhi, 2010.

16 CY CO7

PHYSICAL CHEMISTRY

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: This course helps the students to:

1. Realize the industrial importance of electro chemical processes and optimize the processes to make it industrially viable.
2. Study the effect of colligative properties of dilute solution.
3. Know the kinetics of chemical reactions.
4. Understand the effect of catalyst on a reaction.
5. Deal the properties of molecules and their structure determination using spectroscopy.
6. Appraise the students about the importance and role of physical chemistry in the field of chemical engineering.

Course outcome: At the end of the course, the students will be able to:

1. Describe the operation of electrochemical system for the production of electric energy.
2. Apply fundamental concepts of dilute solutions to engineering problems.
3. Identify the kinetics of a reaction and offer reaction mechanisms.
4. Design a new catalytic material.
5. Operate instruments for studying the structure of chemical compounds.

UNIT I: Electrochemistry

Types of electrolytes,Specific, equivalent and molar conductance and their determinations. Laws of electrolysis and its applications. Ionic mobility, Ionic conductance and relative speed of ions – Hittorf's theoretical device. Transport number and its determination by Hittorf method. Kohlrausch's law statement and its applications - Determination of degree of dissociation of a weak electrolyte, equivalent conductance at infinite dilution for weak electrolyte and solubility products of sparingly soluble salts. Concentration cells with and without transference.

Numerical problems.

UNIT II: Dilute Solutions

Colligative properties: Raoult's law**, l**owering of vapour pressure - measurement of **l**owering of vapour pressure by Ostwald and walker's Dynamic method. Elevation of boiling point - Determination of molecular mass from elevation of boiling point and its measurement by Cottrell's method. Depression of freezing point - Determination of molecular mass from depression of freezing point and its measurement by Beckmann's method. Osmotic pressure and its determination by using Berkeley - Hartley's method.Van'thoff theory of dilute solutions- abnormal colligative properties.

Numerical problems.

UNIT III: Chemical Kinetics

Introduction – Definition of rate, rate constant, order and molecularity. Derivation of expression for the rate constant of a first order, second order and third order reactions. Expression for half-life time of a first order, second order and third order reactions. Determination of order of reaction using integrated rate equation, half-life period and Ostwald's Isolation method. Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, determination of activation energy of reaction. Collision theory of bimolecular reactions and transition state theory.

UNIT IV: Catalysis

Introduction – Definition of catalysis, positive and negative catalyst. Types of catalysis - Homogeneous and heterogeneous catalysis with examples. Characteristics of catalytic reactions.Catalytic promoters, catalytic poisoning and autocatalysis. Acid-base catalysis – Kinetics of acid – base catalyzed reactions and its mechanism. Enzyme catalysis – Mechanism and kinetics of enzyme catalyzed reaction (Michaelis – Menten equation). Factors effecting enzyme catalysis (temperature, salt concentration and pH). Characteristics of enzyme catalysis.

Numerical problems.

UNIT V:Physical properties and molecular spectroscopy

Physical properties: Additive and constitutive properties. Dipole moment– its determination and applications.Rotational spectra of diatomic molecules – principles and relationship between internuclear distance and moment of inertia.Expression for rotational energy. Criterion for absorption of radiation-selection rule and its applications.InfraRed Spectroscopy – Principles, Molecular vibrations, vibrational frequency and its applications.Atomic absorption spectroscopy- Principle, instrumentation

(Block Diagram only) and its applications.Estimation of Nickel by Atomic absorption spectroscopy.

Numerical problems.

Text Books:

1. ArunBahl, B.S. Bahl and G.D.Tuli,, Essentials of Physical Chemistry, S.Chand & company Ltd, New Delhi 2009.

Suggested Books:

1. Puri, Sharma and Pathania , Principles of Physical Chemistry , Vishal Publishing company 2013.
2. G.M.Barrow, Physical Chemistry , McGraw Hill (2008).
3. K.L.Kapoor, A text book of Physical Chemistry , volume 1, 2, 3 & 4 Macmillan 2001.
4. T. Navneeth Rao, Problems in Physical Chemistry, Macmillan India Ltd., Hyderabad 2001.

16MB C01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3 hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: TheObjectives of the course are:

1. to introduce managerial economics and demonstrate its importance in managerial decision making.
2. to develop an understanding of demand and relevance of its forecasting in the business.
3. to provide the basics of market structure and the concept of equilibrium in different market structures.
4. to examine the economic analysis of production process, types of inputs and to explain different costs and their relationship with the output.
5. to understand the importance of project evaluation in achieving a firm's objective.
6. to explain the concept of Accountancy and provided knowledge on preparation and analysis of Final accounts.

Course Outcomes: After completion of the course, student will be able to:

1. apply fundamental knowledge of Managerial economics concepts and tools.
2. understand various aspects of demand analysis and forecasting.
3. understand price determination for different markets.
4. study production theory and analyze various costs & benefits involved in it so as to make best use of resources available.
5. analyze different opportunities and come out with best feasible capital investment decisions.
6. apply accountancy concepts and conventions, Final accounts and financial analysis.

UNIT-I:Introduction to Managerial Economics

Introduction to Economics and its evolution - Managerial Economics -its scope, importance, Its usefulnesstoengineers-Basicconceptsof Managerial economics.

UNIT-II: DemandAnalysis

DemandAnalysis- concept of demand, determinants, Law of demand, its assumptions, Elasticity of demand, price, income and cross elasticity, Demand Forecasting – Types of Market structures. (Simple numerical problems).

UNIT-III: Production and Cost Analysis

Theoryof Production-Firm and Industry-Production function-input-out relations- laws of returns - internal and external economies of scale. Cost Analysis: Cost concepts - fixed and variable costs -explicit and implicit costs-out of pocket costs and imputed costs - Opportunity cost - Cost output relationship - Break- even analysis. (Theory and problems).

UNIT-IV: Accountancy

Book-keeping, principles and significance of double entry book keeping, Journal, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments.

UNIT-V: Capital Budgeting

Introduction to capital budgeting, Methods: traditional and discounted cash flow methods. Introduction to Working capital management. (Numericalproblems).

Text Books:

1. MehtaP.L.,"Managerial Economics–Analysis, Problems and Cases", Sultan Chand & Son'sEducational publishers, 2013.
2. MaheswariS.N. "Introduction to Accountancy", Vikas Publishing House, 2013.
3. Panday I.M. "Financial Management", Vikas Publishing House, 11th edition, 2015.

Suggested Readings:

1. Varshney and KL Maheswari, “Managerial Economics”, Sultan Chand, 2014.
2. M.Kasi Reddy and S.Saraswathi, “Managerial Economics and Financial Accounting”, Prentice Hall of India Pvt Ltd, 2007.
3. A.R.Aryasri, “Managerial Economics and Financial Analysis”, McGraw-Hill, 2013.

16CH C04

CHEMICAL TECHNOLOGY LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

LIST OF EXPERIMENTS

(Minimumof**EIGHT** experiments in the list is to be performed selecting at least **FOUR**from each cycle.)

Cycle –I

1. Analysis of Iron Ore.
2. Analysis of Copper Ore.
3. Estimation of Borax.
4. Estimation of carbonates and bicarbonates ions.
5. Estimation of Dissolved Oxygen in Water.
6. Estimation of Chlorine in Water Sample.
7. Estimation of Calcium Ions in Natural Water.

Cycle – II

1. Estimation of Urea.
2. Estimation of Acid Value of oils.
3. Estimation of Formaldehyde in formalin solution.
4. Estimation of Glucose.
5. Preparation of Nitro-benzene.
6. Preparation of Meta dinitro benzene.
7. Preparation ofAcetanilide.

Text Books:

1. Harris, C. H., “Quantitative chemical analysis”, 7th Ed., W. H. Freeman, New York, 2006.
2. Willard, H. H.,andMeritt, L. L., “Instrumental methods of Analysis”, 7th Ed., ACS Publications, 1989.

Suggested Reading:

1. Skoog, A. D., Holler, F. J., Stanley, R. C., "Principles of Instrumental Analysis", 7th Ed., Brookes Cole, 1997.
2. S.K.Bhasin and Sudha Rani, "Laboratory manual in engineering chemistry", Dhanpathrai Pub. Company, 2009.

16CY C08

PHYSICAL CHEMISTRY LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

Course Objectives: This course helps the students to:

1. Give hands on experience in application of theoretical concepts in experimentation.
2. Develop laboratory skills and ability to work independently.
3. Deepen the student's understanding of the principles of spectroscopy, electro chemistry and kinetics through experimentation.
4. Analyze the materials and estimate various metals.
5. Use various instruments in analytical methods.

Course outcomes: At the end of the course, the students will be able to:

1. Analyze the efficient management of any industrial processes.
2. Ability to understand, explain and select instrumental techniques for analysis.
3. Demonstrate chemical and analytical methods.
4. Apply chemical principles in science and technology as well as on multidisciplinary designteams.
5. Ability to analyze and interpret the experimental data.
6. Gain ability in handling experiments and design new experiments.

List of Experiments

(Minimum of 08 experiments in the list are to be performed)

1. Determination of order of the reaction of hydrolysis of methyl acetate in dilute hydrochloric acid.
2. Determination of order of the reaction between potassium persulphate and potassium iodide.
3. Determination of distribution coefficient of I_2 between CCl_4 and water.
4. Determination of distribution coefficient of benzoic acid between water and toluene.

5. Estimation of amount of HCl and CH_3COOH present in the mixture of acids conductometrically using NaOH solution.
6. Verification of Ostwald's dilution law by determining the dissociation constant of a weak acid Conductometrically.
7. Potentiometric redox titration between Fe^{2+} and $K_2Cr_2O_7$.
8. Potentiometric precipitation titration between KCl and $AgNO_3$.
9. Verification of Beer-Lambert's Law for $CuSO_4$ solution colorimetrically.
10. Estimation of Fe (III) using Potassium thiocyanate solution colorimetrically.
11. Estimation of amount of HCl and CH_3COOH present in the mixture of acids pH metrically using NaOH solution.
12. Determination of pKa of a weak acid pH metrically.

Text Books:

1. B.D.Khosla, V.C. Garg and AdarshKhosla , Senior practical physical chemistry, R.Chand& company, New Delhi (2012).

Suggested Books:

1. J.Mendham and Thomas , Vogel's text book of quantitative chemical analysis, Pearson Education Pvt. Ltd. New Delhi, 6th edition. (2002).
2. S.K.Bhasin and SudhaRani , Laboratory manual in engineering chemistry, Dhanpathrai Publishing Company (2008).
3. MERITT & WILLARD, Instrumental methods of Chemical Analysis, East-West Press (2001).

16ME C13/16EE C05

BASICS OF MECHANICAL AND ELECTRICAL ENGINEERING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

MECHANICAL ENGINEERING LAB

Course Objectives: Student will be able to

1. acquire knowledge in evaluating material characterization and the performance of I.C. Engines.
2. demonstrate this knowledge in tuning of simple components.
3. distinguish between various manufacturing processes.

Course Outcomes: students are able to

1. Evaluate the properties of material by tensile testing and performance of diesel engine.
2. Produce the parts by simple turning process.
3. Understand the concepts of welding, casting (moulding) process.

List of Experiments:

1. To characterize the material by simple tensile testing using UTM.
2. To conduct performance test on four-Stroke single cylinder Diesel Engine.
3. Practice on simple turning on Lathe machine.
4. Moulding practice for simple patterns.
5. Making a straight bead with arc welding.

ELECTRICAL ENGINEERING LAB

Course Objectives:

1. To acquire the knowledge of different types of electrical elements.
2. To verify the basic electrical circuit laws.
3. To determine the parameters and power factor of a coil.

Course Outcomes: The student will be able to

1. Find out the resistance of the given resistor.
2. Understand the voltage division and current division rules.
3. Determine the parameters of the given coil.
4. Measure the power factor of a coil using different methods.

LIST OF EXPERIMENTS

1. Study of different types of resistors, inductors and capacitors.
2. Verification of Ohm's law.
3. Verification of KVL & KCL.
4. Verification of Voltage and current division rules.
5. Measurement of power factor of a coil using 3 ammeters.
6. Measurement of power factor of a coil using 3 volt meters.
7. Determination of the parameters of a coil.

Note: At least **FOUR** Experiments should be conducted in the semester.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

Choice Based Credit System

B.Tech (Chemical Engineering)

SEMESTER – IV

S.No.	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of See in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	16CH C05	Chemical Engineering Thermodynamics - I	3	-	3	30	70	3
2	16CH C06	Chemical Reaction Engineers - I	3	-	3	30	70	3
3	16CH C07	Material Science for Chemical Engineers	3	-	3	30	70	3
4	16CH C08	Mechanical Unit Operations	3/1	-	3	30	70	4
5	16CH C09	Process Heat Transfer	3/1	-	3	30	70	4
6	---	**Elective - I**	3	-	3	30	70	3
PRACTICALS								
7	16CH C10	Fluid Mechanics Lab	-	3	3	25	50	2
8	16MT C07	Programming Laboratory for Numerical Methods	-	2	2	15	35	1
9	16EG C03	Soft Skills and Employability Enhancement Lab	-	2	2	15	35	1
Total			**20**	**7**	**-**	**235**	**540**	**24**

S.No.	Elective-I Course Code	Title of Elective-I Course (Inter Disciplinary and program specific Elective options)
1.	16CY E01	Advanced Organic Chemistry
2.	16MT E01	Numerical Techniques and Statistical Methods
3.	16CH E01	Fertilizer Technology

L: Lecture T: Tutorial D: Drawing P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

AssessmentProcedures for Awarding Marks

The distribution of marks is based on CIE by concerned teacher and the Semester end examination shall be as follows:

Course (in terms of credits)	CIE	Semester end Examination(Marks)	Remarks	Duration of SemesterEnd Examination
Three(3) Credits/ Four(4) Credits	30*	70**	Theory Course/ Engg.Graphics	3 Hours
Two(2) Credits	20*	50***	Theory	2 Hours
Two(2) Credits	25	50	Lab Course/ Workshop	3 Hours
One(1) Credit	15	35	Lab Course	2 Hours
Two(2) Credits	50	—-	Project Seminar/ Seminar	——
Six(6) Credits	50	100	Project	Viva-Voce
One(1) Credit	—-	50***	Environmental Studies,Professional Ethics and Human values	2 Hours
One(1) Credit	50		Mini Project	——-

CIE: Continuous Internal Evaluation

*Out of 30/20 sessional marks(CIE), 10/5 marks are allotted for slip-tests (Three slips test will be conducted, each of 10/5 marks, best two average is considered) and the remaining 20/15 marks are based on the average of two tests, weightage for each test is 20/15 marks.

**The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 20 marks. Part-B carries 50 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

***The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 15 marks. Part-B carries 35 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

Note: A course that has CIE (sessional marks) but no semester end examination as per scheme, is treated as Pass/Fail for which pass marks are 50% of CIE.

A candidate has earned the credits of a particular course, if he/she secures not less than the minimum marks/grade as prescribed. Minimum pass marks for theory course is 40% of total marks i.e., CIE plus semester end examinations where as for the lab course/project is 50%.

16CH C05

CHEMICAL ENGINEERING THERMODYNAMICS – I

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: This course helps the students to understand the:

1. basic thermodynamic laws and principles.
2. concept of energy conservation through the study of the first and second laws of thermodynamics.
3. concept of entropy and its importance in energy conversion.
4. identify, formulate and solve chemical engineering problems involving various types of systems and processes.

Course Outcomes: At the end of the course, the students will be able to:

1 use the fundamentals and differentiate between relations of measurable nature of P, V, T and the un-measurable nature of H, U, A, G.

2 estimate thermodynamic properties of real gases using equations of state, correlations and tables.

3 analyze processes involving ideal gases, such as isothermal, isobaric, isentropic, cyclic.

4 reiterate the first and second laws of thermodynamics and apply their practical implications in engineering design.

5 apply energy balances to open and closed systems and to evaluate the thermodynamic efficiency of nozzles, compressors, turbines.

6 analyze steam power cycles; refrigeration cycles and liquefaction and calculate relevant system efficiencies for the processes.

UNIT – I

The First Law and Other Basic Concepts: Joule's Experiments - Internal Energy - Formulation of the first law of the thermodynamics - the thermodynamic state and state functions - Enthalpy - The steady state flow processes; equilibrium - the phase rule - The Reversible process - Constant V and constant P processes and heat capacity. Volumetric Properties of

Pure Fluids: PVT behavior of pure substances, the Ideal gas, virial equations and their use in the calculation of P-V-T Properties; use of Cubic equations of state, generalized correlations for gases.

UNIT– II

Second law of thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and ideal-gas scale, entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point.

UNIT – III

Thermodynamic properties of fluids: Relationships among thermodynamic properties for a homogenous phase of constant composition; Residual properties; Two-phase systems. Thermodynamic diagrams; generalized property correlations for gases.

UNIT – IV

Conversion of Heat into Work by Power Cycles: Steam power plants, Carnot cycles, Rankine cycle,refrigeration and Liquefaction, vapor-compression cycle, comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump; various processes for liquefaction.

UNIT – V

Thermodynamics of Flow Processes: Energy balances for steady state flow process; Adiabatic and isothermal flow of compressible fluids through pipes of constant cross-section with and without friction; expansion process involving flow through nozzles and turbines, throttling process; compression processes - compressors and pumps; calculation of ideal work and lost work for flow processes.

Text Books:

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd Ed, Wiley India Pvt.Ltd, New Delhi, 2006.
2. H.ScottFogler, “Elements of Chemical Reaction Engineering”, 3rd Ed., Prentice Hall Pvt. Ltd., New Delhi, 2002.

Suggested Reading:

1. J.M. Smith, “Chemical Engineering Kinetics”, 3rd Ed., McGraw-Hill,New York, 1981.
2. K.A.Gavhane, “”Chemical Reaction Engineering-1",NiraliPrakashan Publishers, Pune, India, 2011.

16CH C06

CHEMICAL REACTION ENGINEERING – I

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: This course helps the students to understand the:

1. Classification of reactions, rates and forms of rate expressions.
2. Procedure to interpret the data relating moles, concentration, extent of reaction and conversion.
3. Experimental kinetic data and reaction mechanisms andconcepts of non-ideal reactors.
4. Factors to choose applicable reactor among single, multiple, recycle reactors etc.

Course Outcomes: At the end of the course, the students will be able to:

1. Derive performance equations of batch, and continuous reactors from general material balances.
2. Analyse reactor performance for homogeneous and heterogeneous reactions.
3. Apply the concepts of heat effects on reactions.
4. analyse multiple reactions.
5. Designdifferent types of chemical reactors for batch and continuous operation like CSTR and Tubular.
6. Determinereactor behavior for non-ideal flow.

UNIT – I

Introduction: Classification of Reactions, Definition-Variables affecting the rate of reaction. The rate equation and Stochiometric relations for a single phase reaction aA+bB '! rR+sS. Single and multiple reactions, Elementary and non-Elementary reactions, Molecularity and order of Reaction, Specific reaction rate constant, Testing kinetic models – Steady

state approximation, Equilibrium treatment, Fitting a rate law for the given reaction mechanism, predictability of reaction rate from theory. Temperature dependency from Arrhenius' law, Collision theory and Transition state theory.

UNIT – II

Interpretation of Batch Reactor Data: Constant volume batch reactor: Analysis of total pressure data, conversion. Integral method of Analysis of data for single reaction, multiple reactions, Homogeneous catalyzed reactions, Auto catalytic reactions, reversible reactions, and reactions of shifting orders. Half life method, Partial analysis of the rate equation.Differential method of analysis of data. Variable Volume Batch Reactor: Fractional change in volume of the system, Differential method of analysis, Integral method of analysis.

UNTI – III

Reactor Design: Introduction, Ideal Reactors for a Single Reaction, Space time – space velocity, Steady state mixed flow reactor, Steady state plug flow reactor, Holding time and space time for flow reactors. Design for single reactions, Size comparison of single reactors, multiple reactor systems, Recycle reactor, Auto catalytic reactions – optimum recycle operation, Reactor combinations.

UNIT – IV

Design for Multiple Reactions: Introduction to multiple reactions, Qualitative discussion about product distribution for Parallel, Series and Series-parallel reactions. Quantitative treatment of product distribution and of reactor size for irreversible simple reactions of parallel, and Series only. Temperature and Pressure effects for single reactions, Heat of reaction from thermodynamics, Heat of reaction and Temperature, Equilibrium constants and equilibrium conversions from Thermodynamics. General graphical design procedure, Optimum temperature progression. Heat effects, Adiabatic Operations, Non adiabatic operations. Exothermic reactions in mixed flow reactors – a qualitative treatment.

UNIT – V

Non-Ideal flow: Basics, residence time distribution (R T D), State of aggregation of the flowing stream, earliness of mixing, Role of R T D, state of aggregation and earliness of mixing in determining reactor behaviour. Exit age distribution of fluid, Experimental methods for finding E – pulse, step experiments, Relationship between F and E curves. The convolution integral.Conversion in non- ideal flow reactors.

Text Books:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Ed, Wiley India Pvt.Ltd, New Delhi, 2006.
2. H.ScottFogler, "Elements of Chemical Reaction Engineering", 3rd Ed., Prentice Hall Pvt. Ltd., New Delhi, 2002.

Suggested Reading:

1. J.M. Smith, "Chemical Engineering Kinetics", 3rd Ed., McGraw-Hill,New York, , 1981.
2. K.A.Gavhane, "Chemical Reaction Engineering-1", Nirali Prakashan Publishers, Pune, India, 2011.

16CH C07

MATERIAL SCIENCE FOR CHEMICAL ENGINEERS

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: This course helps the students to understand the:

1. criteria involved in identifying materials for chemical engineers.
2. concept of phase-transformations that occur during material manufacture and vis-à-vis the effect on properties.
3. significance of different properties for selecting material under different combinations of process conditions.
4. possible and latest alternatives available for standard engineering materials.

Course Outcomes: At the end of the course, the students will be able to:

1. apply the basic fundamentals of engineering for material selection.
2. developTime–Temperature–Transformation (T-T-T) relations of materials.
3. apply phase equilibrium diagrams for heat treatment of steels.
4. select the right materials for design and fabrication of process equipment.
5. select materials for high and low temperature applications.
6. identify new or alternate materials for development and operation of process industry.

UNIT – I

Introduction to Engineering Materials: Classification – metals, non-metals, alloys; Introduction to metallic materials: Ferrous metals and alloys – Iron and steel, types of steels like mild steel, carbon steel and stainless steel, Common grades of steel (304, 316); Non-Ferrous metals and alloys of Aluminum, Copper and Nickel; Introduction to non-metallic materials: Polymers, Ceramics, Refractories and Composites; Criteria for material selection.

UNIT – II

Phase Diagrams: Phase rule, Definition and construction of phase diagrams, Basic types of binary phase diagrams: Cu-Au, Al-Si, Al-Cu, Mg-Sn, Cu-Zn. Iron-Iron carbide equilibrium diagram. Applications of Phase Equilibrium Diagrams: Time–Temperature–Transformation (T-T-T) relations of steels, Zone refining, Heat treatment of steels.

UNIT – III

General Properties of Engineering Materials: Mechanical Properties: Stress-strain diagram, Elastic, Plastic, Anelastic and Viscoelastic behavior, Hardness, testing, Deformation – hot and cold working, Creep, Fatigue and Fracture strengthening mechanisms. Thermal Properties: Conductivity, Expansion, Protection, Diffusivity, Stresses and Shock resistance.Optical Behavior: Light & electro-magnetic spectrum, Luminescence, stimulated emission of Radiation, Lasers, Optical fibers. Magnetic Behavior: Magnetism, Susceptibility, Anisotropy and Hysteresis, Ferro-, Para, -and Dia- Magnetism soft and hard magnetic materials.

UNIT – IV

Materials for High and Low Temperature Applications: Ceramics and Refractories – Classification, advantages, general properties and engineering applications. Introduction to Superalloys.Electrical Materials– Different types like conductors, semiconductors and superconductors; general properties and engineering applications. Polymers and Elastomers – Classification, advantages, general properties and engineering applications.

UNIT–V

New Materials: Composite materials - Classification, advantages over alloys, general properties and applications. Nano-materials: Introduction, carbon nanotubes, nanosensors. Biomaterials: Need of ceramics, Interaction with bioenvironment, Biocompatibility, Types of biomaterials - Nearly inert ceramics, surface active ceramics, resorbable ceramics.

Text Books:

1. Raghavan, V., "Elements of Materials Science and Engineering- A first course", 5th Ed, PHI learning pvt.ltd., 2006.
2. Rajput, R. K., A Textbook of Material Science and Engineering, 2nd ed., S.K.Kataria and Sons, 2013.

Suggested Reading:

1. Callister, W. D., "Materials Science and Engineering", 5th Ed, John Wiley and Sons. Inc., 2002.
2. Krishan K. Chawla, "Composite Materials: Science and Engineering", Springer-Science Media, USA, 1987.

16CH C08

MECHANICAL UNIT OPERATIONS

Instruction	3+1 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	4

Course Objectives: This course helps the students to understand the:

1. principles of size reduction using various equipments.
2. techniques for separating solids based on size by different methods.
3. different kinds of filtration units.
4. various aspects of Mixing and Agitation of solids and liquids.

Course Outcomes: At the end of the course, the students will be able to:

1. decide the transport of solids based on their properties.
2. select equipment for industrial application with respect to size reduction.
3. design equipment for industrial application with respect to separation of solids.
4. decide the necessary equipment to screen different particles based on their properties.
5. Apply the different filtration techniques for industrial application.
6. identify the suitable technique for blends and mixing of liquids and solids.

UNIT – I

Particle Technology: Characteristics of solid particles – screen analysis, Differential and cumulative mean diameters for mixture of particles, properties of particulate masses. 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: Industrial screening equipment – Grizzlies, Tromels and gyratory. Capacity and effectiveness of screen.Flotation, Frothing and dispersing agents' magnetic separation, electrostatic precipitators. Particle dynamics: Principles of motion of particles through fluids, drag coefficient for spheres, motion of spherical particles. Free and hindered settling.Classifiers, jigging.Sorting classifiers – Heavy medium and differential settling methods.Principle and working of cyclones and hydro cyclones.

UNIT – III

Solid-liquid separation operations: Flocculation – Batch sedimentation – Thickeners – Thickener design. Principles of centrifugal sedimentation – Centrifugal classifiers and decanters – tubular, disc, bowl and scroll centrifuges.

UNIT – IV

Filtration:Equations for batch filtration. Description of plate and frame filter press, 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: Agitation equipment for liquids – Circulation velocities and power consumption in agitated vessels. Scale up of agitation equipment – 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.

Text Books:

1. W. L. McCabe, J. C. Smith and P.Harriott , Unit Operations of Chemical Engineering, 7thEd., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. Foust A.S, Wenzel L.A., "Principles of Unit Operations", 2nd Ed., John Wiley and sons, NewYork, 1981.

Suggested Reading:

1. Coulson, J. M., and Richardson, J. F., "Chemical Engineering Series", Vol. 2, 4thEd., Pergamon Press Oxford, UK, 1991.
2. C M Narayanan and B C Bhattacharya, "Mechanical Unit Operation for Chemical Engineering",Khanna Publishers, 3rd Ed, 2011.

16CH C09

PROCESS HEAT TRANSFER

Instruction	3+1 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	4

Course Objectives: This course helps the students to understand the:

1. overall view of different modes of heat transfer applicable to process industries.
2. heat transfer to fluids without and with phase change.
3. concept and functioning of different heat exchangers.
4. Fundamentals of heat transfer by conduction, convection and radiation.

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

1. Distinguish between different types of heat transfer
2. Analyze the concepts of heat exchanger
3. Calculatethe rate of heat transfer with and without change of phase.
4. Decide the type of evaporator required for a specific purpose.
5. Identify the effect of combined heat transfer by conduction, convection and radiation.

UNIT - I

Modes of Heat Transfer – derivation of heat conduction equation in rectangular co-ordinates – one dimensional heat conduction without heat generation through plane, cylindrical and spherical walls – Resistance concept - situations involving conduction and convection – critical and optimum insulation thickness – Numerical problems on unsteady heat conduction through semi-infinite slab, infinite slab and cylinder – lumped capacity systems.

UNIT - II

Heat Transfer to Fluids Without Phase Change – forced convection in laminar flow over plates and in tubes – dimensional analysis. Correlations for heat transfer in turbulent flow, natural convection, Agitated vessels,

packed beds – Analogy between heat and momentum transfer – Reynolds, Prandtl and Colburn analogies.

UNIT - III

Heat Transfer to Fluids With Phase Change – heat transfer from condensing vapors – Drop wise and Film wise condensation – Derivation and practical uses of Nusselt equation. Boiling of saturated liquid – maximum heat flux and critical temperature drop, minimum flux and film boiling. Typical heat exchange equipment – counter and parallel flows,

energy balances, log-mean temperature difference and correction for mixed and cross flow – Rating of single and multiple heat exchangers – Description of extended surface heat exchangers.

UNIT - IV

Evaporators - Types– capacity and economy of evaporators – material and energy balances in evaporation – multiple effect evaporation and methods of feeding – Barometric leg, steam traps – heat transfer coefficients in evaporators – Description and working of crystallizers.

UNIT - V

Radiation - Fundamentals of radiation heat transfer, laws of black body radiation, radiating heat exchange between non-black surfaces, combined heat transfer by conduction, convection and radiation, radiation shields.

Text Books:

1. W. L. McCabe, J. C. Smith and P.Harriott, "Unit Operations of Chemical Engineering", 7thEd., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. Donald Q.Kern, "Process Heat Transfer", 1st Ed., McGraw-Hill publishers, New York, 2001.

Suggested Reading:

1. Hollman, J.P., "Heat Transfer", 10th Ed., McGraw-Hill publishers, 2011.
2. Coulson, J. M., and Richardson, J. F., "Chemical Engineering Series", Vol. 1, 4thEd., Pergamon Press Oxford, UK, 1991.
3. B.K.Dutta, "Heat Transfer Principles and applications", PHI learning Pvt. Ltd.,New Delhi, 2004.

16CY E01

ADVANCED ORGANIC CHEMISTRY

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: This course helps the student to

1. impart knowledge of organic chemistry to chemical engineering students.
2. learn nomenclature and isomerism of organic molecules in a better way which forms the basis of our life.
3. gain knowledge in designing new synthetic processes.
4. learn various separation techniques useful for research purpose.
5. learn the latest techniques of instrumental analysis.

Course outcomes: At the end of the course, student will be able to

1. identify organic functional groups using chemical processes.
2. classify the types of isomerism in various organic molecules.
3. illustrate the mechanism of a reaction using oxidizing and reducing agents.
4. design separation techniques commonly used in research industries.
5. analyze the molecules using data from spectroscopic techniques.

UNIT I:

Nomenclature and functional groups

Review of nomenclature of organic compounds. IUPAC system.Chemical reactions (without mechanism) of a) Alcohols – with HX, H_2SO_4, heating/ H+, oxidation and reduction. b) Ethers – with HX c) Carbonyl compounds (aldehydes/Ketones) – with RMgX, NH_3 and its derivatives, oxidation (with $KMnO_4$), reduction (with ZnHg/HCl), hydrazine) d) Carboxylic acids – acidic character, PCl_5, $SOCl_2$, NH_3, esterification, oxidation and reduction e) Amines – basic character, carbylamine reaction, acetylation (difference between 1°, 2° and 3° amines) and diazotization.

UNIT II:

Isomerism and Stereochemistry

Definition of isomerism.Types of isomerism – structural and stereoisomerism.Structural isomerism with examples (chain, positional, functional isomerism and tautomerism). Stereoisomerism conformational and configurational isomerism (Newmann projection formula) – definition, n-butane as example. Geometrical isomerism – cis/trans or E/Z isomerism with one example each. Optical isomerism – Introduction to optical activity, plane polarized light, causes of optical activity. Optical activity in compounds containing one asymmetric (lactic acid) and two similar (tartaric acid).Enantiomers and Diastereomers – definition.Relative (DL) and absolute (RS) configuration of simple molecules like glyceraldehyde, glyceric acid, sec-butyl alcohol. Sequence rules.

UNIT III:

Named reagents and reactions in organic synthesis

Reagents in organic synthesis – Introduction, oxidizing reagents: potassium permanganate (with 2-butene), potassium dichromate (with 1°,2° alcohols) and lead tetraacetate (with 1,2 diol) with mechanism. Reducing reagents: reagents in catalytic reactions – H_2/Pd (to reduce alkenes and alkynes) with any two examples; reagents in chemical reactions – $LiAlH_4$, $NaBH_4$ with two examples (without mechanism). Named reactions – Aldol condensation, Hoffmann degradation and Perkin reaction with mechanism and example.

UNIT IV:

Chromatographic techniques

Introduction – Types of chromatography, TLC and column – principles, processes and applications. HPLC – principle and application.

UNIT V :

Spectroscopic analysis of organic compounds.

IR spectroscopy: Instrumentation, application of IR spectroscopy for identification of organic molecules containing – OH,-NH2,>C=O, -C≡C-, -CN, phenyl, -C-O-C-, -$CONH_2$, -COOH and –COOR.UV spectroscopy: Basic principles, types of excitation, bathochromic and hypsochromic shift, Instrumentation. Application to simple molecules (1,3-butadiene, stilbene and benzaldehyde).

Text Books:

1. R.T.Morrison and R.N.Boyd ,Organic chemistry, 6th edition, Prentice Hall, New Delhi, 1999.
2. Y.R.Sharma, Elementary organic spectroscopy , 5th edition , S. Chand and Co., 2013.

Suggested Books:

1. G.L. David Krupadanam, Analytical chemistry, Orient Longman, A.P., 2004.
2. T. W. Graham Solomons, Organic chemistry, 6th edition, 2007.
3. William Kemp, Organic spectroscopy, 3rd edition, Palgrave, New York, 2005.

16MT E01

NUMERICAL TECHNIQUES AND STATISTICAL METHODS

Instruction:	3 Hours per week
Duration of End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	3

Course Objectives: This course helps the students to understand the:

1. To find the roots of the non-linear equation using the different methods.
2. To identify the solution for Initial Value Problem using numerical techniques.
3. To estimate the statistical averages/ensemble averages of the probability functions.
4. Probability distributions for random phenomenon of the physical data.
5. Statistical hypothesis and assumptions for testing the data.

Course Outcomes: At the end of the course, the students will be able to:

1. Solve the non-linear equations for generating the roots.
2. Solve the first order ordinary differential equations using numerical techniques.
3. Analyse the probability function with the help of statistical averages.
4. Fit the probability distribution (discrete and continuous) for the random phenomenon.
5. Formulate the statistical hypothesis for the statistical data.
6. Interpret the random behaviour of physical data.

UNIT – I

Solution of linear and non-linear equations: Numerical Solution of linear simultaneous equations by Gauss-elimination direct method, Gauss-Jordan direct method, Gauss-Seidel iteration method. Solution of Transcendental (non-linear) equations by Bisection method, Regula-Falsi method and Newton-Raphson method.

UNIT – II

Numerical solutions of ordinary differential equations: Numerical solutions of ordinary differential equations by Euler's Method, modified Euler's method, Taylor's method and Runge-Kutta fourth order method.

UNIT – III

Random variables: Mathematical Expectation, Variance, Co-Variance, and its properties, Probability function, Moments, moment generating function, cumulative generating function and its properties.

UNIT – IV

Probability Distribution: Discrete distribution: Binomial, Poisson distributions, finding Mean and Variance through moment generating function. Continuous distribution: Normal distribution and Exponential distributions**.**

UNIT – V

Testing of Hypothesis: Null and alternative Hypothesis, Types of errors, Level of significance, testing the single mean (small).Testing the chi-square, Goodness of fit for independents of attributes, equality of population variances.

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.
2. M.K.Jain, S.R.K Iyengar and R.K.Jain: Numerical methods for Scientific and Engineering Computation. New Age International publications, 2008.
3. S.C Gupta and V.K.Kapoor, "Fundamentals of Mathematical statistics", S.Chand and Co Publishers, 2006.

Suggested Reading:

1. N P Bali, Manish Goyal, "A Text Book of Engineering Mathematics", 9th Edition, Laxmi publishers, 2016.
2. Kanti B. Datta, "Mathematical Methods of Science and Engineering", CENGAGE Learning publishers, 2014.
3. Miller and Freund, "Probability and Statistics for Engineers", Pearson publishers, 2005.
4. S.S.Shastry, "Introductory Methods of Numerical Analysis**"**, 5thEd, EEE publishers, 2014.

16CH E01

FERTILIZER TECHNOLOGY

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course objectives: This course helps the students to understand the:

1. Use of fertilizers in improving soil productivity and crop yield.
2. Different types of the nitrogenous, phosphatic and potash fertilizers.
3. Various fertilizer application methods.
4. Different organic fertilizer production methods.

Course outcomes: At the end of the course, the students will be able to:

1. Identify the different nutrients and significance of feed stocks for the production of fertilizers.
2. Identify methods for the production of various nitrogenous fertilizers.
3. Apply different manufacture methods for various phosphorous fertilizers.
4. Production methods for potassium and mixed complex fertilizers
5. Differentiate the need, application techniques and uses of new variety of fertilizers.
6. Design effluent treatment methods and impact of fertilizers on environment.

UNIT – I:

Introduction: Fertilizer Technology, Plant Nutrients, Role of essential elements for plant growth. Availability of feed stocks.Nitrogen Fertilizers - Feed stocks for the production of Ammonia, Ammoniasynthesisby – Haber and Kellogg processes.By-productammonia recovery by direct and indirect methods.

UNIT –II

Manufactureof Urea: Manufacture of urea and othernitrogenous fertilizerssuchas ammoniumsulfate, ammonium nitrate, calciumammoniumnitrate, ammoniumchloride. Manufacture of nitric acid.

UNIT – III

Phosphorous fertilizers: manufacture of single and triple super phosphate. Production of ammoniumphosphates – mono-, Di- and nitro-phosphates, Manufacture of phosphoric acid by wet process and thermal process.

UNIT –IV

Introduction to new variety of fertilizers: Potassium fertilizers, mixed and NPK fertilizers.Liquid fertilizers.Bio fertilizers – introduction, advantages over chemical fertilizers, types and uses.

UNIT –V

Fertilizer application techniques: different soil controlled release fertilizers. Effluent treatment methods for various fertilizer plants.Environmental impact of fertilizer plants on Ecosystem. IndianFertilizer industry – production Economics and future plans.

Text Books:

1. Brahma Mishra, "Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd., New Delhi, 2012.
2. Dr. ShaliniSuri, "BioFertilizers and Biopesticides", 1st Ed., APH publishing Corporation, New Delhi, 2011.

Suggested Reading :

1. Fertilizer Association of India, "Fertilizer Handbook", 2nd Ed., Scientific Publisher, New Delhi, 2009.
2. UNIDO, "Fertilizer Manual", 3rd edition, Kluwer Academic Publishers, New Delhi,1998.

16CH C10

FLUID MECHANICS LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

LIST OF EXPERIMENTS

Note:Minimumof**EIGHT** experiments are to be performed.

1. Determination of discharge coefficient of orifice meter and Venturimeter and their variation with Reynold's number.
2. a) Determination of weir meter constant K for V-notch and rectangular notch.

   b) Calibration of rotameter and study of variation of flow rate with tube to float diameter.
3. Determination of viscosity of Glycerol – water solution at different temperatures.
4. Determination of friction factor for flow of water through annulus using Fanning's and Darcy's equations.
5. Determination of friction factor for flow through straight pipes of different diameters and study of variation of friction factor with Reynolds number.
6. Determination of friction losses in pipe fittings.
7. Determination of clearance volume and efficiency of an air compressor.
8. Determination of characteristic curves for centrifugal pumps.
9. a) Determination of friction factor for packed beds.

   b) Determination of minimum fluidization velocity.
10. Determination of pressure drop through helical coils.
11. Determination of velocity profile of air in pipe by pitot tube.
12. Determination of critical velocity by Reynolds Experiments.

Text Books:

1. C.J.Geankopolis, “Transport processes and unit operations”, 3rd Ed., Prentice Hall Publishers, USA, 1993.
2. BireswarMajumdar, “Fluid Mechanics with laboratory manual”, PHI Learning Pvt. Ltd., New Delhi, 2011.

Suggested Reading:

1. Gupta, V. P., “Laboratory manual of Fluid Mechanics and Machines” 3rd Ed., CBS Publishers, New Delhi, 2011.

16 MT C07

PROGRAMMING LABORATORY FOR NUMERICAL METHODS

Instruction:	2 Hours per week
Duration of End Examination:	2 Hours
Semester End Examination:	35 Marks
Continuous Internal Evaluation:	15 Marks
Credits:	1

LIST OF EXERCISES

CYCLE – I: Introduction to MATLAB programming techniques

1. Introduction to 'MATLAB Programming technique'.
2. MATLAB code writing - variables, operators, arrays, loops.
3. MATLAB code writing- functions, input/output statements, plotting.
4. Writing and running programs - learning the 'Built-in functions' in MATLAB software useful for problem solving.

CYCLE – II: Application of MATLAB Programming

5. Numerical Solution of linear simultaneous equations by direct methods:
   i. Gauss-elimination direct method.
   ii. Gauss-Jordan direct method.
6. Numerical Solution of linear simultaneous equations by indirect methods:
   i. Jacobi method.
   ii. Gauss-Seidel indirect method.
7. Solution of non-linear equations by:
   i. Bisection method.
   ii. Newton-Raphson method.
8. Numerical solutions of ordinary differential equations by:
   i. Euler's Method.
   ii. Runge-Kutta fourth order method.
9. Interpolation and Curve fitting by Linear Least square analysis.
10. Interpolation and Curve fitting by Non-linear Least square analysis.

Textbooks:

1. RudraPrathap, "Getting Started with MATLAB: A quick Introduction for Scientists and Engineers", New York, Oxford University Press, 2010.
2. B. S. Grewal, "Numerical Methods in Engineering & Science with programs in C, C++ and MATLAB", Khanna Publishers, 2014.
3. JaanKiusalaas, "Numerical Methods in Engineering with MATLAB", Cambridge University Press, U.S.A., 2005.

Suggested Reading:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, "Numerical methods for Scientific and Engineering Computation",
   New Age International publications, 2008.
2. DukkipatiRao.V, "Applied Numerical Methods using MATLAB", New Age International (P) Ltd. Publishers,
   New Delhi, 2011.
3. Timmy Siauw and Alexander Bayen, "An Introduction to MATLAB Programming and Numerical Methods for Engineers", 1st Ed., Elsevier Publications, Academic Press, USA, 2014.

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SOFT SKILLS AND EMPLOYABILITY ENHANCEMENT LAB

Instruction	2 hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
Continuous Internal Evaluation	15 Marks
Credits	1

Course Objectives: To help the students

1. Participate in group discussions and case studies with confidence and to make effective presentations. Also to learn the art of communication.
2. With- resume packaging, preparing and facing interviews.
3. Build an impressive personality through effective time management & goal setting, self-confidence and assertiveness.
4. Understand what constitutes proper grooming and etiquette in a professional environment. Also to understand academic ethics and value systems.
5. To understand the elements of research and hone their soft skills through a live, mini project.

Course Outcomes: The students will be able to

1. Be effective communicators and participate in group discussions and case studies with confidence. Also be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals. Also learn to manage time effectively and deal with stress.
4. Make the transition smoothly from Campus to Corporate. Also use media with etiquette and know what academic ethics are.
5. To do a live, mini project by collecting and analyzing data and making oral and written presentation of the same.

Exercise 1

Group Discussion and Case studies: Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.

Elements of effective presentation, Structure of presentation, Presentation tools, Body language,

Creating an effective PPT.

Exercise 2

Interview Skills: Resume writing, structure and presentation, planning, defining the career objective, projecting ones strengths and skill-sets.

Interview Skills: concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews.

Exercise 3

Personality Development: Effective Time Management, setting realistic goals, self-confidence and assertiveness, stress management, moral values.

Exercise 4

Corporate Culture: Grooming and etiquette, communication media etiquette,

Academic ethics and integrity.

Exercise 5

Mini Project: General/Technical. Research, developing a questionnaire, data collection, analysis, written report and project seminar.

Suggested Reading:

1. Dr. ShainiVerma, “Body Language- Your Success Mantra”, S Chand, 2006 .
2. Ramesh, Gopalswamy, and Mahadevan Ramesh, “The ACE of Soft Skills”, New Delhi: Pearson, 2010.
3. Covey and Stephen R, “The Habits of Highly Effective People”, New York: Free Press, 1989.