Programme Objectives
Chemical Engineering Department
B.Tech. Chemical Engineering
(Undergraduate programme offered by the Department)

1. **Name of the programme:** Bachelor of Technology
2. **Program Specifications:**

School of Studies:	Engineering & Technology
Department:	Chemical Engineering
Program:	B.Tech in Chemical Engineering (AICTE CBCS Scheme)
Head of the Department:	Dr. A.K. Chandrakar
Date of Approval in Board of Studies:	13.05.2019
Date of Last revision:	2019
Next revision due:	2023

3. **Mode of Study:** Full time (Semester system): Class room teaching; experiential learning; Tutorials; Experimental laboratory training; Project assignments

PURPOSE OF THE COURSE:

The purpose of B.Tech in Chemical Engineering Program has a focus on cutting edge technology to meet industrial application to produce career ready chemical engineers. They meet such an environment with rapidly change in recent technology with chemical processes industries. The curriculum is designed to prepare chemical engineering graduates for further education and personal development through their entire professional career. We strive to accomplish these goals by providing a rigorous and demanding curriculum that incorporates lectures, tutorial, lab and project development experiences. The course will introduce students to forces on fluids mechanics, reaction engineering, process equipment design, energy and mass balance, mass transfer, concepts of thermodynamics and many more subject which are directly or indirectly related

with process industries, and it strongly gives opportunity to student to meet social and industrial environment.

PROGRAMME SPECIFIC OBJECTIVES

- Impart education and training of Chemical Engineering to the students and to eventually make them competent and well qualified Chemical Engineers.
- Provide best knowledge of the Chemical Engineering to the students and nurture their creative talent by motivating them to work on various challenging problems of Chemical Engineering.
- Acquire high end industry centric skills in the field of Chemical Engineering.
- Knowledge of the software used in the field of Chemical Engineering.
- To prepare Professional Engineer with ethical, social and moral values.

PROGRAMME EDUCATIONAL OBJECTIVES

- To make the students ready for successful career leading to higher education and /or in industry related domains of design, research and development, testing and manufacturing.
- To solve diverse real-life engineering problems equipped with a solid foundation in mathematical, scientific and chemical engineering principles.
- To motivate and encourage the students to adopt professionalism, teamwork, leadership, communication skills, ethical approach.
- To provide learning opportunity in a broad spectrum of multidisciplinary fields.

PROGRAMME SPECIFIC OUTCOMES

The graduates will be able to:

- Apply the knowledge of basic science, mathematics and fundamentals of engineering with specialization to solve the complex problems of engineering.
- Identify and formulate for the analysis of the engineering problems considering the knowledge of engineering mathematics, natural and engineering sciences and review of the research articles for substantial conclusions.
- Demonstrate and develop the appropriate solutions of the complex level of chemical engineering design based problems to meet the specified needs and overall sustainability of the processes, considering the

necessary approaches of safety, health hazards, societal and environmental factors.

- Investigate, demonstrate and conduct the design based complex problems using research based knowledge and methodologies, experimental studies, subsequent analysis and interpretation of data to prepare the valid technical reports.
- Understand and demonstrate the impact of relevant professional engineering solutions and knowledge for the sustainable development of society and environment.
- Apply suitably the norms and responsibilities of engineering practices towards the commitment following the principles of engineering ethics.
- Work effectively as an individual or in diversified and multi-disciplinary environments showing the team solidarity.
- Ability to communicate efficiently with the engineering community, society and able to represent and explain the design documentation effectively with clear instructions.
- Demonstrate the knowledge and principles of engineering, management, cost and feasibility studies for the desired projects as an individual, a member or leader in a team of multidisciplinary settings.
- Possess the attitude of lifelong independent learning as per the need of wider context of technological changes and can pursue higher education for careers in academics, research and development.

Course Code	Course Name	Course objective and Course outcomes
CH01TBS01	**PHYSICS**	**Course Objective:** Basic concepts of optics and its applications, electricity and magnetism, semiconductor physics and quantum physics. **Course Outcome:** Understand theory of optics, laser and fiber optics, familiar with electromagnetic theory, learn about semiconductor and their application and gain the knowledge of quantum mechanics.
CH01TES01	**BASIC ELECTRICAL ENGINEERING**	**Course Objective:** An insight to the importance of electrical energy in chemical plants. Basics of electricity, selection of different types of drives for a given application process. Basic insight into power supplies, instrumentation amplifiers in industries. **Course Outcome:** Understand the basic concepts of D.C., single phase and three phase A.C. supply and circuits, and solve basic electrical circuit problems, Understand the basic concepts of transformers and motors used as various industrial drives, Understand the concept of power factor improvement for industrial installations and concept of most economical power-factor
CH01TBS02	**MATHEMATICS-I**	**Course Objective:** Basic concepts of linear algebra and vector calculus. **Course Outcome:** Students will be able to solve System of linear algebraic equations , Vector algebra, vector differential calculus and vector integral calculus
CH01THS01	**ENGLISH**	**Course Objective:** Basic concept of English writing and communication skill **Course Outcome:** Able to prepare and make small presentations, Able to write effective business letters, emails, and reports, Comprehend answering strategies in group discussions and interviews, Comprehend different types of communication and importance of effective communication in a work place.
CH01TMC01	**ENVIRONMENTAL SCIENCES**	**Course Objective:** Introduction to environmental studies, biodiversity, environmental pollution, Environmental impact assessment. **Course Outcome:** Student will understand the - concept of ecosystem and biodiversity, renewable and non-renewable resources. - water, air, noise and soil pollution and their effects, control measures and protection act.

		- Environmental impact assessment, case studies.
CH01PBS01	**PHYSICS LAB**	**Course Objective:** Physics lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses. **Course Outcome:** Students should be able to - State various laws which they have studied through experiments - Describe principles of optical fibre communication
CH01PES01	**BASIC ELECTRICAL ENGINEERING LAB**	**Course Objective:** first hand experience of verifying various theoretical concepts learnt in theory course of Basic Electrical Engineering. **Course Outcome:** Get an exposure to common electrical components, Make electrical connections by wires of appropriate ratings, Understand the usage of common electrical measuring instruments, Understand the basic characteristics of transformers and electrical machines, Get an exposure to the working of power electronic converters.
CH01PES02	**ENGINEERING GRAPHICS & DESIGN**	**Course Objective:** Introduction to Engineering drawing, projections, overview of computer graphics **Course Outcome: s**tudent will understand - principle of engineering graphics and their significance - orthographic and isometric projection - computer graphics system, software and application.
CH01PMC01	**INDUCTION TRAINING PROGRAMME**	**Course Objective: To assimilate the students with atmosphere and facilities of the institute.** **Course Outcome:** Students will become familiar with the facilities, working and academic culture, administrative and residential environment of the institute.
CH02TBS03	**MATHEMATICS-II**	**Course Objective:** Basic concepts of transforms, ordinary and partial differential equations **Course Outcome:** Students should be able to solve - Simple first and second order ODE by Analytical methods - First and second order differential equations numerically - Partial differential equations numerically - Problems relating to Laplace transforms
CH02TBS04	**CHEMISTRY**	**Course Objective:** To understand fundamental knowledge of chemical laws and bonding and types of reaction

		Course Outcome: Students should be able to 1. Explain quantum energy and spectroscopy 2. Describe various theories of VSEPER, V.B and molecular orbital 3. Acquire the knowledge of various types of reaction involving addition, substitution, elimination etc.
CH02TES02	**PROGRAMMING FOR PROBLEM SOLVING**	**Course Objective:** To impart the fundamental knowledge of programming, algorithm and function structure etc. and improve the interest in the field of computers to adjust to the demands of current trends **Course Outcome:** 1. Explain a basic understanding of computer software and hardware 2. Develop skill in writing programs in a technical programming language. 3. Develop problem-solving skills and knowledge of computing fundamentals to a wide variety of engineering and technology problems
CH02TES03	**THERMODYNAMICS**	**Course Objective:** To impart knowledge of basic concepts in thermodynamics laws and industrial applications of thermodynamics like power plants, refrigerators, automobile engines, pumps etc. **Course Outcome:** Students will be able to 1. Explain basics of thermodynamics, work and energy 2. Describe phase transition, ideal gas law and Van der Waals law 3. explain first and second laws of thermodynamics and its applications
CH02PBS02	**CHEMISTRY LAB**	**Course Objective:** To perform experiments illustrating the principles of chemistry relevant to the study of science and engineering. **Course Outcome: S**tudents will learn to: 1. Estimate chlorine ion in water sample 2. Measure molecular/system properties such as surface tension, viscosity, concentration andconductance of solutions, redox potentials, hardness of water, etc 3. Synthesize of urea formaldehyde, acetanilide and Asprin compound.
CH02PES03	**PROGRAMMING FOR PROBLEM SOLVING LAB**	**Course Objective:** To impart the fundamental knowledge of c programming and algorithm **Course Outcome:**

		1. Familiarization with programming background 2. Knowledge of c programming
CH02PES04	**WORKSHOP & MANUFACTURING PRACTICES**	**Course Objective:** To understand the basic knowledge of the hand tools and general purpose machine tools and its safety measures in workshop **Course Outcome:** 1. Develop creativeness, approach to work and planning abilities within students. 2. Description of hand tools and machine tools 2. draw of a product/part such as carpentry job, sheet metal job, fitting job, assembly of system and pipe fitting apply the various hand tools and general purpose machine tool to make or assemble the product/part. Select and use various measuring and gauging instrument which are required for different types of jobs.

Course Code	Course Name	Course objective and Course outcomes
CH03TBS05	**Biology**	**Course Objective:** Students will be introduced to the basics of biology such as cell structure and functions, inheritance & evolution, basic concepts of genetics, and an introduction to microbiology. **Course Outcome:** Students will get insight into biology as a science, outlining the diversity, organization and fundamental principles of living systems.
CH03TBS06	**Mathematics-III**	**Course Objective:** Basic concepts of statistics, curve fittings, correlation coefficient, probability, distribution and sampling methods. **Course Outcome:** Students should be able to solve statistics Problems, problem based on correlation, regression and curve fittings, pobability problems, problems relating to mean, standard deviation.
CH03TES04	**Engineering and Solid Mechanics**	**Course Objective:** Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems, axioms, and dynamics of rigid bodies. Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

		Course Outcome: Students will be able to understand the use of basic concepts of resolution and composition of forces analyse beams, truss or any engineering component by applying conditions of equilibrium, list advantages and disadvantages of various geometric sections used in engineering design. Understand the different stresses and strains occurring in components of structure and calculate the deformations such as axial, normal deflections under different loading conditions.
CH03TPC01	**Material and Energy Balance Calculations**	**Course Objective:** The course will serve as a basis for all further chemical engineering courses that are part of the curriculum. **Course Outcome:** Students completing the course will develop mastery over process calculations relevant to chemical engineering processes, be able to handle elementary flow-sheeting, material and energy balance calculations, be able to solve problems based on without and with chemical reactions, and involving concepts like recycle, bypass and purge, be familiar with equations of state and properties of gases and liquids, including phase transition.
CH03TPC02	**Fluid Mechanics**	**Course Objective:** The objective of this course is to introduce the mechanics of fluids (fluid statics and fluiddynamics), relevant to Chemical Engineering operations. The course will introduce students to forces on fluids, hydrostatic forces on submerged bodies, Eulerian and Lagrangian descriptions of flow, flow visualization, integral analysis involving mass and momentum balances, Bernoulli

		equation, flow through pipes and ducts, flow measurement and instruments, flow transportation - pumps, blowers and compressors, conservation of mass, linear and angular momentum in differential form, Navier-Stokes equation, viscous flows, skin and form friction, potential flows and boundary layer theory. Turbulence and turbulent flows will be introduced. **Course Outcome:** Students should be able to calculate velocity profiles by simplification of equations of motion in simple 1-D flows boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes, two phase gas/liquid pressure drop, power requirements and NPSH requirements of pumps.
CH03TPC03	**Thermodynamics –II**	**Course Objective:** To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium. **Course Outcome:** Students should be able to understand various law of Thermodynamics, Vapor- Liquid equilibria, Liquid-Liquid equilibria and Chemical reaction equilibria.
CH04THS02	**Business Communication and Presentation Skill**	**Course Objective:** To develop the communication skills like writing technical letters, reports and presentation skills. **Course Outcome:** Students should be able to communicate properly, write technical letters and reports and present reports and seminars in an attractive way.

CH04TPC04	**Numerical Methods in Chemical Engineering**	**Course Objective:** To introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming. Fundamentals of numerical methods/algorithms to solve systems of different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations), will be introduced. The course would enable students to write their own computer programs using programming languages like C and commercial software like Matlab. Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc. Practicals to involved solving actual chemical engineering problems through computer programming and coding. **Course Outcome:** Students will be able to solve chemical engineering problems involving Linear and non-linear equations and solve ordinary and partial differential equations using programming languages like C and softwares like MATLAB.
CH04TPC05	**Inorganic Chemical Technology**	**Course Objective:** The course will serve as a basis for all Chemical Engineering students to understand the various processes involved in the manufacturing of chemical products and engineering problems associated with it. **Course Outcome:** Students will be able to describe sources and processes of manufacture of various industrially important chemicals

		draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals. Explain and calculate economic aspects of Projects involved in manufacturing of chemicals
CH04TPC06	**Particle and Fluid Particle-Processing**	**Course objective:** Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed. **Course Outcome:** Students will be able to calculate drag force and terminal settling velocity for single particles. Calculate pressure drop in fixed and fluidized beds know the significance and usage of different particulate characterization parameters, and equipment to estimate them describe size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment. Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.

CH04TPC07	**Process Instrumentation**	**Course Objective:** Objective of the course is to introduce the basics of instrumentation and process control through a hands-on practical experience. Principles of operation of different measuring devices for temperature, level, pressure, flow, pH, humidity, density, and viscosity will be introduced to impart knowledge of transmitters, transducers, converters, control valves, digital and analog components related to PLC, DCS, SCADA systems. **Course Outcome:** Students will be well-familiar with instrumentation and automation as relevant to modern chemical plant operation.

Course Code	**Course name**	**Course objective and Course outcomes**
CH5TPC06	Heat Transfer	**Course Objective:** 1.To provide a fundamental understanding of heat transfer in the mode of conduction, convection and radiation 2. To understand the fundamental laws and their correlation 3. To understand basic knowledge of various heat transfer equipments. **Course Outcome:** students would be able to 1. Identify the basic principle of heat transfer 2. Solve problems related to conduction, convection, radiation and analyze heat exchangers 3. Explain the concepts of evaporation and condensation
CH5TPC07	Mass Transfer - I	**Course Objective:**

		1. To provide the understanding of mass transfer operations and equipment. 2. To impart the understanding of separation processes such as diffusion, distillation and absorption. **Course Outcome:** students will be able to: 1. Identify the concepts of phase equilibrium in mass transfer related problems 2. Solve problems related to distillation, diffusion and absorption and mass transfer equipment. 3. Design plate /packed column for mass transfer operations.
CH5TPC08	Chemical Reaction Engineering-I	**Course Objective:** To impart the knowledge of the kinetics and thermodynamics of single and multiple reaction and the effect of temperature and pressure on reaction systems. **Course Outcome:** students will be able to: 1. Develop rate of reaction for homogeneous reactions. 2. Interpret batch reactor data and design ideal reactors for single and multiple reactions. 4. Describe different aspects of design for multiple reactions 5. Explain the effect of temperature and pressure on reaction rate
CH5TPE11	Engineering Materials	**Course Objective:** To provide the understanding of selection of Material of construction for a given application, maintenance and properties for various engineering materials **Course Outcome:** Students will be able to:

		1. Explain Crystalline, Non –Crystalline and non-ferrous material 2. Describe mechanical properties and causes of mechanical failure 3. Explain types of corrosion and describe method to control them 4. Describe simple Phase Diagram
CH5TPE12	Fundamentals of Biochemical Engineering	**Course Objective:** 1.To impart the knowledge of the Biological sciences, Biotechnology and Bio Chemical Engineering and a requisite for Biobased Industry 2. To relate the principles of chemical engineering in biological systems. **Course Outcome:** students will be able to: 1.Calculate microbial and enzymatic kinetics 2. Describe cell cultivation and Sterilization Methods 3. Explain concepts and correlation of mass transfer in bioprocess.
CH5TPE13	Food Engineering	**Course Objective:** To impart knowledge of the food process engineering, preservation, packaging and separation processes in food processing. **Course Outcome:** Students will be able to: 1. Identify the unit operations in food processing 2. Evaluate various separation process involved in processing of food. 3. evaluate effect of packaging and storage on food quality
CH5TPE14	Polymer Technology	**Course Objective:**

		To develop the abilities required for production, processing, properties testing and Environmental effects of polymers and its manufacturing Industries. **Course outcome:** students would be able to 1. Describe types of polymerization and synthesis 2. Explain kinetics and thermodynamics of polymerization 3. Apply mechanisms of polymer degradation and environmental effect
CH5TOE11	Fluidization Engineering	**Course Objective:** To impart the fundamental knowledge of Fluidization and understand the different aspects of fluidized bed systems **Course outcome:** students would be able to 1. Describe fluidization and industrial applications 2. Evaluate pressure drop, bubble size, heat and mass transfer rates for the fluidized beds 3. Apply model equations for fluidized beds
CH5TOE12	Financial Management	**Course Objective:** To provide essential knowledge of organisation of finance, various model of pricing and risk evaluation. **Course outcome:** Students would be able to explain the fundamental concepts of Financial management and study practical situations
CH5TOE13	Managerial Economics	**Course Objective:** To impart knowledge of the economics principles involved in chemical plants **Course Outcome:** Students would be able

		1. Develop knowledge on Managerial Economics and Cost Analysis 2. Integrate knowledge about Market & Pricing Policies 3. Analysis the financial through ratios
CH5TOE14	Financial Accounting and Costing	**Course Objective:** To provide essential information for effective working of students in their professional career **Course Outcome:** Students would be able to analyse costing systems, budgeting systems, cost management systems and performance measurement systems
CH6TPC09	Mass Transfer – II	**Course Objective:** 1. To provide basic knowledge of fundamental mass transfer operations and mechanisms 2. To understand the mass transfer in LLE, leaching, drying and humidification operation. **Course Outcome:** Students would be able to 1. explain the basics of Mass Transfer and related laws 2. Identification of mechanisms of mass transfer, Formulation of rate equations 3. solve problems related to drying, leaching and crystallization
CH6TPC10	Process Dynamics and Control	**Course Objective:** 1. To provide fundamental knowledge on process control strategies. 2. To impart knowledge on theoretical analysis of open loop and closed loop systems **Course Outcome:** Student would be able to

		1. Evaluate dynamic behaviour of first and second order system 2. Determine the process stability in Laplace domain 3. Analyze open-loop systems and linear closed loop systems 4. Develop working knowledge of control system by frequency response
CH6TPC11	Organic Chemical Technology	**Course Objective:** To study process technologies of various organic process industries such as oil, soap, polymer and cellulose . **Course Outcome:** Students will be able to: 1. Describe the processes involved in manufacturing of various organic chemicals. 2. Make the process flow diagrams. 3. analyze important process parameters such as raw materials, MOC etc. and major engineering problems during production.
CH6TPE21	Process Equipment Design–I	Course Objective: 1. To understand the chemical engineering principles applicable to mechanical process design for various process equipment and standard codes for design of chemical plant equipment **Course Outcome:** Student will be able to: 1. Design pressure and storage vessels and their supports 2. Evaluate the parameters of equipment design and important steps involved in design.
CH6TPE22	Fertilizer Technology	**Course Objective:** To impart the understanding of essential knowledge of fertilizer industry which include

		production process, reaction and separation steps in a flow diagram for variety of fertilizers. **Course Outcome:** Student would be able to 1. Explain reactions and unit operations steps in manufacturing of various fertilizers 2. Explain characterization process and engineering problems in fertilizer manufacturing
CH6TPE31	Fuel Combustion Energy Technology	**Course Objective:** To understand different types of conventional and non-conventional energy resources including solid, liquid and gaseous fuels. **Course outcome:** Students would be able to 1. Analyze solid, liquid, gaseous fuels and characterize fuels 3. Describe about alternate energy sources 4. Explain available nonconventional (renewable) energy resources and techniques to utilize them effectively
CH6TPE32	Environmental Engineering	**Course Objective:** To understand the significant issues of environmental pollution and their control principles **Course Outcome: Students will be able to:** 1. Explain environmental pollution and its effect 2. describe methods of controlling of Water Pollution and Air Pollution 3. Analyze the characteristics of hazardous industrial waste and its handling and management

		4. explain case studies of air and water pollution control in chemical industries.
CH6TOE21	Process Utilities and Safety	**Course Objective:** To understand the basic knowledge about various process utilities applied in the chemical process industry and problems related to hazards & safety **Course Outcome:** Students will be able to: 1. Evaluate the requirements of process utilities in process industries. 2. calculate the steam requirement and its applications as utility. 3. Explain fire and explosion and its prevention methods

Course Code	**Course name**	**Course objective and Course outcomes**
CH7TPC13	Process equipment design-II	**Course Objective:** This course enables students to integrate all the subjects they have learned and design plant / processes from chemical engineering principles. Graduates may be able to understand chemical engineering principles applicable to designing chemical engineering equipment. 2. Implement standard codes for the design of chemical plant equipment. 3. Analyze specifications of process equipment. 4. Design process equipment and accessories thereof. **Course Outcome:** Students should be able to design, calculate required size / power / internals etc. for all process equipment in PFD

		along with necessary instrumentation, safety aspects. Students should be able to calculate the cost of equipment. Students should be able to demonstrate the technical economic feasibility of the selected process.
CH7TOC14	CRE II	**Course Objective:** This course enables students to 1. Understand the fundamental principles and experimental techniques of heterogeneous reaction systems. Apply the principles of transfer operation in kinetics studies of heterogeneous reaction systems. Controlling phase control in heterogeneous reaction systems. Evaluate physical and surface-affected catalytic activity and selectivity. Properties of catalysts. **Course Outcome:** At the end of the course, students will be able to: 1. explain the concepts of reactor design and reaction kinetics. 2. Explain reactor data. Identify ideal reactors and explain various aspects of design for single reactions. 4. Explain various aspects of design. Many responses. 5. Analyze the effects of temperature and pressure on conversion.
CH7TPC15	New Separation Process	**Course Objective:** This is a course that continues with further chemical engineering operations. This foundation forms chemical engineering theory and is therefore required in almost all courses and professional careers of a chemical engineer. **Course Outcome:** Explain membrane processes in terms of membrane, feed, sweep, recent, permeate, and solute membrane interactions. Difference between microfiltration, ultrafiltration, nanofiltration, virus filtration, sterile filtration, filter-assisted filtration and reverse osmosis in terms of

		average pore size. Explain common idealized flow patterns in membrane modules.
CH7TPE41	Petroleum Refinery Engineering	**Course Objective:** To impart knowledge of petroleum refining, hydrocarbon processing and derived petrochemicals. **Course Outcome:** At the end of the course, students will be able to explain 1. Petroleum refining and thermal cracking processes. 2. Expansion Catalytic Cracking and Catalytic Reforming Process. 3. Produce fuels such as aviation gasoline, motor fuel, kerosene, jet fuel. 4. Construction of lubricating oil. 5. Storage and transportation of petroleum products.
CH7TPE42	Polymer Technology-I	**Course Objective:** 1. Deals with raw material identification and characterization to ensure polymer product quality with various processing techniques. 2. To develop the skills required to work in the production, processing, testing, marketing and sales departments of the plastics, rubbers and fiber manufacturing industry. **Course Outcome:** Select appropriate techniques of polymerization. 2. Produce plastic using appropriate reactions and unit operation steps. 3. Produce rubbers using appropriate reactions and unit operation steps. 4. Produce fiber using appropriate reactions and unit operation steps. 5. Apply various polymer processing techniques.
CH7TPE43	Design and development of catalyst	**Course Objectives:** To gain knowledge of catalytic characteristics, mechanism of catalytic reactions, and design of catalytic reactors. **Course Outcome:** The differences between chemisorption and physical adsorption, the list

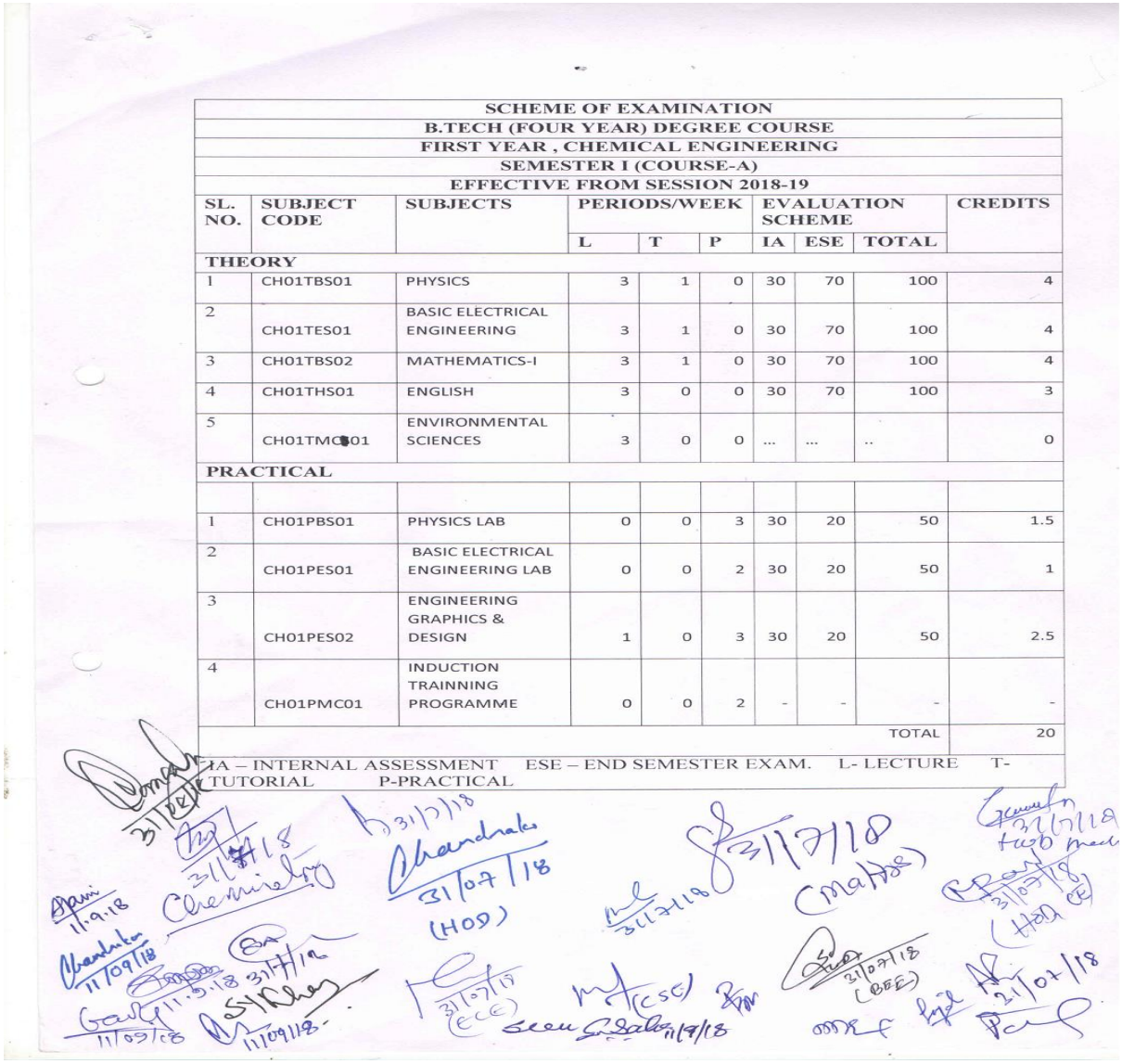
		steps involved in the adsorption of a solute, and which phases can control the rate of adsorption explain the concept of success in fixed-bed adsorption. Upon completion of this course, students will be able to: 1. Develop different catalytic reaction mechanisms. 2. Separating a catalyst. 3. Assess the effects of external heat and mass transfer in heterogeneous catalysts. 4. Calculate the effectiveness of a porous catalyst. 5. Design different types of reactors for catalytic reactions.
CH7TOE31	Transport Phenomena	**Course Objectives:** To provide knowledge about model development, with appropriate boundary conditions, as well as individual and simultaneous motion, heat and mass transfer. **Course Outcomes:** Upon completion of this course, students will do the following: 1. Analyze heat, mass, and momentum transport in a process. 2. Formulation of problems with appropriate boundary conditions. 3. To develop stable and transient solutions to problems associated with heat, mass, and momentum transport.
CH7TOE32	Water conservation and management	**Course Objectives:** Applying water management principles related to process plants. **Course Outcomes:** On completion of this course, students will do the following: 1. Evaluate the performance of industrial boilers and furnaces. 2. Identify the scope for recycle and reuse of water. 3. Choose ways to reduce waste and conserve water.

Course Code	Course Name	Course Objective and Course outcomes
CH8TPC16	Process equipment design-III	**Course Objective:** Chemical engineers should have knowledge about design of mass transfer equipment like absorption, distillation column, dryer etc. It will also be useful to use design software that is widely used in chemical industries. **Course Outcome:** 1. Students will be able to design mass transfer equipment for the chemical process. 2 Students will be able to prepare drawings for chemical process equipment.
CH8TPC17	Project Engineering, Economics and management	**Course Objective:** This course is required for the future professional career. **Course Outcome:** 1. Reducing the need for working capital for a given project. 2. Calculation of the cost of equipment used in the total project cost of the plant. 3. Calculate the cash flow from a given project. 4. Select a site for the project from the given options. 5. List various milestones related to the concept of the project to be commissioned.
CH8TPE51	Petrochemical Technology	**Course Objectives:** To impart knowledge of petroleum refining, hydrocarbon processing, and derived petrochemicals. **Course Outcome**: Upon completion of this course, students will be able to: 1. Select the appropriate characterization criteria. 2. Specify the properties of petroleum products. 3. To gain knowledge of various separation and conversion processes involved in petroleum refining. 4. Maintaining knowledge of

		manufacturing of various petrochemical products.
CH8TPE52	Polymer Technology-II	**Course Objective:** 1. Deals with raw material identification and characterization to ensure polymer product quality with various processing techniques. 2. To develop the skills required to work in the production, processing, testing, marketing and sales departments of the plastics, rubbers and fiber manufacturing industry. **Course Outcome:** 1. Select the appropriate techniques of polymerization. 2. Produce plastic using appropriate reactions and unit operation steps. 3. Produce rubbers using appropriate reactions and unit operation steps. 4. Produce fiber using appropriate reactions and unit operation steps. 5. Apply various polymer processing techniques.
CH8TPE53	Membrane Separation Technology	**Course Objective:** Graduates will be able to 1. Understand the need for novel separation techniques 2. Apply various novel separation techniques in process industries 3. Analyze the performance of different separation techniques 4. Select the appropriate separation techniques for specific applications. **Course Outcome:** After going through this course, students will be able to understand the basic principles of 1. Separation procedures. 2. Apply chemical engineering principles to explain the separation mechanism. 3. Analyze different separation techniques based on separation factors. 4. Select the appropriate separation process for a specific application.

CH8TOE41	Optimization Techniques	**Course Objectives:** To study and apply optimization techniques in the chemical process industry. **Course Outcome:** Upon completion of this course, students will be able to: 1. Formulate objective tasks for constrained and unrelated optimization problems. 2. Use different optimization strategies. 3. Solve problems using non-traditional optimization techniques. 4. Application of various optimization techniques for problem solving.
CH8TOE42	Modeling and simulation	**Course Objectives:** Graduates will be able to 1. Understand chemical engineering systems over the period of modeling theory 2. Specific simulations from the design of devices 3. Apply software chemical tools such as UNISIM to model chemical processes. 4. Develop algorithms for modeling and solve models. **Course Outcomes:** At the end of the course, students will be able to expand the importance of ODE and PDE. 2. Develop a model equation for a given system. 3. Solve structural, thermal, fluid flow problems. 4. Demonstrated ability to resolve models for various processes / unit operations. 5. Demonstrate the ability to use a process simulation.
CH8TOE43	Renewable energy	**Course Objectives:** Graduates may be able to understand the fundamentals and characteristics of renewable energy sources. 2. Apply chemical engineering principles to use renewable energy sources. Use various renewable energy conversion systems for energy efficiency. 4.

		Evaluate the performance of the energy conversion system **Course Outcomes:** After going through this course, students will be able to understand the importance of 1. Renewable energy sources. 2. Principles of existing and emerging technologies exploit renewable energy. 3. Analyze the performance of renewable energy systems. 4. Develop electricity generation plans using renewable energy systems.



SCHEME OF EXAMINATION
B.TECH (FOUR YEAR) DEGREE COURSE
FIRST YEAR , CHEMICAL ENGINEERING
SEMESTER I (COURSE-A)
EFFECTIVE FROM SESSION 2018-19

SL. NO.	SUBJECT CODE	SUBJECTS	PERIODS/WEEK			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
THEORY									
1	CH01TBS01	PHYSICS	3	1	0	30	70	100	4
2	CH01TES01	BASIC ELECTRICAL ENGINEERING	3	1	0	30	70	100	4
3	CH01TBS02	MATHEMATICS-I	3	1	0	30	70	100	4
4	CH01THS01	ENGLISH	3	0	0	30	70	100	3
5	CH01TMC01	ENVIRONMENTAL SCIENCES	3	0	0	...	...	..	0
PRACTICAL									
1	CH01PBS01	PHYSICS LAB	0	0	3	30	20	50	1.5
2	CH01PES01	BASIC ELECTRICAL ENGINEERING LAB	0	0	2	30	20	50	1
3	CH01PES02	ENGINEERING GRAPHICS & DESIGN	1	0	3	30	20	50	2.5
4	CH01PMC01	INDUCTION TRAINNING PROGRAMME	0	0	2	-	-	-	-
								TOTAL	20

IA – INTERNAL ASSESSMENT ESE – END SEMESTER EXAM. L- LECTURE T- TUTORIAL P-PRACTICAL

SCHEME OF EXAMINATION

B.TECH (FOUR YEAR) DEGREE COURSE

FIRST YEAR , CHEMICAL ENGINEERING

SEMESTER II (COURSE-B)

EFFECTIVE FROM SESSION 2018-19

SL. NO.	SUBJECT CODE	SUBJECTS	PERIODS/WEEK			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
THEORY									
1	CH02TBS03	MATHEMATICS-II	3	1	0	30	70	100	4
2	CH02TBS04	CHEMISTRY	3	1	0	30	70	100	4
3	CH02TES02	PROGRAMMING FOR PROBLEM SOLVING	3	0	0	30	70	100	3
4	CH02TES03	THERMODYNAMICS	3	1	0	30	70	100	4
PRACTICAL									
1	CH02PBS02	CHEMISTRY LAB	0	0	3	30	20	50	1.5
2	CH02PES03	PROGRAMMING FOR PROBLEM SOLVING LAB	0	0	3	30	20	50	1.5
3	CH02PES04	WORKSHOP & MANUFACTURING PRACTICES	1	0	3	30	20	50	2.5
								TOTAL	20.5

IA – INTERNAL ASSESSMENT ESE – END SEMESTER EXAM. L- LECTURE
T-TUTORIAL P-PRACTICAL

SCHOOL OF STUDIES, ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from session 2019-20)
B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, THIRD SEMESTER

S.No.	Course No.	Subject	Periods			Evaluation Scheme			Credits
						Sessional Exam			
	THEORY		L	T	P	IA	ESE	Total	
01	CH03TBS05	Biology	3	1	0	30	70	100	4
02	CH03TBS06	Mathematics -III	3	1	0	30	70	100	4
03	CH03TES04	Engineering and Solid Mechanics	3	1	0	30	70	100	4
04	CH03TPC01	Material and Energy Balance Calculations	3	1	0	30	70	100	4
05	CH03TPC02	Fluid Mechanics	3	1	0	30	70	100	4
06	CH03TPC03	Thermodynamics –II	3	1	0	30	70	100	4
Practical									
01	CH03PPC01	Chemical Engineering Lab-I	0	0	3	30	20	50	1.5
02	CH03PPC02	Fluid Mechanics Lab	0	0	3	30	20	50	1.5
Total			18	6	6			700	27

IA – Internal Assessment **ESE- End Semester Examination** **Total Marks - 700**
Total Periods - 30 **Total Credits – 27**

BOS held on 13th May 2019

SCHOOL OF STUDIES, ENGINEERING & TECHNOLOGY
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B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, FOURTH SEMESTER

S.No.	Course No.	Subject	Periods			Evaluation Scheme			Credits
						Sessional Exam			
	THEORY		L	T	P	IA	ESE	Total	
01	CH04THS02	Business Communication and Presentation Skill	3	0	0	30	70	100	3
02	CH04TPC04	Numerical Methods in Chemical Engineering	3	1	0	30	70	100	4
03	CH04TPC05	Inorganic Chemical Technology	3	0	0	30	70	100	3
04	CH04TPC06	Particle and Fluid Particle-Processing	3	0	0	30	70	100	3
05	CH04TPC07	Process Instrumentation	3	0	0	30	70	100	3
Practical									
01	CH04PPC03	Numerical Methods in Chemical Engineering Lab	0	0	3	30	20	50	1.5
02	CH04PPC04	Particle and Fluid Particle-Processing Lab	0	0	3	30	20	50	1.5
03	CH04PPC05	Process Instrumentation Lab	0	0	3	30	20	50	1.5
Total			15	1	9			650	20.5

IA – Internal Assessment **ESE- End Semester Examination** **Total Marks - 650**
Total Periods - 25 **Total Credits – 20.5**
BOS held on 13th May 2019

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

THIRD YEAR, FIFTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
						Sessional			ESE	Sub Total	
	THEORY		L	T	P	IA	MSE	Total			
01.	CH5TPC06	Heat Transfer	3	1	0	20	20	40	60	100	4
02.	CH5TPC07	Mass Transfer-I	3	1	-	20	20	40	60	100	4
03.	CH5TPC08	Chemical Reaction Engineering-I	3	1	-	20	20	40	60	100	4
04.	CH5TPE1X		3	1	-	20	20	40	60	100	4
05.	CH5TOE1X		3	0	-	20	20	40	60	100	3
	PRACTICAL										
01.	CH5PPC03	Heat Transfer Lab	-	-	3	30	-	30	20	50	2
02.	CH5PPC04	Mass Transfer-I Lab	-	-	3	30	-	30	20	50	2
03.	CH5PPC05	Chemical Reaction Engineering Lab	-	-	3	30	-	30	20	50	2
TOTAL			15	4	9					650	25

IA – Internal Assessment **MSE – Mid Semester Examination** **ESE - End Semester Examination**

Total Marks – 650 **Total Periods - 28** **Total Credits - 25**

BOS held on 24th May 2017

DEPARTMENT OF CHEMICAL ENGINEERING
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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

THIRD YEAR, SIXTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
						Sessional			ESE	Sub Total	
	THEORY		L	T	P	IA	MSE	Total			
01.	CH6TPC09	Mass Transfer-II	3	1	-	20	20	40	60	100	4
02.	CH6TPC10	Process Dynamics and Control	3	1	-	20	20	40	60	100	4
03.	CH6TPC11	Organic Chemical Technology	3	-	-	20	20	40	60	100	3
04.	CH6TPE2X		3	1	-	20	20	40	60	100	4
05.	CH6TPE3X		3	1	-	20	20	40	60	100	4
06.	CH6TOE2X		3	0	-	20	20	40	60	100	3
	PRACTICAL										
01.	CH6PPC06		-	-	3	30	-	30	20	50	2
02.	CH6PPC07		-	-	3	30	-	30	20	50	2
TOTAL			18	4	6					700	26

IA – Internal Assessment **MSE – Mid Semester Examination** **ESE - End Semester Examination**
Total Marks – 700 **Total Periods - 28** **Total Credits – 26**

BOS held on 24th May 2017

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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LIST OF PROFESSIONAL ELECTIVES OFFERD BY THE DEPARTMENT OF CHEMICAL FOR V and VI SEMESTER

Semester	Subject Code (PE)	Subject
V	CH5TPE11	Engineering Material
	CH5TPE12	Fundamentals of Biochemical Engineering
	CH5TPE13	Food Engineering
	CH5TPE14	Polymer Technology
VI	CH6TPE21	Process Equipment Design-I
	CH6TPE22	Fertilizer Technology
	CH6TPE31	Fuel Combustion Energy Technology
	CH6TPE32	Environmental Engineering

PE - Professional Elective

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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LIST OF OPEN ELECTIVES OFFERD FOR V and VI SEMESTER

Semester	Subject Code (OE)	Subject
V	CH5TOE11	Fluidization Engineering
	CH5TOE12	Financial Management
	CH5TOE13	Managerial Economics
	CH5TOE14	Financial Accounting and Costing
VI	CH6TOE21	Process Utility and Safety
	CH6TOE22	Enterprise Resource Planning
	CH6TOE23	Management Information System
	CH6TOE24	Six Sigma and DOE

OE- Open Elective

Note: In addition to the open elective courses, as prescribed above, the students are free to opt for any other subject of same credit from inter/intra school duly approved by the Board of Studies of the respective departments.

BOS held on 24th May 2017

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FOURTH YEAR, SEVENTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
	THEORY		L	T	P	Sessional IA	Sessional MSE	Sessional Total	ESE	Sub Total	
01.	CH7TPC13	Process Equipment Design- II	3	1	-	20	20	40	60	100	4
02.	CH7TPC14	Chemical Reaction Engineering-II	3	1	-	20	20	40	60	100	4
03.	CH7TPC15	New Separation Processes	3	1	-	20	20	40	60	100	4
04.	CH7TPE4X		3	1	-	20	20	40	60	100	4
05.	CH7TOE3X		3	1	-	20	20	40	60	100	4
	PRACTICAL										
01.	CH7PPC08	Minor Project	-	-	6	30	-	30	20	50	3
02.	CH7PPC09	Vocational Training Viva Cum Seminar	-	-	3	50	-	50	-	50	2
		TOTAL	15	5	9					600	25

IA – Internal Assessment
MSE – Mid Semester Examination
ESE - End Semester Examination
Total Marks – 600
Total Periods - 29
Total Credits - 25

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)
SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FOURTH YEAR, EIGHTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
	THEORY		L	T	P	Sessional IA	Sessional MSE	Sessional Total	ESE	Sub Total	
01.	CH8TPC16	Process Equipment Design- III	3	1	-	20	20	40	60	100	4
02.	CH8TPC17	Project Engineering, Economics & Management	3	1	-	20	20	40	60	100	4
04.	CH8TPE5X		3	1	-	20	20	40	60	100	4
06.	CH8TOE4X		3	1	-	20	20	40	60	100	4
	PRACTICAL										
01.	CH8PPC10	Project	-	-	8	60	-	60	40	100	4
		TOTAL	12	4	8					500	20

IA – Internal Assessment
MSE – Mid Semester Examination
ESE - End Semester Examination
Total Marks – 500
Total Periods - 24
Total Credits – 20

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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LIST OF PROFESSIONAL ELECTIVES OFFERD BY DEPARTMENT OF CHEMICAL ENGINEERING FOR VII and VIII SEMESTER

Semester	Subject Code (PE)	Subject
VII	CH7TPE41	Petroleum Refinery Engineering
	CH7TPE42	Polymer Technology - I
	CH7TPE43	Design and Development of Catalyst
VIII	CH8TPE51	Petrochemical Technology
	CH8TPE52	Polymer Technology - II
	CH8TPE53	Membrane Separation Processes

PE - Professional Elective

15/05/18 15/05/18 15/05/18 15/05/18 15.5.18 15/5/18 15/5/18

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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LIST OF OPEN ELECTIVES OFFERD FOR VII and VIII SEMESTER

Semester	Subject Code (OE)	Subject
VII	CH7TOE31	Transport Phenomena
	CH7TOE32	Water Conservation and Management
VIII	CH8TOE41	Optimization Techniques
	CH8TOE42	Process Modeling & Simulation
	CH8TOE43	Renewable Energy

OE- Open Elective

Note: In addition to the open elective courses, as prescribed above, the students are free to opt for any other subject of same credit from inter/intra school duly approved by the Board of Studies of the respective departments.

15/05/18 15/05/18 15/05/18 15/05/18 15.5.18 15/5/18 15/5/18

BOS held on 15th May 2018

SUBJECT CODE/SUBJECT	L	T	P	Credit
CH01TBS01/PHYSICS	3	1	0	4

Unit - 1: Optics: Interference and Diffraction

Introduction, Young's experiment, theory of interference, Coherent and non-coherent sources, Fresnel's Bi-prism and Newton's ring experiment.

Diffraction of light, Fresnel and Fraunhofer's diffraction, diffraction due to plane diffraction grating.

Unit - 2: Electromagnetic Theory

Coulomb's law, electrostatics field and potential, electric flux, Gauss' law, Poisson's and Laplace's equation, Equation of continuity for charge conservation, Ampere's and Faraday's laws, Maxwell's Electromagnetic equations.

Unit - 3: Laser and Fiber optics

Introduction, elementary idea of spontaneous and stimulated emission, active medium, population inversion, Einstein's coefficients, Types of lasers and important applications of lasers.

Introduction to optical fibers, basic principles of optical fiber, critical angle, numerical aperture, maximum acceptance angle, classification of optical fiber.

Unit -4: Semiconductor Physics and Devices

Formation of energy in solids, Energy band gap of metals, insulators and semiconductors, classification of semiconductor: Intrinsic and Extrinsic semiconductors, Fermi levels in intrinsic and extrinsic semiconductors, Electrical conductivity in conductors and semiconductors, working of P-N Junction diodes and Bipolar Junction transistor.

Unit - 5: Introduction to Quantum Mechanics

Introduction to QuantumMechanics, Photoelectric effect, Compton effect, wave-particle duality, uncertainty principle, wave function, De-Broglie waves, Phase and Group velocity, Davisson and Germer experiment, Schrodinger wave equation, particle in a box (1-Dimentional).

Text Books and References

1) Applied Physics – I and II by Navneet Gupta, Dhanpat Rai & Co.
2) Engg. Physics by S. K. Srivastava and R. A. Yadav, New Age Pub. New Delhi
3) Engg. Physics by Uma Mukherjee, Narosa Publication
4) Engg. Physics by M. N. Avadhanulu, S. Chand Pub.
5) Electricity and Magnetism by Rangwala and Mahajan, Tata McGraw Hill, 1998
6) Concepts of Physics Part -II by H. C. Verma, BharatiBhawan (P&D), 1998
7) Modern Physics by Beiser, McGraw Hill Inc. New York, Publication 1995
8) Modern Physics by Mani and Mehta, East-West Press Pvt. Ltd. 1998
9) Introduction to Electrodynamics, David Griffith
10) J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
11) B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2007).
12) S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
13) Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
14) P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
15) Online course: "Semiconductor Optoelectronics" by M R Shenoy on NPTEL
16) Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL

Subject code	L	T	P	Credit
CH01TES01/BASIC ELCETRICAL ENGINEERING	3	1	0	4

1. Elements in an Electrical circuit: R, L, C, Diode, voltage and current sources [3L + 1T]

2.DC circuits, KCL, KVL, Network theorems, Mesh and nodal analysis [6L + 2T]

3.Step response in RL, RC, RLC circuits [3L+1T]

4. Phasor analysis of AC circuits [6L+2T]

5. Single-phase and 3-phase circuits. (3L+1T)

6. Two port networks, BJT, CE and small signal model, operational amplifiers, model and applications. (3L+1T)

7. Introduction to digital circuits (6L+2T)

8. Transformers: modelling and analysis. (6L+2T)

9. Energy in magnet ic field. (3L+1T)

10. Electromechanical energy conversion: principles and examples (3L+1T)

11. Principles of measurement of voltage, current and power (3L+1T)

Subject code	L	T	P	Credit
CH01TBS02/ **MATHEMATICS-I**	3	1	0	4

Basic concepts of linear algebra and vector calculus.

1. Linear Algebra: Matrices, Vectors, Determinants, Linear Systems (12L + 4T)
Matrices, Vectors: Addition and Scalar Multiplication, Matrix Multiplication, Linear Systems of Equations, Gauss Elimination, Linear Independence. Rank of a Matrix. Vector Space, Solutions of Linear Systems: Existence, Uniqueness, Determinants, Cramer's Rule, Inverse of a Matrix. Gauss-Jordan Elimination.

2. Linear Algebra: Matrix Eigen value Problems (9L + 3T)
Eigen values, Eigenvectors, Applications of Eigen value Problems, Symmetric, Skew-Symmetric, and Orthogonal Matrices. Asymptotes: definition, properties and problems.

3. Vector Differential Calculus. Grad, Div, Curl (12L + 4T)
Vectors in 2-Space and 3-Space, Inner Product (Dot Product), Vector Product (Cross Product), Vector and Scalar Functions and Fields, Derivatives, Curves. Arc Length. Curvature, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

4. Integral Calculus. Integral Theorems (12L + 4T)
Line Integrals, Path Independence of Line Integrals, Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals,

Subject code	L	T	P	Credit
CH01THS01/ ENGLISH	3	0	0	3

1. Vocabulary Building

The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

2. Basic Writing Skills

Sentence Structures , Use of phrases and clauses in sentences , Importance of proper punctuation , Creating coherence , Organizing principles of paragraphs in documents , Techniques for writing precisely

3. Identifying Common Errors in Writing

3.1 Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

4. Nature and Style of sensible Writing

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion.

5. Writing Practices

Comprehension, Précis Writing, Essay Writing.

6. Oral Communication (This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Suggested Readings:

(i) Practical English Usage. Michael Swan. OUP. 1995.
(ii) Remedial English Grammar. F.T. Wood. Macmillan.2007
(iii)On Writing Well. William Zinsser. Harper Resource Book. 2001
(iv) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
(v) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
(vi) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

CODE/SUBJECT	L	T	P	CREDIT
CH01TMC01/ENVIRONMENTAL SCIENCES	3	0	0	0

ENVIRONMENTAL STUDIES

~~CR: 4~~ NC 04 Class

Introduction to environmental studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development. Ecosystems: Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries), Natural Resources Renewable and Non---renewable Resources: Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter---state). Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. Biodiversity and Conservation: Levels of biological - diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega---biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex--situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational value. Environmental Pollution: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Pollution case studies. Environmental Policies & Practices. Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human Communities and the Environment, Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements Chipko, silent valley, Bishnois of Rajasthan. Environmental ethics: role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). Field work: Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems-pond, river etc.

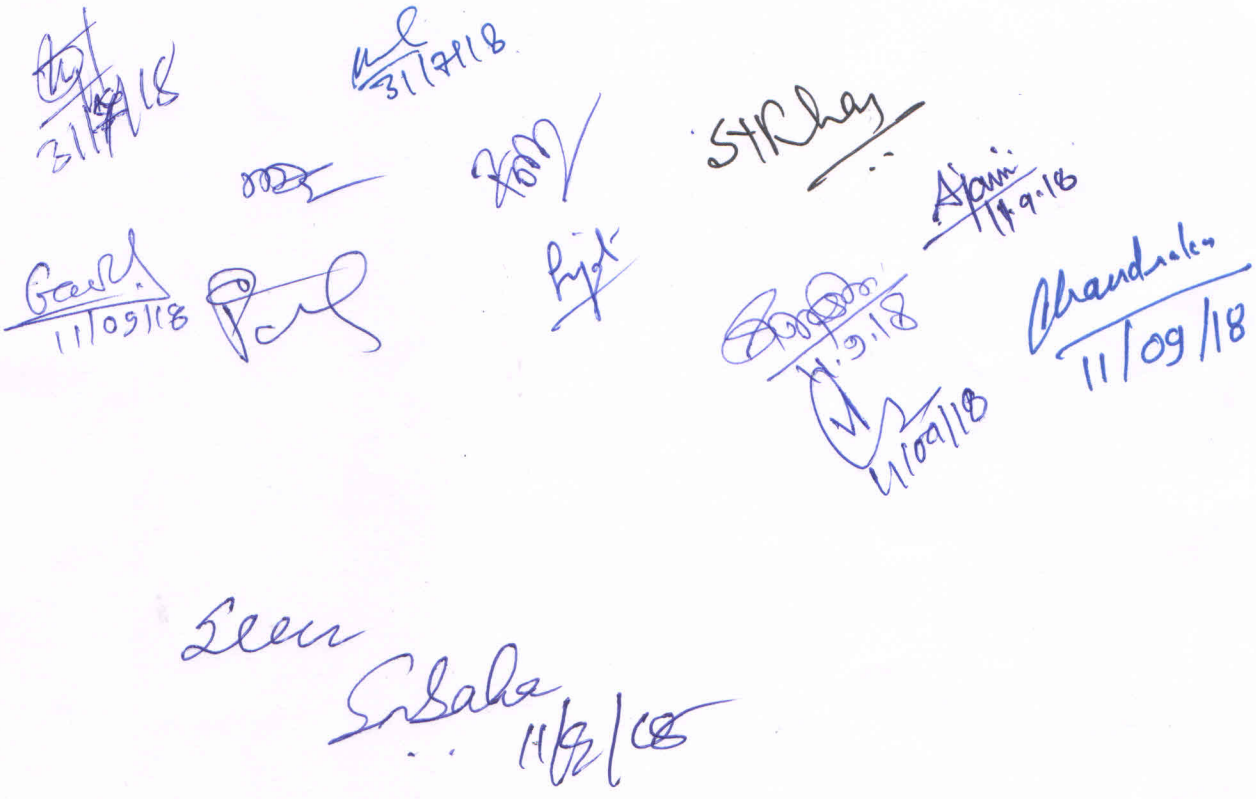
Suggested Readings:

1. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
2. Grumbine,R. Edward, and Pandit, M.K.2013. Threats from India's Himalaya dams. Science, 339: 36---37.
3. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
4. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.

SUBJECT CODE/SUBJECT	L	T	P	Credit
CH01PBS01/PHYSICS LAB	0	0	3	1.5

List of Experiments:

1. To determine the wavelength of sodium light with help of Fresnel's Bi-prism.
2. To determine the refractive index and dispersive power of the material of prism with the help of spectrometer.
3. To determine the sodium light by Newton's ring method.
4. To determine the wavelength of sodium light by plane diffraction grating using spectrometer.
5. To demonstrate the diffraction pattern and determine the wavelength of different colors of mercury (white) light using plane diffraction grating and spectrometer.
6. To determine the wavelength and number of lines per cm on a diffraction grating using semiconductor laser diode.
7. To determine the specific rotation of sugar solution with the help of polarimeter.
8. Determine the width of the single slit and diameter of circular aperture using Fraunhofer diffraction pattern produced by semiconductor laser diode.
9. To determine the Energy band gap (E_g) of a semiconductor material using P-N junction diode.
10. To determine the e/m ratio by Thomson's method
11. To study the P-N junction diode characteristics, in forwarded and reverse bias conditions.
12. To study the Zener diode characteristics.
13. To study the characteristics and gain of Transistor in C-B and C-E mode.
14. Determine the Planck's constant.



SUBJECT CODE/NAME	L	T	P	Credit
CH01PES01/ BASIC ELECTRICAL ENGINEERING LAB	0	0	2	1

List of experiments/demonstrations:

- Basic safety precautions. Introduction and use of measuring instruments–voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope).
- Sinusoidal steady state response of R-L, and R-C circuits–impedance calculation and verification. Observation of phase differences between current and voltage. Resonancein R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidalwave-shapeduetoB-Hcurvenonlinearityshouldbeshownalongwitha discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
- Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents).
- Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
- Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
- Torque Speed Characteristic of separately excited dc motor.
- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super synchronousspeed.
- Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
- Demonstration of (a) dc-dc converters (b) dc-ac converters–PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

SUBJECT CODE/SUBJECT	L	T	P	Credit
CH01PES02/ENGINEERING GRAPHICS & DESIGN LAB	1	0	3	2.5

ENGINEERING GRAPHICS & DESIGN

UNIT-I

Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments,lettering, Conic sections including the Rectangular Hyperbola (General method only);Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

UNIT-II

Orthographic Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes.

Projections of Regular Solids

Inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioningand scale.

UNIT-III

Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of RightRegular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic viewsof geometrical solids, objects from industry and dwellings (foundation to slab only)

UNIT-IV

Isometric Projections covering,

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions;Isometric Views of lines, Planes, Simple and compound Solids; Conversion of IsometricViews to Orthographic Views and Vice-versa, Conventions;

UNIT-V

Overview of Computer Graphics

listing the computer technologies that impact on graphical communication, Demonstratingknowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard,Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs,Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), TheCommand Line (where applicable), The Status Bar, Different methods of zoom as used inCAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compoundSolids].

Suggested Text/Reference Books:

(i) Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House

(ii) Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

(iii)Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication

(iv) Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

(v) (Corresponding set of) CAD Software Theory and User Manuals

SUBJECT CODE	L	T	P	Credit
CH02TBS03/ **MATHEMATICS-II**	3	1	0	4

1. **Transforms** [6L + 2T]

Laplace Transforms, Fourier Series and Transforms

2. **First-Order ODEs** [9L + 3T]

Basic Concepts,Solutions of Separable ODEs, Exact ODEs, Linear ODEs ,Solving ODEs by Laplace Transforms

3. **Second-Order Linear ODEs** [9L + 3T]

Homogeneous Linear ODEs of Second Order, Euler-Cauchy Equations, Wronskian,Nonhomogeneous ODEs, Solution by Variation of Parameters

4. **Series Solutions of ODEs, Special Functions** [12L + 4T]

Power Series Method, Legendre.'s Equation, Legendre Polynomials,Bessel's Equation, Bessel Functions, Sturm-Liouville Problems, Orthogonal Functions

5. **Part ial Different ial Equat ions** (9L + 3T)

Basic Concepts, Classification, Solution of PDEs: Separation of Variables, Fourier Series, Laplace Transforms

SUBJECT	L	T	P	Credit

SUBJECT CODE/NAME	L	T	P	Credit
CH02TBS04/CHEMISTRY	3	1	0	4

Unit-I **Concept of Quantum Energy and Spectroscopy:** Quantization of Energy, Regions of spectrum. Electronic Spectroscopy: Electronic Transition, Woodward Fiesher rules for calculating λ_{max} of conjugated dienes & α,β-unsaturated carbonyl compound, various shifts in λ_{max} and intensities. Infra Red Spectroscopy: Conditions for Infra Red Spectroscopy, Molecular vibrations & factors affecting Infra Red frequencies. **[8 L]**

Unit-II **Chemical Bonding in Molecules:** Introduction of chemical bonding, VSEPER Theory, V.B.Theory and Molecular Orbital Theory. Energy level diagrams of diatomic molecules and ions. **[16 L]**

Unit-III Concept of Chirality, Enentiomers, Diastereomers,Meso-compounds and Recimic mixtures. Conformation of Acyclic hydrocarbons (Ethane, Propane & n-Butane) and Cyclic hydrocarbon (Cyclohexane), Plane of symmetry, Center of symmetry, Absolute and Relative Configuration (R &S, D & L and E & Z). **[8 L]**

Unit-IV Reactivity of Organic Molecules, Factors influencing acidity, basicity and nucleophilicity of molecules, kinetic vs thermodynamic control of reactions. **[12 L]**

Unit-V Strategy for Synthesis of Organic Compounds: Reaction intermediates: Stability of Free Radicle, Carbocation and Carbanion. Introduction to reaction involving Addition, Elimination, Substitution and Ring opening and Cyclization. **[16 L]**

31/7/18 31/7/18 11.9.18 11.9.18 11/09/18 11/09/18 11/09/18

seen 11/9/18

Subject code/NAME	L	T	P	Credit
CH02TES02/PROGRAMMING FOR PROBLEM SOLVING	3	0	0	3

Unit 1

Introduction to Programming (3 lectures)

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) -

Idea of Algorithm (3 lectures): steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples.

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Unit 2

Arithmetic expressions and precedence (12 lectures)

Conditional Branching and Loops

Writing and evaluation of conditionals and consequent branching

Iteration and loops

Arrays (6 lectures) Arrays (1-D, 2-D), Character arrays and strings

Unit 3

Basic Algorithms (6 lectures)

Searching ,concept of binary search etc , Basic Sorting Algorithms Bubble sort etc,Finding roots of equations, introduction of Algorithm complexity

Unit *4*

Function (5 lectures)

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference binary search etc

Recursion functions (5 lectures) Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, etc.

Unit 5

Structure (4 lectures)

Structures, Defining structures and Array of Structures

Pointers (3 lectures) Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Suggested Text Books

(i) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill

(ii) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Suggested Reference Books

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

SUBJECT CODE/	SUBJECT	L	T	P	Credit
CH02TES03/	THERMODYNAMICS	3	1	0	4

Objectives:
Principles and application of first and second law of thermodynamics, and phase equilibria.

Contents :

1. Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat [3L + 1T]

2. Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P,V, T processes; Mass and energy balances for open systems . [6L + 2T]

3. Phases, phase transitions, PVT behavior; description of materials – Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior [6L + 2T]

4. Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion. [3L + 1T]

5. Statements of the second law; Heat engines, Carnot's theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. (6L + 2T)

6. Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties. (6L + 2T)

7. Application of thermodynamics to flow processes-pumps, compressors and turbines

   (3L +1T)

8. Thermodynamic analysis of steam power plants; Rankine cycle; Internal combustion engine, Otto engine; Diesel engine;Jet engine. (6L + 2T)

9. The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes. (6L + 2T)

Suggested Text Books
1.J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill International Edition,2005.
Suggested References Books
1.M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering

SUBJECT CODE/SUBJECT	L	T	P	Credit
CH02PBS02/CHEMISTRY LAB	0	0	3	1.5

List of Experiments:

Group – A:

1. Standardization of sodium thiosulphate solution by standard potassium dichromate solution.
2. To determine the Normality and Strength (g/L) of given Ferrous Ammonium Sulphate solution 'A' using standard Ferrous Ammonium Sulphate (N/30) solution 'B' taking KMnO4 solution as an intermediate.
3. To determine the concentration of hypo solution ($Na_2S_2O_3.5H_2O$) iodimetrically with given Iodine (N/50) solution.
4. Find out the Temporary hardness of given water sample using 0.01M EDTA solution, buffer solution (pH-10) and EBT as an indicator.
5. To determine chloride ion in a given water sample by Argentometric method (Mohr's method)

Group – B:

6. Preparation of Urea Formaldehyde resin.
7. Acetylation of Primary Amine: Preparation of Acetanilide.
8. Base Catalyzed Aldol Condensation: Synthesis of Dibenzalpropanone.
9. [4+2] Cycloaddition Reaction: Diels-Alder reaction.
10. Preparation of Asprin and calculate its yield.

Group – C:

11. To calculate the λ_{max} of a given compound using UV-visible spectrophotometer.
12. To separate the metallic ions by paper chromatography.
13. To determine the surface tension of a liquid by stalagmometer.
14. To determine the percentage composition of the given mixture consisting of two liquids A and B (non interacting system) by viscosity method.
15. To determine the relative viscosity of given liquids by Ostwald's viscometer.

Note: At least two Experiments from each group must be performed.

SUBJECT CODE/NAME	L	T	P	Credit
CH02PES03/PROGRAMMING FOR PROBLEM SOLVING LAB	0	0	3	1.5

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

SUBJECT CODE/NAME	L	T	P	Credit
CH02PES04/ WORKSHOP & MANUFACTURING PRACTICES	1	0	3	2.5

Lectures & videos 10 hours)

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures)
2. CNC machining, Additive manufacturing (1 lecture)
3. Fitting operations & power tools (1 lecture)
4. Electrical & Electronics (1 lecture)
5. Carpentry (1 lecture)
6. Plastic moulding, glass cutting (1 lecture)
7. Metal casting (1 lecture)
8. Welding (arc welding & gas welding), brazing (1 lecture)

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4Th edition, Pearson Education India Edition, 2002.

(iii) Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology–I" Pearson Education, 2008.

(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

CH03TBS05 Biology [L:3, T:1,P:0]

Objectives

Students will be introduced to the basics of biology such as cell structure and functions, inheritance & evolution, basic concepts of genetics, and an introduction to microbiology

Contents:

1. Basics: Diversity of life, prokaryotes and eukaryotes, basic cell constituents and macromolecules. [6L + 1T]

2. Biochemistry: Metabolism (Catabolism and Anabolism) and Bioenergetics. [12L + 3T]

3. Genetics: Basic principles of Mendel, molecular genetics, structure and function of genes and chromosomes, Transcription and Translation, gene expression and regulation. [12L + 3T]

4. Cell Biology: Macromolecules, membranes, organelles, cytoskeleton, signalling, cell division, differentiation, and motility. [12L + 3T]

5. Microbiology: host-microbe interactions, physiology, ecology, diversity, and virology. [6L + 2T]

Total 60 [L + T]

Course outcomes

Students will get insight into biology as a science, outlining the diversity, organization and fundamental principles of living systems.

Text Book

1. Gardner, Simmons & Snustad "Principles of Genetics" Student Edition, Wiley publication, 2006.
2. P.K. Gupta, "Principles of Genetics", Rastogi Publication, 2018-19.
3. Prescott's, "Microbiology" Joanne Willey Publication.
4. David L. Nelson and Michael M. Cox, "PRINCIPLES OF BIOCHEMISTRY", W.H. Freeman & Company, 2008
5. Gerald Karp, Janet Iwasa, Wallace Marshall, "Karp's Cell Biology" Global Edition, 2018

CH03TBS06 Mathematics-III [L:3, T:1,P:0]

Unit I : Introduction to statistics, mathematical statistics, variable, frequency distribution, exclusive and inclusive class intervals, type of series, graphical representation: histogram, frequency polygon, ogive measure of central tendency various types of averages, Mean median mode for grouped and ungrouped data, geometric mean, harmonic mean, measure of dispersion Skewness and Kurtosis.

Unit II : Curve fittings by method of least square- straight line parabola correlation-scatter cliagrem's Karl Pearson's coefficient of correlation. Limits for correlation coefficient, rank correction. Regression linear regression, equation to the line of regression. Regression coefficient, angle between two lines of regression.

Unit III : Theory of probability-Mathematical and statistical definition of probability sample space. Finite sample space sample point, events theorem of total probability. Sample and compound event. Conditional probability, theorem of compound probability, Baye's theorem, use of binomial theorem.

Unit IV : Theroritical distribution- Binominal distribution mean, standard deviation and Pearson's β and γ coefficient. Poisson distribution, mean, variance normal distribution.

Unit V : Random and simple sampling-mean, and standard deviation in simple sampling of attribute, test of significant for large sample test of significance based on Chi square, T, F and Z distribution degree of freedom, condition for applying.

Text Books:

1. M. Roy, "Mathematical Statistics"
2. Biswal, "Probability & Statistics", PHI.
3. A.A.AFTI, "Statistics analysis"
4. S. C. Gupta and Kapoor, "Fundamental of Mathematical Statistics"

CH03TES04 Engineering and Solid Mechanics [L:3, T:1,P:0]

Objectives:

Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems, axioms, and dynamics of rigid bodies. Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

Contents:

1. Introduction, Point Kinematics: Moving point in various coordinate systems. (Cartesian, Cylindrical, Path) [3L+1T]
2. Rigid body kinematics: Translation and rotation, relative motion, angular velocity, General motion of a rigid body, General relative motion. [6L+2T]
3. Equivalent force systems, Resultant forces, Linear and Angular Momentum, Laws of motion (Euler's Axioms), Free Body Diagrams, Dynamics of point mass models of bodies. [6L+2T]
4. Equilibrium of rigid bodies, distributed forces, Analysis of structures: Trusses, Forces in Beams: Shear Force and Bending Moment. [9L+3T]
5. Frictional forces, Laws of Coulomb friction, impending motion. [3L+1T]
6. Inertia tensor, Principal Moments of Inertia, Moment of momentum relations for rigid bodies, Euler's Equations of Motion. [6L+2T]
7. State of stress at a point, equations of motion, principal stress, maximum shear stress, Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain. [6L+2T]
8. Uniaxial stress and strain analysis of bars, thermal stresses, Torsion of circular bars and thin walled members, Bending of straight/curves beams, transverse shear stresses, deflection of beams, Buckling of columns. [6L+2T]

Total 60[L+T]

Text/Reference Books:

1. Irving H. Shames, Engineering Mechanics, 4th Edition, Prentice Hall. (2006)
2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill. (2011)
3. Andy Ruina and Rudra Pratap, Introduction to Statics and Dynamics, Oxford University Press. (2011)
4. Shanes and Rao, Engineering Mechanics, Pearson Education. (2006)
5. Bansal R.K., A Text Book of Engineering Mechanics, Laxmi Publications. (2010)
6. Khurmi R.S., Engineering Mechanics, S. Chand & Co. (2010)
7. Tayal A.K., Engineering Mechanics, Umesh Publications. (2010)

Course outcomes

Student s will be able to

- Understand the use of basic concepts of Resolution and composition of forces

- Analyse beams, truss or any engineering component by applying conditions of equilibrium
- List advantages and disadvantages of various geometric sections used in engineering design
- Understand the different stresses and strains occurring in components of structure
- Calculate the deformations such as axial, normal deflections under different loading conditions.

CH03TPC01 Material and Energy Balance Calculations [L:3, T:1,P:0]

Objectives

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Contents :

1. Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations [3L+1T]
2. Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law. [6L+2T]
3. Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use. [6L+2T]
4. Material Balances with recycle, bypass and purge. [6L+2T]
5. Material Balance: With chemical reaction, Concept of stoichiometry and mole balances, examples, including combustion. [6L+2T]
6. Material Balance: Introduction, solving material balance problems without chemical reaction. [6L+2T]
7. Energy balance: open and closed system, heat capacity, calculation of enthalpy changes. [6L+2T]
8. Energy balances with chemical reaction: Heat of reaction, Heat of combustion. [6L+2T]

Total [45L+15T]

Suggested Text Books

1. S. N. Saha, "Chemical Process Engineering Calculation", Dhanpat Rai Publication Co. (Pvt.) Ltd., New Delhi
2. Bhatt, B. I., Vora, S. M.,"Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.

Suggested References Books

1. Felder, R. M.; Rousseau, R. W.,"Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000
2. Hougen, O. A., Watson, K. M., Ragatz, R. A.,"Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors, 2004
3. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering" , Eighth Ed., Pearson India Education Services, 2015.
4. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa,"Process Calculations" , Second Edit ion, Prentice Hall of India.
5. Sikdar, D. C., "Chemical Process Calculations" , Prentice Hall of India.

CH03TPC02 Fluid Mechanics [L:3, T:1,P:0]

Objectives:

The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations. The course will introduce students to forces on fluids, hydrostatic forces on submerged bodies, Eulerian and Lagrangian descriptions of flow, flow visualization, integral analysis involving mass and momentum balances, Bernoulli equation, flow through pipes and ducts, flow measurement and instruments, flow transportation - pumps, blowers and compressors, conservation of mass, linear and angular momentum in differential form, Navier-Stokes equation, viscous flows, skin and form friction, potential flows and boundary layer theory. Turbulence and turbulent flows will be introduced.

Contents :

1. Introduction to fluids, Types of fluids, Concept of viscosity, Forces on fluids, Normal and shear stresses. [3L+1T]
2. Fluid statics –Hydrostatic equilibrium, pressure distribution, Manometry, Forces on submerged bodies, Buoyancy. [3L+1T]
3. Kinematics of fluid flow- Eulerian and Lagrangian descriptions, Flow visualization, Streamfunction, Vorticity and Circulation. [3L+1T]
4. System and control volume approaches, Integral balances – mass and momentum, Euler's equation of motion, Bernoulli equation and applications. [4L+2T]
5. Reynolds number, Laminar Flow for Newtonian and Non Newtonian fluid, Turbulent flow through pipes and close channels and its characteristic equations. [5L+1T]
6. Head loss in pipe flow, Friction losses due to sudden changes in velocity or direction of flow, expansion, contraction, Effect of fittings. [6L+2T]
7. Flow measurement, variable head meters, variable area meter, insertion meter. [3L+1T]
8. Transportation of fluids - pumps, blowers, compressors selection and design of pumps. [3L+1T]
9. Differential analysis: mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag. [6L+2T]
10. Potential flow, Potential function, Solution of Laplace equation. [3L+1T]
11. Boundary layer theory, Blasius solution, Boundary layer separation. [6L+2T]

Total [45L + 15T]

Suggested Text Books

1. M. Whit e, Fluid Mechanics, 8 th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-H il l International Edition 2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.

5. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th.,Wiley (2007).

Suggested References Books

1. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India 2010.
2. R. L. Panton, Incompressible Flow, 3rd Edition, Wiley-India 2005.
3. R. B. Bird, W. E. Stewart and E. N. Light foot, Transport Phenomena, 2nd Edition, Wiley India 2002.

Other Resources and Study Material

Students should be able to calculate

- Velocity profiles by simplification of equations of motion in simple 1-D flows
- Boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
- Two phase gas/liquid pressure drop
- Power requirements, NPSH requirements of pumps

CH03TPC03 Thermodynamics –II [L:3, T:1,P:0]

Pre-requisites: Thermodynamics-I

Objectives:
To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium. Introduction to molecular thermodynamics.

Contents

1. Review of first and second law of thermodynamics. [3L+1T]
2. Solution Thermodynamics: fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties. [12L+4T]
3. Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. [6L+2T]
4. Vapor-liquid equilibrium: phase rule, simple models for VLE;VLE by modified Raoult's law; VLE from K-value correlations; Flash calculations. [6L+2T]
5. Ideal solutions, activity and activity coefficient, Wilson, NRTL, UNIFAC and UNIQUAC models. [6L+2T)
6. Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas equilibria. [6L+2T]
7. Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single react ions, multi reaction equilibria. [6L+2T]

Total [45L+15T]

Suggested Text Books

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition,2005.
2. Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press, Hyderabad,1997.
3. K V Narayanan, "A Textbook of Chemical Engineering Thermodynamics", Prentice Hall Of India, New Delhi 2011

Suggested References Books

1. R.C. Srivastava, "Thermodynamics an core course", 3rd edition, PHI publication, India, 2007.

CH04THS02 Business Communication and Presentation Skill

[L:3, T:0,P:0]

Unit I : Business communication covering, Role of communication in information age; concept and meaning of communication; skills necessary for technical communication; Communications in a technical organization; Barriers to the process of communication.

Unit II: Style and organization in technical communication covering, Listening, speaking, reading and writing as skills; Objectivity, clarity, precision as defining features of technical communication; Various types of business writing: Letters, reports, notes, memos; Language and format of various types of business letters; Language and style of reports; Report writing strategies; Analysis of a sample report

Unit III: Communication and personality development covering, Psychological aspects of communication, cognition as a part of communication; Emotional Intelligence; Politeness and Etiquette in communication; Cultural factors that influence communication; Mannerisms to be avoided in communication; Language and persuasion; Language and conflict resolution.

Unit IV: Language Laboratory emphasizing Listening and comprehension skills; Reading Skills; Sound Structure of English and intonation patterns;

Unit V: Oral Presentation and professional speaking covering, Basics of English pronunciation; Elements of effective presentation; Body Language and use of voice during presentation; Connecting with the audience during presentation; Projecting a positive image while speaking; Planning and preparing a model presentation; Organizing the presentation to suit the audience and context; Basics of public speaking; Preparing for a speech;

Text books:

1. Fred Luthans, Organizational Behaviour,McGraw Hill
2. Lesikar and petit, Report writing for Business
3. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill
4. Wallace and masters, Personal Development for Life and Work, Thomson Learning

Reference books :

1. Farhathullah, T. M. Communication skills for Technical Students
2. Michael Muckian, John Woods, The Business letters Handbook
3. Herta A. Murphy, Effective Business Communication
4. MLA Handbook for Writers of Research Papers

CH04TPC04 Numerical Methods in Chemical Engineering

[L:3, T:1,P:0]

UNIT – I Introduction of Errors and their Analysis, types of errors, numerical problems on error analysis, curve fitting: method of least squares, fittings of straight line and parabola and by method of moments, fitting of exponential curves $y = ae^{bx}$, fitting of the curve $y = ab^x$, fitting of the curve $y = ax^b$.

UNIT – II Numerical Solution of Algebraic and Transcendental Equations: Graphical method bisection Method, Secant Method, Regula-falsi Method, Newton Raphson Method, Solution of a system of simultaneous linear algebraic Equations Direct method: Gauss elimination Method, Gauss Jordan method, Iterative methods .Jacobi Iterative Method, Gauss Seidel Iterative method.

UNIT – III The Calculus of Finite Differences: Finite differences, Difference formula, operators and relation between operators. Inverse Operator, Interpolation with equal intervals: - Newton's forward and backward interpolation formula. Interpolation with Unequal intervals: - Lagrange's interpolation Newton's difference formula, inverse interpolation.

UNIT –IV Numerical Differentiation and Integration: - Numerical Differentiation Newton's forward and Backward difference interpolation formula. Maxima and Minima of a Tabulated function, Numerical Integration :- Trapezoidol rule , simpson is (1/3)rd and (3/8)th rule, Boole's rule, weddle rule , Difference Equations -: Definition ,order and degree of a difference equation, Linear difference equations, Difference equations reducible to Linear form simultaneous difference equations with constant coefficients.

UNIT – V Numerical solution of ordinary differential equation : Taylor series method, Euler's method, Modified Euler method Runge's method Runge Kutta method, numerical method for solution of partial differential equations. General linear partial differential equation. Laplace equation and Poisson equation.

Books Recommended :

1. JAIN & IYNGAR Numerical Methods for Scientific and Engineering Computations.
2. RAO G.S. Numerical Anlysis.
3. Grewal B S Numerical Methods In Engineering and Science.
4. Das K K Advance Engineering Methods.
5. Rajaraman V Computer Oriented Numerical Methods

CH04TPC05 Inorganic Chemical technology [L:3, T:0,P:0]

Unit I : Sulfur and Sulfur Chemicals : Sulfur, Sulfuric acid, SCSA, DCDA processes, Sodium thiosulfate, Alums.
Marine Chemical Industries : Common salt, Chemicals from sea bittern.

Unit II : Industrial Gases and Selected Inorganic Chemicals : Manufacture and use of Hydrogen, Carbon dioxide, Acetylene, Oxygen, Nitrogen and inert gases, Inorganic chemicals: Barium, boron, chromium, lithium, manganese.

Unit III : Fertilizers : Status of industry, Grading and classification of fertilizers, Raw materials, Hydrogen production, Fixation of nitrogen, Synthesis, Ammonia based fertilizers, Phosphoric acid, Phosphatic and other fertilizers: SSP, TSP, UAP, DAP and nitro-phosphate, Potash fertilizers, NPK, Corrosion problems and Materials of construction, Bio-fertilizers.

Unit IV : Soda Ash : Manufacturing, Special materials of construction, Solvay and modified Solvay process, Environmental consideration, Corrosion problems and materials of construction.

Chlor Alkali Industry : Electrochemistry of brine electrolysis, Current efficiency, Energy efficiency, Diaphragm cells, Mercury cells, Mercury pollution and control, Caustic soda, Chlorine, Hydrochloric acid, Corrosion problems and materials of construction .

Unit V : Cement, Glass and Refractory: Manufacturing, Environmental consideration, Corrosion problems, Engineering problems and materials of construction.

Books Recommended:
1. R.N. Shreve & J. A. Brink, "Chemical Process Industries"
2. Chem Tech I, II, III, IV- IIT, Madras
3. Dryden Co. M. G. Rao and M. Sitting, "Outlines of Chemical Technology".

CH04TPC06 Particle and Fluid Particle-Processing [L:3, T:0,P:0]

Pre-requisites : Fluid Mechanics

Objectives

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Contents :

1. Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. [1L+0T]
2. Solid particle characterization: Particle size, shape and their distribution, Screen analysis, standard screens; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area. [3L+1T]
3. Mixing and storage of Solids: Types of important mixers like kneaders, dispersers, masticaters, roll mills, muller mixer, pug mixer, blender, screw mixer etc., mixing index; Types of storage equipments, Bin, Silo, Hoper, etc. [3L+1T]
4. Transport of fluid-solid systems: mechanical conveying, pneumatic and hydraulic conveying. [2L+1T]
5. Size reduction: Major equipment's- Crushers, grinders, ultrafine grinders, laws of communition, Close circuit and open circuit grinding. [3L+1T]
6. Mechanical separations: Industrial screen; their capacity and effectiveness. [2L+1T]
7. Sedimentation: Elutraition, Classification and sedimentation, Free Settling, hindered settling, flow of solids through fluid, Stoke's law, Richardson-Zaki equation, design of settling tanks. [3L+1T]
8. Centrifugal separation, design of cyclones and hydrocyclones. [2L+1T]
9. Separation of solids from fluids: Introduction, filter bags, venture scrubber, electrostatic precipitator. [2L+1T]
10. Filtration: cake filtration, Concepts, plate and frame filter, leaf filter, rotary drum filter, etc. [3L+1T]
11. Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Applications of fluidization. [3L+1T]
12. Packed bed: Void fraction, superficial velocity, channelling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus. [3L+1T]
13. Introduction to nanoparticles: Properties, characterization, synthesis methods, applications. [3L+1T]

Total [33L+12T]

Suggested Text Books

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., McGraw Hill.
2. Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth-Heinemann, 5th edition 2002.

Suggested References Books

1. Rhodes, M. J., "Introduction to Particle Technology", 2nd edition, John Wiley, Chichester ; New York, 2008.
2. Allen, T., "Powder Sampling and Particle Size Determination", Elsevier, 2003.
3. Masuda, H., Higashitani, K., Yoshida, H., "Powder Technology Handbook", CRC, Taylor and Francis, 2006.
4. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., Wiley, 2013.

Course Outcomes

Students will be able to

- Calculate drag force and terminal settling velocity for single particles
- Calculate pressure drop in fixed and fluidized beds
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage

CH04TPC07 Process Instrumentation [L:3, T:0,P:0]

Objectives

Objective of the course is to introduce the basics of instrumentation and process control through a hands-on practical experience. Principles of operation of different measuring devices for temperature, level, pressure, flow, pH, humidity, density, and viscosity will be introduced to impart knowledge of transmitters, transducers, converters, control valves, digital and analog components related to PLC, DCS, SCADA systems.

Contents :

1.	Basics of control system components, signals and standards	[3L+1T]
2.	Pressure measuring instruments/sensors	[3L+1T]
3.	Level measurement	[3L+1T]
4.	Flow measuring instruments	[3L+1T]
5.	Temperature measuring devices	[3L+1T]
6.	Humidity, density, viscosity and pH measuring devices	[3L+1T]
7.	Pressure controllers: regulators, safety valves	[3L+1T]
8.	Flow control actuators: different types of valves	[3L+1T]
9.	Electrical and pneumatic signal conditioning and transmission	[5L+2T]
10.	Computer process control, PLC, DCS, SCADA	[2L+1T]
11.	Instrumentation of process equipment	[2L+1T]

Total [33L+12T]

Suggested Text Books

1. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, Mc-Graw Hill (2005).
2. S.K. Singh, Industrial Instrumentation and Control, 3rd edition, McGraw-Hill (2008).

Suggested References Books

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A.,"Process Dynamics and Control", 2nd edition, John Wiley (2003).
2. Stephanopoulos, G.,"Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984).

13/5/19 13/05/19 13/05/19 13/5/19 13/5/19 13/5/19 13/5/19

B.Tech. V Semester

CH5TPC06: Heat Transfer (3 1 0)

Unit I :Conductive Heat Transfer : Heat transfer by conduction in solid, Fourier's Law, Compound resistance in series,Heat flow through a cylinder, Unsteady state heat conduction with applications.

Unit II : Convective Heat Transfer : Heat transfer by forced convection inlaminar and turbulent flow, Natural convection, Counter current, parallel flow, cross flow, Thermal analysis of heat exchangers, Rate of heat transfer, Overall heat transfer coefficient, Individual heat transfer coefficient, Fouling factors.

Unit III :Radiative Heat Transfer : Electromagnetic radiation**,** Radiation heat transfer, Wien's displacement law, Kirchoff's law, Stefan-Biltzmann law, Radiation between surfaces,Combinedheat transfer by conduction, convection and radiation.

Unit IV :Heat Transfer Equipments : Heat exchangers and general design of parallel, countercurrent, Shell & tube heat exchangers, Extended surface equipment.

Unit V :Heat Transfer with phase change : Evaporation – Types of evaporators and fields of their applications, Single andmultiple effect evaporators: their design and operation, Vapor recompression, Heat transfer from condensing vapours, Heat transfer to boiling liquids.

Text Books:

1. Process Heat Transfer by D.Q.Kern.
2. Heat Transmission by Mc. Adams.
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith, Julian C and HarriotPeter. Fifth edition McGraw Hill Inc.
4. Chemical Engineering by Coulson J. M., Richardson Vol.-I

CH5TPC07: Mass Transfer - I (3 1 0)

Unit I: Principle of Diffusion : Theory of diffusion, molecular diffusion in gases and liquids, Diffusion velocities, Mass transfer coefficient for mass transfer through known areas.

Unit II: Phase Equilibria : Vapor-liquid equilibrium curves and boiling point diagram, Volatility, Solubility of gases, Enthalpy –concentration diagrams.
Equilibrium Stage Operations Principles, Determination of number of ideal stages for two-component systems by graphical and absorption factor methods

Unit III: Flash distillation, differential distillation, steam distillation, Azeotropic distillation and Extractive distillation, Continuous distillation with rectification, Reflux ratio, Minimum reflux ratio, calculation of number of plats – Lewis sorel Method, McCabe Thiele Method.

Unit IV: Fenske equation, Optimum reflux ratio, Analysis of fractionating column by enthalpy concentration diagram method, Plate efficiencies, Packed Column, height equivalent to theoretical plate.

Unit V: Gas Absorption : Design of packed towers, Principles of absorption, Rate of absorption, Two film theory, Overall coefficients, HTU method, Interrelation between heat transfer, momentum transfer and mass transfer.

Text Books:

1. Mass Transfer by Robert E Trebyl, McGraw Hill Inc.
2. Unit Operations of Chemical Engineering by McCabe Warren, Smith Julian C andHarriot Peter. Fifth edition McGraw Hill Inc.
3. Principles of Mass Transfer and Separation Processes by B. K. Dutta, Prentice Hall, 2005.
4. Transport Processes and Unit Operations by C. J. Geankoplis, Prentice Hall International Inc.
5. Chemical Engineering Vol. I by Coulson J.M. & Richardson J.F.
6. Introduction to Chemical Engineering by Badger & Bancherro, TATA McGraw Hill Inc.

CH5TPC08: Chemical Reaction Engineering-I (3 1 0)

Unit I : Kinetics of Homogeneous Reactions : Kinetics and thermodynamics of chemical reactions, Kinetics of homogenous reactions rate theories, Analysis of rate equations.

Unit II : Interpretation of Batch Reactor Data : Irreversible reactions, Total pressure method of kinetic studies, Analysis of complex rate equations, Complex reactions, Chain reactions,Variable volume reactions, Rate constants and equilibrium.

Unit III : Ideal Reactor for Single Reaction : Ideal batch reactors, Steady state mixed flow reactor, Steady state plug flow reactor, Size comparison of single reactor, Multiple-reactor system,

Unit IV : Design for Multiple Reaction : Introduction to multiple reaction, Qualitative treatment of product distribution and reactor size for parallel reactions, Reversible first order reactions in series, Favorable contacting patterns for irreversible reactions in series (First order &followed by first order)

Unit V: Temperature and Pressure Effects: Single reaction, General graphical design procedure, Optimum temperature progression, Heat effects- adiabatic and non-adiabatic operations, van Heerden relationship.
Multiple reaction: Temperature and vessel size for maximum production.

Text Books:

1. Chemical Engineering kinetics by J.M. Smith
2. Chemical Reaction Engineering by O Levenspieal
3. Elements of Chemical reaction Engineering by H.S. Foggler

Reference Book:

1. Reaction Kinetics for chemical Engineering by S. H. Walas

CH5TPE11: Engineering Materials (3 1 0)

Unit I : Crystalline and Non –Crystalline Material : Crystalline state, Atomic bonding, Bravias lattices; Miller indices, Structure of some common inorganic compounds, Structural imperfections: Point defects in crystals.
Economic, environmental and social issue of material usage.

Unit II: Mechanical Properties : Mechanical properties like elastic and plastic deformations, hardness, toughness, fatigue, creep etc. and their variation with temperature.
Failure of materials : Failure of materials under service conditions,

Unit III : Corrosion : Mechanism of corrosion- dry and wet corrosion, Factors influencing corrosion, Atmospheric corrosion, Methods of corrosion control, Cathodic and anodic control, Inhibition and other precautionary measures.

Unit IV : Non-Ferrous Metals : Copper, Brasses, Bronze, Aluminium, their mechanical properties, Workability and applications, Corrosion resistance. Non-metallic materials of construction.

Unit V : Phase diagram : Phase rules, Equilibrium phase diagram, cooling curves and their relations to properties of metals and alloys , Iron –carbon equilibrium diagram. Response of materials to chemical environment.

Text Books:

1. CHEMTECH- Materials of Construction by O.P. Kharbanda
2. Corrosion and its Prevention III by K.S. Rajagopalan
3. Introduction to Material Science for Engineers by James F. Shackel Ford.
4. Element of Material Science and Engineering by L.H.Van Vlack
5. Corrosion Engineering by M.G.Fontanne and N.D. Grehnee.
6. Chemistry of Engineering Materials by C.K.Agrawal.
7. Materials Science and Engineering by V. Raghavan, Prentice Hall of India, New Delhi
8. Materials Science for Engineers by L. H. VanVlack, Addison-Wesley Publishing Co.

Reference Book:

1. Chemical Engineering HandBook by Robert H. Perry.

CH5TPE12: Fundamentals of Biochemical Engineering (3 1 0)

Unit I: Introduction: Biotechnology, biochemical engineering, biological process, definition of fermentation, enzymes kinetics and its applications.

Unit II: Cell Cultivations: microbial cell cultivation, animal cell cultivation, plant cell cultivation, cell growth measurement, cell immobilization.

Unit III: Sterilization: Sterilization Methods, Thermal Death Kinetics, Design Criterion, Batch Sterilization, Continuous Sterilization, and Air Sterilization

Unit IV : Agitation and Aeration: Basic mass-transfer concepts, correlations form mass-transfer coefficient, measurement of interfacial area, correlations for interfacial area, gas hold-up, power consumption, oxygen absorption rate, scale-up, and shear sensitive mixing

Unit V: Chemicals of life: lipids, sugars and polysaccharides, from nucleotides to RNA and DNA, amino acid into proteins, hybrid biochemical.

Text books:

1. Fundamentals of Biochemical Engineering by Rajiv Dutta, Springer Berlin Heidelberg New York.
2. Biochemical Engineering Fundamentals by James E. Bailey and Davis F. Ollis, second edition , McGraw-Hill Book Company.
3. Biochemical Engineering by James M. Lee, Washington State University, Prentice-Hall Inc. in 1992

CH5TPE13: Food Engineering (3 1 0)

Unit I: Introduction- General aspects of food industry, world food demand and Indian scenario, constituents of food, quality and nutritive aspects.
Food additives, standards, deteriorative factors and their control, preliminary processing methods, conversion, preservation operation and quality standards.

Unit II- Energy Engineering in Food Processing - Generations of Steam, Fuel Utilization, Electric Power Utilization, Process Controls in Food Processing, Systems for Heating and Cooling Food Products.
Material and energy balance in food systems and calculation. Common unit operations in food processing – Cleaning, evaporation, crystallization.
Thermal Properties of Foods: Specific heat, Enthalpy, Thermal Conductivity, Thermal diffusivity, Latent heat, Modes of Heat Transfer - Freezing Systems , Frozen-Food Properties , Freezing Time refrigeration system for food products.

Unit III- Separation processes in food processing- Electrodialysis Systems, Reverse Osmosis Membrane Systems, Membrane Performance, Ultrafiltration Membrane Systems, Concentration Polarization.
Types of Reverse-Osmosis and Ultrafiltration Systems, Drying Processes, Dehydration Systems, Dehydration System Design, Sedimentation, Centrifugation, Mixing.

Unit IV- Production and utilization of food products –Food Process Principles: Pasteurization, Blanching, Sterilization techniques and types.
Soft and alcoholic beverages, dairy products, meat, poultry and fish products, treatment and disposal of food processing wastes.

Unit V- Packaging - Introduction, Food Protection, Product Containment, Product Communication, Product Convenience.
Innovations in Food Packaging, Food Packaging and Product Shelf-life, Food canning technology, fundamentals of food canning technology.

Text book:

1. Introduction to Food Engineering by R. Paul Singh, Dennis R. 5th Edition

Reference books:

1. Fundamentals of Food Engineering by Stanley Charm.
2. Fundamentals of Food Process Engineering by Toledo RT; 2nd ed, 2000, CBS Publishers
3. Fundamentals of Food Processing Operation by Heid, J.L. and Joslyn, M.A, The AVI Publishing Co; Westport, 1967.
4. Food Process Engineering by Heldman, D.R, The AVI Publishing Co; Westport, 1975.
5. Encyclopedia of Food Engineering by Hall, C.W; Farall, A.W. & Rippen, A.L, Van Nostrand - Reinhold.

CH5TPE14: Polymer Technology (3 1 0)

Unit I : Introduction to Polymer Science : Classification of polymer and functionality, Polymerization, Polymer structure, Molecular weight distribution and thermal transition types.

Unit II : Polymer Synthesis : Step and Chain growth polymerization and its kinetics, Copolymerization and its kinetics, Reaction mechanism of synthetic Polymer.

Unit III : Conformation, Solution and Molecular Weight : Thermodynamics of polymer solution, Flory Huggins theory, Process of polymer dissolution, Nature of polymer molecules in solution, Measurement of molecular weight, Osmometry, Light scattering, GPC, Viscosity of dilute polymer solution.

Unit IV : Soild State Properties : Amorphous state, Glass transition temperature, Glassy solid and glass transition, The crystalline state, Crystal melting temperature, Degree of crystallinity & its effect on properties of polymer.

Unit V : Polymer Degradation & the Environmental Effect : Polymer stability and types of degradation. The management of plastics and its effect on environment, biodegradation.

Text books:

1. Polymer Science and Technology by Fried

2. Outlines of Polymer Technology by Sinha PHI

CH5TOE11: Fluidization Engineering (3 0 0)

Unit I : Phenomenon of Fluidization, Industrial applications of fluidized beds.

Unit II : Gross behavior of fluidized beds-Minimum fluidizing velocity and pressure drops; Voidage, Transport disengaging height.

Unit III : Bubbles in dense beds-Davidson Model, stream of bubbles, Bubbling bed models.

Unit IV : Emulsion phase, Turn-over rate of solids, Residence Time Distribution of Solids, Diffusion model of solids movement, Interchange coefficient of solid into and out of wake.

Unit V : Flow Pattern of Gas through fluidized beds, diffusion model for gas flow; two region models, evaluation of interchange coefficients.

Text book:

1. Fluidization Engineering by D Kunii and O Levenpiel, John Wiley, 1969

References book:

1. Fluidization by J. F. Davidson and D. Harrison, Academic Press 1971.
2. Fluidization and Fluid Particles Systems by F.A. Zenz and D. F. Othmer, Reinhold Publishing,1960

CH5TOE12: Financial Management (3 0 0)

Unit I : Introduction, scope and objective, organisation of finance function,

Time value risk and return and valuation of money, valuation of long term securities various model of pricing.

Unit II : Statement of changes in financial position , sources and uses of working capital ,cash flow statement, balance sheet, profit loss account and its process.

Financial ratio analysis- meaning, types , importance and limitataions**,** calculation of various ratios.

Unit III : Capital budgeting- principals, techniques **,**various methods of capital budgeting.

Concept and measurment of cost and capital, and various approaches for measurement of cost of capital and computation.

Analysis of risk and uncertainity-various approaches for risk evauation.

Unit IV : Theory of working capital management – concept and deination of gross, working capital and net working capital, trade off between profitability and risk

Unit V : Operating financial and combined leaverage- introduction, defination and concept and various approaches.

Text books:

1 Financial Management by Khan and Jain, TMGH

2. Financial Management by Kuchhal, Vikas Publication

3. Financial Management- Paresh Shah-Willey India Pvt. Ltd.

CH5TOE13: Managerial Economics (3 0 0)

Unit I : Introduction to Managerial Economics, Different Area of Managerial Economics, Micro and Macro Economics, Nature and Scope of Managerial Economics- Demand Analysis, Law of Demand and its Exceptions. Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Supply Analysis, Law of Supply, Elasticity of Supply: Definition, Types, Measurement and Significance of Elasticity of Supply.

Unit II : Law of Return, Revenue Analysis, Theory of Production and Cost Analysis: Production Function, Cobb-Douglas Production Function, ACMS Production Function, Investment Function.
Cost Analysis: Cost Concept, Opportunity Cost, Fixed Vs Variable Cost, Explicit Costs Vs Implicit Costs, Out of Pocket Costs Vs Imputed Costs. Break-even Analysis *(*BEA*)* **-** Determination of Break-even Point (Simple Problem) - Managerial Significance and Limitation of BEA.

Unit III : Introduction to Market & Pricing Policies: Element of Market , Types of Market, Concept of Market, Classification of Market based on the nature of competition, Types of Competition, Features of Perfect Competition, Feature of Imperfect Competition, Monopoly and Monopolistic Competition, Price-Output Determination in case of Perfect Competition and Monopoly.
Objectives and Policies of Pricing: Introduction, Full Cost or Cost plus Pricing, Differential Pricing, Going Rate Pricing, Marginal Cost Pricing, Trade Association Pricing, Loss Leadership Pricing, Administered Pricing

Unit IV: Forms of Business Organization: Introduction, Definition, Essential Element of Good Organization, Principles of Organization, Formal and Informal Organisation, Organisation Structure, Concept of Ownership Organization, Types of Ownership, Partnership, Joint Stock Company, Types of Joint Stock Company, Co-Operative Organization, Public Sector Organisation.
Capital and Capital Budgeting: Capital and Its Classifications, Need of Working Capital and Its Assessment, Factors Affecting Working Capital, Fundamental of Accounting, Types of Capital, Method and Sources of Raising Finance ,Nature and Scope of Capital Budgeting, Features of Capital Budgeting Proposals, Method of Capital Budgeting: Payback Method, Accounting Rate of Return (ARR) and Net Present Value Method (Simple Problems).

Unit V: Fundamental of Financial Accounting: Nature of Accounting, Important Accounting Terminology, Accounts and Types of Accounts, Rules of Debit and Credit, System of Book Keeping, Book of Accounts, Journal, Ledger, Trial Balance, Final Account, Trading Account, Profit and Loss Accounts and Balance Sheet.
Financial Analysis Through Ratios: Classification of Financial Ratios, Liquidity Ratios, Leverage Ratios, Activity Ratios, Profitability Ratios, Current Ratio, Acid Test Ratio, Debt Equity Ratio, Assets Coverage Ratio, Debt Service Coverage Ratio, Inventory Turnover Ratio, Debtor Velocity Ratio, Creditor Velocity Ratio, Gross Profit Ratio, Net Profit Ratio, Return on Equity Ratio.

Text Books:

1. Managerial Economics by Yogesh Maheshwari, PHI
2. Managerial Economics By Joel Dean, PHI
3. Managerial Economics By Craig H. Petersen, W. Cris Lewis, Sudhir K Jain
4 Financial Accounting For Management By Ambrish Gupta, Pearson Eduction
5 Managerial Economics By H. Craig Peterson & W. Cris Lewis, PHI
6 Managerial Economics By Suma Damodaran, Oxford University Press
7 Managerial Economics and Financial Analysis By Aryasri, TMH

CH5TOE14: Financial Accounting and Costing (3 0 0)

Unit I : Financial Accounting: Introduction to Book keeping, Double-entryaccounting, Journal & Ledger posting, Financial Statements & Analysis,Trial balance, preparation of Trading and Profit & Loss account and Balance Sheet.

Unit II : Ratio Analysis: Balance sheet ratios-current ratio, Fixed Asset ratio,Liquidity ratio, Capital Gearing Ratio, Profit-loss account ratios-Gross Margin ratio, Net Margin Ratio, Combined ratios-Return on Investment ratio, Net Profit to Total Assets ratio, Creditors turnover ratio.

Unit III : Costing: Objectives of costing, Elements of costing, methods of costing, preparation of cost sheet, job costing, Marginal costing, absorption costing, Process costing and Standard Costing-Material, labour, overhead cost variance, Activity Based Costing and Target Costing, Cost-Profit-Volume analysis and problems on cost-volume-profit analysis.

Unit IV : Working Capital Management: Introduction, concepts of working capital,operating and cash conversion cycle, permanent and variable workingcapital, balanced working capital position, determinants of working capital, Estimating working capital needs, Policies for financing current assets, Issues in working capital management.

UNIT-V

Capital Budgeting: Nature and scope of capital budgeting, features of capital budgeting, Methods of capital budgeting-DCF, NON-DCFtechniques-Accounting rate of Return, Net present Value, Payback period, discounted payback period, Profitability Index.

Text Books :

1. T. Vijaya Kumar, Accounting for Management, 1/e, Tata McGraw-Hill, 2009.
2. I. M. Pandey, Financial Management, 9/e, VikasPulishing House, 2009.
3. M.Y. Khan and P. K. Jain, Cost Accounting, 2/e, TMH, 2014.
4. M.Y. Khan and P. K. Jain, Management Accounting: Text, Problems and Cases, 6/e TMH, 2013.
5. M.Y. Khan, P. K. Jain, Basic Financial Management, 3/e, TMH, 2000.

B.Tech. VI Semester

CH6TPC09: Mass Transfer – II (3 1 0)

Unit I: Humidification Operations : Definitions, Humidity chart and its use in measurement of humidity and calculations of humidification operations, Adiabatic humidification.

Unit II : Leaching : Equipment, Principles of leaching, Calculation of number of ideal stages, Stage efficiency

Unit III : Liquid- Liquid Extraction : Equipment, Principles of extraction, Panchon – Savorit method, Counter current extraction using reflux application of McCabe method, Extraction in packed and spray column.

Unit IV: Crystallization : Principles, yield of crystals, Super solubility curve, Crystal growth, Equipment and application of principles to design.

Unit V : Drying : Equipment, Principles, Mechanism and theory of drying, Calculation of drying time.

Text Books:

1. Mass Transfer by Robert E Trebyl, McGraw Hill Inc.
2. Unit Operations of Chemical Engineering by McCabe Warren, Smith Julian C and Harriot Peter, Fifth edition, McGraw Hill Inc.
3. Principles of Mass Transfer and Separation Processes by B. K. Dutta, Prentice Hall, 2005.
4. Transport Processes and Unit Operations by C. J. Geankoplis, Prentice Hall International Inc.
5. Chemical Engineering Vol. I by Coulson J.M. & Richardson J.F.
6. Introduction to Chemical Engineering by Badger & Bancherro, TATA McGraw Hill Inc.

CH6TPC10: Process Dynamics and Control (3 1 0)

Unit I : Process Control : Importance of process control in chemical plants and systems, Various types of Control systems viz open loop and closed loop control, feedback and feed forward control, servo and regulator control; Importance of dynamic behavior of processes in process control, Physicaland block diagram representation of control system, Use of Laplace transformation in analysisof control systems.

Unit II : Simple System Analysis : Laplace transformation and transfer function, Blockdiagrams, Linearization, First and higher order systems, Interacting and non-interactingsystems, Distributed and lumped parameters systems, Dead time.

Unit III : Linear Open Loop Systems : Response of first order, second order and higherorder systems, Linearization of non-linear systems, Transportation lag.
Linear Closed Loop Systems : Study of various control system and their components viz.controllers, final control elements, Measuring instruments, Closed loop transfer functions,Transient response of simple control system, Stability criterion and analysis.

Unit IV : Root Locus, Stability Criterion and Transient Response :
Transient response analysis form root locus, Application of root locus to control system, Routh stability criterion.

Unit V : Frequency Response Analysis : Design of control system by frequency response, Closed loop response by frequency response, Frequency response technique: Phase marginand gain margin, Bode stability criterion; Nyquist stability criterion

Text Books:

1. Process Systems Analysis and Control by D.R. Coughnaowr, McGraw-Hill,Inc.
2. Chemical Process Control by G. Stephanopolous, Prentice-Hall.
3. Process Control by P. Hariott., TMH edn.

Reference Books:

1. Process Dynamics and Control by D.E. Seborg, , T. Edgar and D.A. Mellichamp, JohnWiley and Sons, Inc
2. Process Control: Modeling, Design, and Simulation by B.W. Bequette, Prentice-Hall,Inc.

CH6TPC11: Organic Chemical Technology (3 0 0)

Unit I : Oils & Fats : Status and scope, Major oils seeds production in India, Expression, Solvent extraction, Energy & solvent requirements, Mineral, seeds and other oil bearing materials, Hydrogenation of oils, Corrosion problems and materials of construction of equipments.

Unit II : Soaps & Detergents : Raw materials, Manufacture of detergents, Active detergent matter, Biodegradability, Fat splitting, Purification of fatty acids, Soap manufacture, Total fatty matters (TFM), Glycerin manufacture, Materials of construction.

Unit III : Cane Sugar : Cane production & varieties, Manufacturing equipment &technology, Cane sugar refining, Bagasses utilization, Energy requirements and conservation, Environmental considerations, Khandsari technology, Molasses based industries, Materials of construction.

Unit IV : Polymers : Status and scope, Applications, Classification of polymers, Degree and modes of polymerization, Molecular weight and it distribution, Selected industrial polymerization including plastics, Synthetic rubber and polymeric foams, Synthetic fibers.
Penicillin : Manufacturing process, Scope and applications.

Unit V : Regenerated Cellulose : Growth of industry, Raw materials, Pretreatment, Pulping, Manufacture of paper, Recovery of chemicals, Environmental considerations, viscose rayon.
Varnishes and Paints : Scope and applications, Types of coatings, General manufacturing procedure, Environmental considerations.

Text Books:

1. Chemical Process Industries – R.N. Shreve & J.A. Brink

2. Chemtech I , II, III , IV – IIT Madras

3. Outlines of Chemical Technology by Dryden , Co. M.G. Rao and M. Sitting.

Reference Book:

1. Handbook of Oil &Colour, Chemists Association OCCA.

CH6TPE21: Process Equipment Design–I (3 1 0)

Pressure and Storage Vessels : Design of pressure and storage vessels and their supports. End closures, Flat plates, Flanged, Dished, Hemispherical, Ellipsoidal and conical ends.

Text Books:

1. Introduction to Chemical Equipment Design (Mechanical Aspects) by B.C. Bhattacharya– Chemical Engineering Education Development Center.
2. Process Equipment Design By Brownell & Young
3. Process Equipment Design by M.V. Joshi
4. Chemical Engineering by Coulson J.M., Richardson Vol- I
5. Process Equipment Design by Shrikant D. Dawande

Reference Books:

1. Hand book of Chemical Engineering by J.H.Perry
2. IS Codes.

CH6TPE22: Fertilizer Technology (3 1 0)

Chemical fertilizers and organic manures – types of chemical fertilizers, Nitrogenous fertilizers- Methods of production, Characteristics, Specification and storage of ammonium sulphate, ammonium nitrate and ammonium chloride and urea Phosphatic fertilizers- Methods of production, Characteristics, Specification and storage of single super phosphate, triple super phosphate, Potassic fertilizers- Methods of production, Characteristics, Specification and storage of potassium chloride, potassium sulphate and potassium schoenite; Complex and NPK fertilizers-Methods of production, Characteristics, Specification and storage of Mono ammonium phosphate, Diammonium phosphate, Nitrophosphates, Fertilizers And Environment.

Text Books :

1. Commercial Fertilizers by G.H. Collings, 5th Edn., McGraw Hill, New York, 1955.
2. Chemistry and Technology of Fertilizers by A.V. Slacks, Interscience, New York, 1966.

Reference Book :

1. Editorial board-Handbook of fertilizer technology, The Fertilizer Association of India, New Delhi, 1977.

CH6TPE31: Fuel Combustion Energy Technology (3 1 0)

Unit I : Solid Fuel : Classification of fuel, Origin, Composition, Characteristics and analysis of coal washing & storage of coal, Physical & chemical processing of coal, Various classification systems of coal briquetting, Carbonization, Gasification of coal.

Liquid fuels: Origin, composition, characteristics and classification of crude oil, crude oil processing cracking and reforming, storage and handling of liquid fuel

Gaseous fuel: Classification of gaseous fuel, Natural gas, Coal gas, Coke oven and blast furnace gas, producer gas, water and Carbureted water gas

Unit II: Fuel Combustion Calculation: Fundamentals of various combustion calculations with numerical examples.

Unit III: Combustion Process: General Principles of combustion, Flame, Draught, Limits of Inflammability, Types of combustion Process- Surface, Submerged, Pulsating, Slow combustion.

Unit IV: Energy Conservation: Energy consumption pattern in various sectors, various ways of energy conservation in various process industries including petroleum.

Unit V: Non – Conventional Energy Technologies : General principles with applications and technology of Biomass Energy, Solar Energy, Geothermal Energy, Wind Energy, Nuclear Energy, Hydal, Tidal and Ocean Energy.

Text Book:

1. Elements of Fuel Combustion & Energy Engineering by S.N. Saha, Dhanpat Rai Publication Co. Pvt. Ltd. New Delhi, 2014

CH6TPE32: Environmental Engineering (3 1 0)

Unit I :Environmental Pollution and Its Effect : Environment and its components, Sources and type of pollutants, General effects on man, animal, vegetation and property.

Unit II : Air Pollution : Air quality criteria and standards, Ambient air sampling and analysis, Stack emission standards, Stack sampling and analysis, Meteorology and dispersion of air pollutants, Atmospheric lapse rate and stability, Plumebehavior, Control of gaseous and particulate pollutants from mobileand stationery sources.

Unit III : Water Pollution : Water quality criteria and effluent discharge standards,Domestic and industrial sources of waste water, Waste water sampling and analysis methods as per BIS specifications, Physico-chemical and biological methods of waste water treatment, Recovery of materialfrom process effluents.

Unit IV: Pollution Due to Hazardous Industrial Waste : Nature of hazardous waste materials from various chemicaland allied Industries, Methods of disposal, destruction and reuse, Nuclear wastes and their management.
Solid waste from commercial, domestic and industrial sectors-composition and characterization, recycle, resource recovery and disposal.
Unit V: Environmental Pollution Management : Case studies of air and water pollution control inchemical industries.

Text Books:

1. Environmental Pollution Control Engineering by C. S. Rao, New Age InternationalLtd.
2. Environmental Engineering by N N Basak, Tata McGraw-Hill Pub. Co. Ltd.
3. Essentials of Environmental Studies by K. Joseph and R. Nagendran, Pearson Education (Singapore) Pvt. Ltd.

CH6TOE21: Process Utilities and Safety (3 0 0)

Unit I :Introduction : Role and types of process utilities in process industries.
Heat Transfer Media : Characteristics properties, Classification, Selection and their industrialapplication.

Unit II : Steam System : Generation and application in chemical process plants, Design of efficient steamheating systems, Condensate utilization, Flash steam.
Steam Traps : Types and characteristics.

Unit III : Water: Characteristic and conditioning for process industries e.g., steam piping, boilerfeed, cooling etc., Recycling of process water.

Unit IV :Introduction to process safety : Accidents and loss statistics, Nature of the accidents /hazardous process.
Toxicology : Toxic material and biological response, Dose responses relationship and models,Threshold dose and its definition, Material safety data sheets and industrial hygiene evaluation.
Safety Devices : Personal safety devices and general hygiene management, Storage and ventilation.

Unit V : Fire and Explosion : Definition, Flammability characteristics and explosion, Designto prevent fires and explosions by inverting, purring, ventilation, sprinkler systems, Staticelectricity controls,Relief and relief sizing in vapor/gas, Liquid and runway reaction services.

Text Books:

1. High Temperature Heat Carrier by A. V. Chechetckin, Pergammon Press.
2. Efficient use of Steam by P. M. Goodal, Guilford
3. Chemical Process Safety : Fundamentals with applications by A. Crowl Daniel and F. L.Joseph, Prentice Hall.

Reference Book:

1. Handbook of Heat Transfer Media by P. L. AaeringerRenold.

CH6TOE22: Enterprise Resource Planning (3 0 0)

Unit I : Introduction to Enterprise resource planning, Evolution of ERP, MRP, MRP-II, e-ERP, Generic business model with reference to ERP, Structure of ERP Two tier architecture client, server, Three tier architecture, repository, RDBMS, Operating systems, Generic model of ERP system - Design tree node structure, Design of, Role/Activity Diagrams, Benchmarking, Types of Benchmarking, Process of Benchmarking.

Unit II : Introduction to Business Process Re-engineering, Procedure of BPR, Principle of BPR, Process improvement Process redesign.

Unit III : Introduction : Supply chain Management and ERP, understanding the supply chain with case examples, Supply chain performance with measures, Achieving strategic fit and scope, Supply chain drivers, Supply chain obstacles, ERP Vs SCM, Benefits of supply chain improvement, Introduction of Logistics Types of Logistics, Types of Logistics, Benefits of Logistics.

Unit IV: Integrated SAP model, Integrated Data, Master Data, Transactional Data, Integrated processes, Evolution Electronic Data Interchange (EDI), Use of EDI, and Benefits of EDI, Selection of ERP: Introduction Opportunities and problems in ERP selection, Approach to ERP selection of ERP.

Unit V: Origins of SAP, SAP's Markets, SAP architecture and integration, SAP Business structure, Customization of SAP, SAP R/3 material Management, Sales and Distribution, Production, Plant Maintenance, Quality Management, Methodology for ERP implementation, Implementation phases, Implementation of Life cycle, Implementation failure

Text Books:

1. Enterprise Resource Planning: Theory and practice by Rahul V, PHI Publication.
2. Enterprise Resource Planning: Concepts and practice by V.K. Garg, TMH Publication.
3. Enterprise Resource Planning by Alexis Leon, McGraw-Hill Publication

CH6TOE23: Management Information System (3 0 0)

Unit I : Organisation & Types, Decision Making, Cost & value of information**,** Intoductuion to information in buisiness, types of informaton system ,need , importance , scope and charecterstics of information system. Component of information system , developing information system.

MIS concept evaluation and charecterstics structure of MIS , MIS v/s data processing, MIS and DSS

Unit II : Solving Business Problems with Information System, Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS- dataflow diagram, flow chart etc.

Data base technology- introduction, data base and enterprice management, data independence data base approaches , data base architecture , data models , DBMS SQL and working , 4GL, data administration.

Unit III : Business application of information technology: electronic commerce Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations, Information system for managerial Decision Support, Information System for Strategic Advantage.

Unit IV : Managing Information Technology, Enterprise & Global Management, Security & Ethical Challenges, Planning & Implementing Change. Reports: Various types of MIS reports, GUI & Other Presentation tools.

Unit V : Advanced concepts in information system: Enterprise Resource Planning: introduction, various modules like Human Resources, Finance, Accounting, Production & Logistics. Supply Chain Management, CRM, Procurement, Management System Object Oriented modeling case studies.

Text Books:

1. Introduction to Information System by O. Brian, McGraw Hill.
2. Management Information System by O. Brian TMH.
3. MIS by Rahul De, Wiley.
4. MIS by Louden and lauden, PHI
5. Information System Analysis & Design by Bansal, TMH.
6. Management Information System by Jawadegar, TMH.
7. Information System for Modern Management by Murdick, PHI.
8. Enterprise Resource Planning by Alexis Leon, TMH.
9 MIS by Sadagopan, PHI

BOS held on 24th May 2017

CH6TOE24: Six Sigma and DOE (3 0 0)

Unit I : Quality Perception : Quality in Manufacturing, Quality in Service Sector, Differences between Conventional and Six Sigma concept of quality.
Probability Distribution: Normal, Binomial, Poisson distribution.
Basics of Six Sigma: Concept of Six Sigma, Defects, DPMO, DPU, Attackson X'S, Customer focus, Six Sigma for manufacturing, Six Sigma for service, Z score, Understanding Six Sigma organization, Leadership council, Project sponsors and champions, Master Black Belt, Black Belt, Green Belts.

Unit II : Methodology of Six Sigma: DMAIC, DFSS, Models of Implementation of Six Sigma, Selection of Six Sigma Projects. , Introduction to software for Six Sigma,Understanding Minitab, and Graphical analysis of Minitab plots.

Unit III : Six Sigma Tools: Project Charter, Process mapping, Measurement system analysis, Hypothesis Testing, Quality Function deployment, Failure mode effect analysis,\

UNIT-IV: Design of Experiments,: Applications of experimental Design, basic principles, design guidelines, statistical design and problems. Experimental design; statistical analysis of data. Loss function and its calculations.

Unit V : Comparative Experiments: Statistical concepts**,** sampling and sampling Distributions, Inferences about the differences in means, randomized design, and inference about differences in means paired comparison design, inferences about the variances of normal distributions, problems. Experiment with single factor: the analysis of variance (ANOVA), analysis of fixed effects models, model adequacy checking, practical interpretation of results, sample computer output, determining the sample size, discovering the dispersion effect, the regression approach to the ANOVA, and non-parametric method in the ANOVA.

Text Books:

1. Lean Six Sigma Using Sigma XL and Minitab by Issa Bass, Barbara Lawton, 1/e, Tata McGraw-Hill, 2010.
2. DOE by phillip ross PHI.
3. What is Six Sigma by P. Pande and L. Holpp, 1/e, Tata McGraw-Hill, 2002.
4. The Six Sigma Way by P. Pande, 1/e, Tata McGraw-Hill, 2003.
5. What is Design for Six Sigma by R. Cavanagh, R. Neuman, P. Pande, 1/e, Tata McGraw- Hill, 2005.
6. Six Sigma by KK BHOTE Mc-graw hill.
7. Design and Analysis of Experiments by D.C. Montgomery, 8th Edition, John Wiley.

B.Tech. VII Semester

CH7TPC13 : Process Equipment Design- II (3 1 0)

Design of Heat Transfer Equipments : Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Vertical & Horizontal Condensers and Evaporators.

The candidates will be allowed to use the following reference book in the examination hall :

1. Hand book of Chemical Engineering J. H. Perry
2. Tubular Heat Exchange Manufacture Association Manual
3. ISI Codes.

Candidates have to bring their own copies of the above books and they will be not supplied by the university or the examination centers.

Text Books :

1. Process Heat Transfer by D. Q. Kern
2. Heat Transmission by McAdams
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith Julian and Harriot Peter, Fifth Edition, McGraw Hill Inc.
4. Chemical Engineering by J. M. Coulson and Richardson, Volume- I

CH7TPC14 : Chemical Reaction Engineering - II (3 1 0)

Unit-I : Basics of Non-Ideal Flow : Exit Age Distribution of Fluid, RTD, Conversion in Non-ideal Flow Reactors, Models for Non-ideal Flow- Dispersion Model, Chemical Reaction and Dispersion, Tank in Series Model.

Unit-II : Mixing of Fluids : Self Mixing of Single Fluid- Degree of Segregation, Early and Late Mixing, Mixing of Two Miscible Fluids.

Unit-III : Fluid Particle Reactions : Un-Reacted Core Model: Diffusion Through Gas Film Control, Diffusion Through Ash Layer Control, Chemical Reaction Control, Rate of Reaction for Shrinking Spherical Particles, Determination of Rate Controlling Step.

Unit-IV : Fluid – Fluid Reactions : Kinetic Regimes for Mass Transfer and Reaction, Rate Equations for Various Regimes, Film Conversion Parameter, Application to Design, Reactive and Extractive Reactions.

Unit V: Catalysis : Heterogeneous Catalysts, General Characteristics, Adsorption on Solid Surface, Physical Properties of Catalysts, Preparation of Catalyst, Steps in Catalytic Reaction.

Text Books :

1. Chemical Engineering Kinetics. J.M. Smith.
2. Chemical Reaction Engineering. Octave Levenspiel.
3. Chemical Reaction Engineering. H.Scott Fogler.
4. Principles of Reaction Engineering, Central Techno Publications. S.D.Dawande,
5. Chemical Engineering, Volume IV. Coulson and Richardson

BOS held on 15th May 2018

CH7TPC15 : New Separation Processes (3 1 0)

Unit I : Overview of Separation Processes: Basic Concepts of Separation Processes, Physico-Chemical Properties and Other Factors Controlling Separation, Limitations of Conventional Separation Processes and New Separation Processes, Equilibrium and Rate Governed Separation Processes and their Characteristics.

Unit II : Membrane Based Separation Processes: Principle of Membrane Separations Process, Advantages and Disadvantages, Classification, Membrane Materials, General Methods of Preparation and Characterization of Membranes, Membrane Modules, Concentration Polarization.

Unit III : Porous Membrane Based Processes: Reverse Osmosis, Ultrafiltration, Microfiltration, Nano-filtration, Dialysis, Ion-Selective Membranes and Electro-dialysis, Industrial Applications of Porous Membrane Based Processes.

Unit IV : Non-Porous Membrane Based Processes: Gas separation, Pervaporation, Liquid Membranes and their Industrial Applications, Medical Applications of Membranes, Miscellaneous Membrane Processes, Membrane Distillation, Membrane Reactors.

Unit V : Other Non-Conventional Separation Processes: Foam and Bubble Fractionation, Pressure and Temperature Swing Adsorption, Cloud Point Extraction, Centrifugal Separation Processes, Super Critical Fluid Extraction.

Text Books :

1. Separation Process Principles by J D Seader and E J Henley John Wiley & Sons, Inc.
2. Separation Processes by C J King, McGraw-Hill, Inc.
3. Membrane Separation Processes by K. Nath, PHI, New Delhi.
4. Membrane Technology and Applications by R W Baker, John Wiley and Sons, Ltd, UK.
5. Handbook of Industrial Membrane Technology by M.C. Porter, Crest Publishing House.

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BOS held on 15th May 2018

CH7TPE41: Petroleum Refinery Engineering (3 1 0)

Unit I : Petroleum Crude and Refining : Origin, Formation & Occurrence of Petroleum Crude, Exploration, Drilling and Processing, Reserve and Deposit of World, Indian Petroleum Refinery, Compositions, Classification & Physical Properties of Petroleum Crude.

Unit II : Physical Properties and Testing Methods of Petroleum Products : Evaluation of Petroleum, Physco-Chemical Properties of Various Petroleum Products as Per API / ASTM / BIS Specifications.

Unit III : Crude Processing : Pre-Treatment of Crude, Heating Techniques of Crude, Types of Distillation Columns & their Efficiencies, Atmospheric and Vacuum Distillation of Crude, Blending of Gasoline.

Unit IV : Chemical Treatment & Refining Operation : Chemical Treatment of Petroleum Products, Caustic Soda Treatment, Treatment With H_2SO_4 & H_2, Mercaptan Removal & Oxidation Process, Sulphur-Removal From Petroleum Products – Doctor's Treatment, Hydro De-Sulphurization, Dewaxing and Refining of Lubricating Oils.

Unit V : Cracking & Reforming Operation : Visbreaking, Thermal Cracking, Catalytic Cracking, Hydrocracking, Catalytic Reforming, Alkylation, Isomerization and Polymerization, Naphtha Cracking, Delayed Coking & Fluidized Coking.

Text Books :

1. Petroleum Refinery Engineering by W.L. Nelson
2. Petroleum Refining by Gary and Handwarke, Marcel Dekker
3. Petroleum Refining & Petrochemicals by N.K. Sinha, Umesh Publications New Delhi.
4. Petroleum Refining Technology by I.D. Mall, CBS Publishers & Distributors Pvt. Ltd. New Delhi.

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CH7TPE42: Polymer Technology - I (3 1 0)

Unit I : Introduction to Polymer Science : Classification of Polymer and their Functionality, Polymerization, Polymer Structure, Molecular Weight Distribution, Number Average, Weight average, Z-Average Molecular Weight, Chemical Structure and Thermal Transition Types, Mechanism of Polymerization.

Unit II : Polymer Synthesis : Step Growth Polymerization and its Kinetics, Molecular Weight of Step Growth Polymerization, Chain Growth Polymerization and its Kinetics, Copolymerization and its Kinetics, Polymerization Techniques, Reaction of Synthetic Polymer, Chemical Structure Determination.

Unit III : Conformation, Solution and Molecular Weight : Thermodynamics of Polymer solution, Flory Huggins Theory, Polymer Conformation and Chain Dimensions, Process of Polymer Dissolution, Nature of Polymer Molecules in Solution, Measurement of Molecular weight, Osmometry, Light Scattering, GPC, Viscosity of Dilute Polymer Solution.

Unit IV : Soild State Properties : Amorphous State, Glass Transition Temperature, Glassy solid and Glass Transition, Crystalline State, Crystal Melting Temperature, Degree Of Crystallinity & its Effect on Properties of Polymer, Mechanical Properties and Methods of its testing.

Unit V : Polymer Degradation & Environmental Effect : Polymer Degradation and Stability, Types of Degradation, Thermal Degradation, Mechanical Degradation, Photo Degradation, Degradation by High Energy Radiation, Hydraulic Degradation, Management of Plastic in Environment, Biodegradation.

Text Books :

1. Polymer Science and Technology by Fried

2. Outlines of Polymer Technology by Sinha PHI

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CH7TPE43: Design and Development of Catalyst (3 1 0)

Structure of Solid Surfaces, Chemisorption and Physiosorption, Thermodynamics and Kinetics of Surface Processes, Principles of Heterogeneous Catalysis, Preparation, Characterization and Classification, Kinetics of Heterogeneous Reactions, Physical, Chemical and Mathematical Description of Catalyst Deactivation, Deactivation by Fouling, Poisoning and Sintering, Deactivation and Regeneration of Catalyst Pellets, Deactivation and Regeneration of Fixed Beds, Dynamics of Polyfunctional Catalysts, Electro catalysis and Photocatalyis, Mechanism and Kinetics of Some Typical Heterogeneous Catalytic Reactions, Applications in Fertilizer, Petroleum, Petrochemical Industries and Pollution Control.

Text Books :

1. Preparation of Catalyst VI : Scientific bases for the preparation of Haterogeneous Catalysts by G. Poncelet, J. Martens, B. Delmon, Elseveir
2. Catalyst Preparation : Science and Engineering by John Regalbuto, CRC Press

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CH7TOE31: Transport Phenomena (3 1 0)

Unit I : Introduction to Transport Phenomena : Similarity between Momentum, Heat and Mass Transfer, The Continuum Hypothesis, Basic Laws of Fluid Motion, Newton's Second Law of motion, Principle of Balance between Momentum, Heat and Mass Transfer, Principles of Conservation of Momentum, Mass and Energy.

Unit II : Momentum Transport Phenomena : Momentum Transport in Laminar Flow: Newton's Law of Viscosity, Science of Rheology, Prediction of Viscosity and its Dependence on Temperature, Pressure and Composition, Boundary Conditions, Shell Balance Approach for Stress Distribution and Velocity Profiles, Introduction to Time Derivatives and Vector Analysis, Equation of Continuity and Equation of Motion and their Application in Fluid Flow Problems.

Unit III : Unsteady State Momentum Transport : Flow Near a Wall Suddenly Set in Motion, Momentum Transport Phenomena in Turbulent Flow, Definitions of Friction Factors, Friction Factor for Flow in Tubes, Around Spheres and Through Packed Bed Column.

Unit IV : Energy Transport Phenomena : Energy Transport in Laminar Flow: Fourier's Law of Heat Conduction, Prediction of Thermal Conductivities and its Dependence on Temperature, Pressure and Composition, Boundary Conditions, Shell Balance Approach, Types of Heat Sources, Principle of Extended Surfaces, Types of Cooling Fans, Free and Forced Convection, Unsteady State Heat Transport, Unsteady State Heat Conduction in Solids, Heating of Semi-Infinite Slab, Heating of Finite Slab, Application.

Unit V : Mass Transport Phenomena : Definitions of Concentration, Velocities and Mass Fluxes, Fick's Law of Diffusion, Prediction of Diffusivity and its Dependence on Temperature, Pressure and Composition, Boundary Conditions, Shell Balance Approach For Mass Transfer Problems, Problems of Diffusion with Homogeneous and Heterogeneous Chemical Reaction, Diffusion and Chemical Reaction in Porous Catalyst - The Effectiveness Factor, Equation of Continuity for Multicomponent Mixtures.

Text Books :

1. Transport Phenomena by R.B. Bird, W.E. Stewart and E. W.Lighfoot, John Wiley & Sons.
2. Transport Phenomena by R. S. Brodkey and H. C. Hershey, McGraw-Hill.
3. Fundamentals of Momentum Heat and Mass Transfer by J. R. Welty, C. W. Wicks, R. E. Wilson and G. Rorrer, John Wiley & Sons.

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CH7TOE32: Water Conservation and Management (3 1 0)

Introduction, Water Cycle, Water Storage, Water Quality, Water Conservation in Homes, Water Conservation in Work Place; Water Management-Water Quality, Controlling Use and Quality of Water, Water Flow Management, Water Quality Control, Testing Water Salinity, Preserving Water Quality, Minimizing Evaporation, Water Sanitation, Water Audits, Water Conservation in Agriculture, Water Conservation in Process Industries, Water Conservation in Construction Industries, Water Conservation in Service Industries.

Text Books :

1. Water Conservation, Management and Analysis by V. Madireddi and Subba Rao, Readworthy Publications (P) Ltd
2. Protection and Conservation of Water Resources by Hadrian F. Cook, John Wiley & Sons Inc.
3. Water Resources, Conservation and Management by S.N. Chatterjee, Atlantic Publishers & Dist.

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B.Tech. VIII Semester

CH8TPC16: Process Equipment Design- III (3 1 0)

Mass Transfer Equipments : Absorption Tower, Distillation Tower, Tunnel and Rotary Dryers.

Text Books :

1. Hand Book of Chemical Engineering J. H. Pery
2. Coulson & Richardson Volume–VI
3. Mass Transfer by R. Treybal
4. ISI Codes

Candidates have to bring their own copies of ISI Code book and they will be not be supplied by the university or the examination centers.

CH8TPC17: Project Engineering, Economics & Management (3 1 0)

Unit I : Nature and Importance of Project and Project Engineering : Concept of Project and Project Management, Characteristics of Project, Introduction to Project Engineering, Role of a Project Leader, General Design Considerations, Plant Layout and Site Selection, Flow Diagram, Concept of Scale Up, Concepts of Techno-Economic Feasibility Report.

Unit II : Technical and Financial Analysis : Technical Analysis, Financial Analysis, Significance of Financial Analysis, Elementary Knowledge of Book of accounts- Journal, Ledger, Balance sheet, Profit and Loss Account. Cost Estimation, Cash Flow Investment, Production Cost, Capital Investment, Cost Indices, Production and Overhead Cost, Interest and Taxes.

Unit III : Project Financing and Value Engineering : Meaning and Importance of Project Finance, Means of Finance and Sources of Project in India, Financial Institution Structure and Financial Assistance, Norms of Finance and Term Loan Procedure, Value Engineering – Function, Aims and Procedure.

Unit IV : Capital Expenditure, Profitability & Alternative Investments : Importance and Kinds of Capital Expenditure Decision, Capital Budgeting Process, Criteria of Capital Budgeting, Depreciation and its Calculation Methods, Methods of calculating profitability, Alternative investments, Break Even Analysis.

Unit V : Network Techniques for Project Management : Introduction, Development of Project Network, Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Time Analysis, Gantt Chart.

Text Books :

1. Plant Design & Economics for chemical Engineers by M.S. Peters & K. D. Timmerhaus.
2. Projects: Planning, Analysis, Selection, Financing, Implementation and Review by Prasanna Chandra.
3. Project Engineering of Process Plants by H. F. Rase
4. Pilot Plants and Models and Scale up Methods in Chemical Engineering by R. E. Johnston.

CH8TPE51: Petrochemical Technology (3 1 0)

Unit I : Survey of Petrochemical Industries : Petrochemical Industries in India, Plastic and Synthetic Fiber Industries, Product of Petroleum Industries, Feed Stocks for Petrochemical Production, Purification and Separation of Feed Stocks, Chemicals from Methane.

Unit II : Chemicals From C_2 Hydrocarbons : Chemicals from Ethane, Ethylene and Acetylene, Naphtha Cracking and Reforming, Hydrogen from Reforming of Hydrocarbons.

Unit III : Chemicals From C_3, C_4 and Higher Fractions : Chemicals from Propane, Propylene, Butanes, Butylene etc. Production of Synthesis Gases from Higher Fractions. Carbon Compound, Dehydrogenation of Hydrocarbon and Higher Paraffins.

Unit IV : Polymers of Olefins : Polymers and their Properties, Polymers from Olefins-Polyethylene (HDPE, LDPE), Polypropylene, Vinyl Polymers. Production of BTX, Benzene Derivatives, Products from Toluene, Oxidation Products of Toluene, Synthetic Fibers and their Production.

Unit V : Synthetic Rubber, Plastics and Detergents : Synthetic Rubber and its Production, Classifications of Plastics, Different types of Resin and their Production, ABS Plastics, Poly Carbonates (PC), Poly Urethanes, Polyamides, Polystyrene, Synthetic Detergents and their Production, Petroleum Coke and Carbon Black.

Text Books :

1. Modern Petroleum Technology by G.D. Hobson and W Pow.
2. A Textbook on Petrochemical Technology by Bhaskara Rao.

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CH8TPE52: Polymer Technology - II (3 1 0)

Unit I : Additives, Blends & Composites : Additives, Plasticizers, Fillers & Reinforcements, Stabilizers, Flame Retardants, Biocides, Processing Additives, Colorants, Polymer Blends, Interpenetrating Network, Introduction to Polymer Composites, Composite Fabrication.

Unit II : Polymer Reaction : Hydrolysis, Acidolysis, Aminolysis, Hydrogenation, Addition and Substitution Reaction, Reaction of Various Specific Groups, Cross Linking Reaction, Reaction Leading of Graft & Block Copolymers, Miscellaneous Reactions.

Unit III : Experimental Methods : Polymers Synthesis, Isolation and Purification of Polymers, Polymer Fractionation, Molecular Weight Determination, Molecular Weight Distribution Curve, Determination of Glass Transition Temperature.

Unit IV : Engineering and Specialty Polymers : Engineering Thermoplastics, Polyolefins, Vinyl Polymers, Polyamides, Polycarbonates, Polysulphone, Fluoropolymers, Inorganic Polymers, Thermoplastic Polyesters, Natural and Synthetic Rubber, Cellulose and its Derivatives.

Unit V : Polymer Processing & its Manufacturing : Basic Processing Operations, Extrusion, Modeling, Calendering, Coating, Injection Moulding, Compression Moulding, Transfer Moulding, Blow Moulding, Die Casting, Rotation Casting, Film Casting.

Text Books:

1. Polymer Science and Technology by Fried
2. Outlines of Polymer Technology by Sinha PHI

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CH8TPE53: Membrane Separation Processes (3 1 0)

Introduction to Membrane Separation Process, Principle of Membrane Separation, Physical and Chemical Properties of Membranes, Classification, Driving Forces in Membrane Separation Processes, Advantages and Limitations of Membrane Processes, Membrane Types, Materials, Preparation and Characterization, Various Methods of Membrane Manufacture, Structure and Function of Symmetric and Asymmetric Membranes, Membrane Modules, Module Cascading, Chemical Potential and Osmosis, Retention and Permeability and its Estimation, Salt Rejection, Concentration Polarization and Membrane Fouling, Concept of Zeta Potential, Major Application Areas of Membrane, Various Membrane Processes, Design, Operation, Maintenance and Industrial Applications of Membrane Based Processes.

Text Books :

1. Separation Process Principles by J. D. Seader, Ernest J. Henley, Wiley
2. Separation Process Engineering by Phillip C. Wankat, PHI
3. Membrane Technology and Applications by R W Baker, John Wiley and Sons, Ltd, UK.
4. Membrane Separation Processes by K. Nath, PHI, New Delhi

Reference :

1. Webcourse (NPTEL) Novel Separation Processes by Prof. Sirshendu De, IIT Kharagpur

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CH8TOE41 : Optimization Techniques (3 1 0)

System Analysis and Modeling : Introduction to Systems Analysis and Modeling with Reference to Chemical Engineering Problems, Differential Method for Solving One and Two Variable Problems With and Without Constraints, Case Studies, Application of Langrangian Multiplier Method.

Search Methods: One Dimensional Search Method- Newton's Method, Quasi Newton's Method, Polynomial Approximation Methods, Sequential Search Methods - Golden Section Method, Dichotomous Search Method, Interval Halving Method, Fibonacci Method.

Linear Programming: Modeling, Graphical Method, Single Phase Simplex Method, Two Phase Simplex Method, Duality, Dual Simplex Method.

Geometric Programming: As Applied to Chemical Engineering Problems with Degree of Difficulty Equal to Zero and One, with and without Constraints.

Dynamic Programming: Introduction to Dynamic Programming as Applied to Discrete Multistage Problems Like Cascade of CSTR, Train of Heat Exchanger etc., Computer Programming Techniques applied to Optimization.
Methods for Global Optimization.

Text Books :

1. Optimization Theory and Practice by Beveridge and Schecheter
2. Optimization Techniques for chemical Engineers by AsgharHussain
3. Optimization by S.S. Rao
4. Linear Programming by Hadley

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CH8TOE42: Process Modeling & Simulation (3 1 0)

Introduction : Uses of Mathematical Models, Scope of Coverage, Principles of Formulations. Mathematical Modeling in Chemical Reaction Engineering: CSTR, PFR, Batch Reactor, Semibatch Reactor, Series of Isothermal CSTR, Constant Hold-Up CSTR's, CSTR's with Variable Hold Ups, Gas Phase Pressurized CSTR, Non Isothermal CSTR, Bioreactor, Trikle Bed Reactor.

Mathematical Modeling in Mass Transfer : Ideal Binary Distillation Column, Multi-Component Non-ideal Distillation Column, Batch Distillation with Hold Up, Steam Distillation, Multi-Solute Batch Liquid- Liquid Extraction, Continuous Extraction, Multistage Countercurrent Extraction, Plug Flow Type Liquid- Liquid Extraction, Reactor with Mass Transfer, Absorption, Adsorption.

Mathematical Modeling in Heat Transfer : Two Heated Tanks, Single Component Vaporizer, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Multicomponent Flash Drum, Cooling Towers.

Mathematical Modeling of Other Chemical Processes: Interacting and Non-Interacting Systems with and without Heaters, Isothermal Hydraulic System, Forward and Backward Feed Triple Effect Evaporator.

Introduction of MATLAB and Use of Language, Simulation, Program Development and Numerical Solutions of Above Processes.

Text Books :

1. Process Modeling, Simulation and Control for Chemical Engineers by W. L. Luyben, McGraw Hill, 1990.
2. Process Plant Simulation by B. V. Babu, Oxford University Press, 2004.
3. Optimisation Techniques for Chemical Engineers by A. Hussain and K. Gangaiah, Macmillan, 2001.
4. Process Control: Modeling, Design and Simulation by B. W. Bequette. Prentice-Hall India, 2006.
5. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.

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CH8TOE43: Renewable Energy (3 1 0)

Introduction- World Energy Status, Current Energy Scenario in India, Environmental Aspects of Energy Utilization, Energy and Sustainable Development.

Solar Energy - Basic Concepts, Flat Plate and Concentrating Collectors, Solar Desalination, Solar Photo Voltaic Conversion, Solar Cells.

Wind Energy - Availability, Wind Power Plants, Wind Energy Conversion Systems, Site Characteristics, Types of Wind Turbines.

Energy from Biomass - Biomass Resources, Biomass Conservation Technologies- Direction Combustion, Pyrolysis, Gasification, Anaerobic Digestion, Bioethanol and Biodiesel Production.

Other Renewable Sources - Tidal Energy, Geothermal Energy, Hydroelectric.

Text Books :

1. Renewable Energy Resources by John Twidell and Tony Weir, Taylor & Francis
2. Renewable Energy Sources and Emerging Technologies by D.P. Kothari, K. C. Singal, Rakesh Ranjan, PHI Learning Pvt Ltd.
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