



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited "A++" Grade by NAAC | 12B Status by UGC | Approved by AICTE

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School of Bio and Chemical Engineering

Department of Chemical Engineering

1.2.1 New Courses Introduced in 2022- 2023

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S11BLH12	PROBLEM SOLVING TECHNIQUES USING C	L	T	P	EL	C	Total Marks
		2	0	2	0	3	100

Course Objective:

- Understand control structures, functions and Arrays in C.
- Construct modules for real time applications using Functions in C.
- Comprehend pointers and file handling mechanisms.

UNIT 1: BITS AND BYTES IN COMPUTING**9 Hrs.**

Computers: Hardware – Software – Processor – Memory – I/O devices – Interface – Programming Languages – Evolution from COBOL, FORTRAN to C, Python – Need

Algorithms: Role in problem solving – Analysis – Design – Flowcharts: Role in problem solving – Symbols – Design – Pseudocode: Role in problem solving – Design - Program: Role in problem solving – Design

Practice Problems:

1. Describe a simple real world problem in your domain/department and describe it in the form of problem statement, input, output and provide its solution in terms of algorithm, flowchart, **pseudo code and program.**

UNIT 2: C: MATH BEHIND CODING**9 Hrs.**

C: Structure of program – Character set – Tokens – Keywords – Identifiers – Constants – Variables – Datatypes – Strings – Operators and its types – Functions – Header Files

Algorithmic Strategies: Iteration and Recursion – Efficiency – **Role of Time and Space consumption while building an algorithm – Complexities**

Practice Problems:

1. Describe a simple real world problem in your domain/department and provide a computing and non-computing solution for the same. Calculate the time and space consumed in both solutions. Compare and contrast the pros and cons in both solutions.
2. Write an algorithm, flowchart, pseudo code followed by a simple C code to do find the Factorial and Fibonacci series using both iteration and recursion.

UNIT 3: C: MAGIC BEHIND INSTANT OUTPUTS**9 Hrs.**

Advanced Coding Concepts: Decision Making using Branching Statements and its types – **Decision Making using Looping Statements and its types** – Switch Statements – Break – Continue – Goto – Jump Statements

Case Study: Fun with Code -- Printing Alphabets / Flags of Countries / Flying Alphabet Screensaver

Practice Problems:

1. Describe a problem statement in your domain/department whose solution involves repetition of same steps and provide code as solution involving for, while and do while loops.
2. Describe a problem statement in your domain/department whose solution involves decision making and provide code as solution involving if-else, nested if-else and ladder if-else.
3. **Develop a simple scientific calculator using Switch case statement.**

UNIT 4: STORING GROUP OF HOMOGENOUS ELEMENTS: ARRAYS**9 Hrs.**

Diving into Arrays: Definition – Syntax – Types – Representation: Row & Column Order – Dynamic Arrays

Idea behind Functions: Declaration – Definition – Types – Calling – Arguments – Prototypes – Call by Value – Call by Reference – Pointers

Case Study: Fun with Code – Simple Game Development using Arrays and Functions

Practice Problems:

1. Describe a problem statement in your domain/department where you need to work with group of same type of data. Provide a solution in terms of C program to store and manage the data effectively.
2. You're playing UNO cards, suddenly a person is getting rev card. Write a C program to reverse the round by storing the number of players in array.
3. Write a C program for Vehicle Regulation System where odd number ending vehicles can use the road on odd days and even number ending vehicles can use the road on even days using two separate arrays to store and display the odd and even numbers.

UNIT 5: STORING GROUP OF HETEROGENOUS ELEMENTS: ARRAYS**9 Hrs.**

Outset of Structure and Union: Structure Definition & Declaration – Structures Fusion with: Arrays – Pointers – Functions–

Union Initiation, Definition & Declaration

Working with Files: File Handling Functions – Read – Write – Other Operations – Different File Types

Case Study: Report on using File Functions to create Score Board for any game, importing it to program

Practice Problems:

1. Describe a problem statement in your domain/department where you need to work with group of different type of data. Provide a solution in terms of C program to store and manage the data effectively.
2. Write a C program to get the details of the student (roll no, name, date of birth, state, 10th percentage and 12th percentage) using Structure. Calculate the age of the student and display the eligibility status for his admission. Eligibility criteria: more than 60 percent in 10th and 12th, age>=17, state==TN.
3. Write a menu driven C program for library management system with ten entries:
(i). Add Book (ii). Add Author (iii). Add Category (iv). Book Cost
(v). Display - Book by Author, Book by Category, Book under cost
4. Write a C program to create an employee Union with employee details (id, name, salary) Accept the details of 'n' employees, rearrange the data in ascending order of employee name, id and salary as three different functions and display it.

Max.: 45 Hrs

COURSE OUTCOMES:

On completion of the course, student will be able to

- CO1. - Interpret the difference between components of problem solving such as algorithm, flowchart, pseudo code and source code.
- CO2. - Build simple solution for any given problem statement using various components of problem solving techniques and measure its efficiency in terms of time and space.
- CO3. - Infer and examine the roots and foundation of C programming's key concepts like Data types, Operators.
- CO4. - Devise and correlate the use of different core concepts such as Arrays and Functions in C language.
- CO5. - Formulate real time solutions through programs using Structure and Union in C language.
- CO6. - Design and Develop various Application Oriented Program for solving real time societal problems.

TEXT / REFERENCE BOOKS

1. Yashavant Kanetkar, 'Let us C', BPB Publications, Fourteenth Edition
2. R.G. Dromey "How to solve it by computer", Pearson Education, Low Price Edition.
3. Balagurusamy, "Programming in ANSI C", McGrawHill Publications, Eighth Edition.
4. Greg Perry, Dean Miller "C Programming Absolute Beginner's Guide", Third Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Exam Duration: 3Hrs.

PartA:10 Questions of 2marks each-No choice

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks



SCYB1101	CHEMISTRY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To understand the basic concepts of quantum chemistry from bonds to bands
- To learn the principles and applications of energy levels in molecules
- To know the importance of electrochemistry in batteries.
- To explore the concept of corrosion mechanism and design principles.
- To study the various synthetic approaches in nano chemistry.

UNIT 1: ATOMIC AND MOLECULAR STRUCTURE**9 Hrs.**

Introduction to quantum chemistry – Motion of a quantum mechanical particle in one dimension (time-independent) – Physical meaning of wave function – Schrodinger equation for Hydrogen atom (No derivation. Only wave function). Angular and radial wave functions and probability densities – Quantum numbers – Principal, azimuthal, spin and magnetic quantum numbers – Wave functions and orbital shapes - s, p, d, f - LCAO-MO of H₂ – Band theory of solids: Conductors, semi-conductors– Role of As and Ga doping on band structures.

UNIT 2: MOLECULAR SPECTROSCOPY**9 Hrs.**

Electromagnetic spectrum – Interaction of radiation with matter – Energy levels in molecules – Microwave spectroscopy – Principle – Classification of molecules based on moment of Inertia – Rotational energy expression (J levels) – Calculation of J for CO molecule – Vibrational spectroscopy – Normal modes of vibrations – Vibrations of polyatomic molecules (CO₂ and H₂O) – Determination of Force constant – [Electronic transitions in organic molecules](#) – Mathematical derivation of Beer- Lambert's law.

UNIT 3: ELECTROCHEMISTRY**9 Hrs.**

Electrochemistry: Galvanic cell - Electrochemical cell representation - EMF series and its significance. Batteries: Terminology – Mechanism of Lead-acid accumulator - Mechanism of Nickel-cadmium batteries. Mechanism of Lithium batteries: Li/SOCl₂ cell - Li/I₂ cell - Lithium-ion batteries. [Mechanism of Fuel Cells: Hydrogen-oxygen fuel cells](#) - Solid oxide fuel cell (SOFC).

UNIT 4: CORROSION SCIENCE**9 Hrs.**

Introduction: Definition. Types: Dry corrosion: Mechanism - Pilling-Bedworth rule – Wet Corrosion: Mechanism. Types: Galvanic corrosion and differential aeration cell corrosion. Galvanic series and its significance. Factors influencing corrosion. Corrosion prevention: Material selection and design - Cathodic protection – Sacrificial anodic method and impressed current method – Inhibitors – Anodic and Cathodic inhibitors.

UNIT 5: CHEMISTRY OF MATERIAL SCIENCES**9 Hrs.**

Phase equilibria: Gibbs phase rule – Terms involved in Phase rule – Phase diagram of water system – Thermal method of analysis – Construction of simple eutectic system (Lead-Silver alloy system). Fuels– Classification of fuels – Determination of calorific values of solid fuels by bomb calorimeter– [Manufacture of synthetic petrol by Fischer-Tropsch method](#) – Knocking in IC engines – Chemical structure – Octane and cetane rating of fuels. Nanomaterials: Size dependent properties of nanomaterials – [Synthesis of gold and silver nanoparticles by Chemical reduction method– Applications of nanoparticles in medicine.](#)

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Apply the principles of quantum chemistry for energy level quantization in molecules.
- CO2. - Analyze the molecular transitions by interaction of EMR with matter
- CO3. - Assess the reaction mechanism in electrochemical storage device
- CO4. - Comprehend the corrosion mechanism for environmental sustainability. Examine the mechanism of corrosion for mitigation.
- CO5. - Interpret the role of phase diagram/ fuels/ nanoparticles in chemical/ material science.
- CO6. - Apply the concept of chemical science in real world applications.

TEXT / REFERENCE BOOKS

1. A.K.Chandra, Introductory Quantum Chemistry, Tata McGraw-Hill, 4th edition, 2019.

2. Ira N. Levine, Physical chemistry, 6th Edition, 2018.
3. Ira N. Levine, Quantum chemistry, 7th Edition, 2013.
4. David W. Ball and Thomas Baer, Physical Chemistry, Wadsworth Cengage Learning, 2nd Edition, 2014.
5. Mars G Fontana, Corrosion Engineering, 3rd Edition, Tata McGraw Hill, 2018.
6. Douglas A. Skoog and Donald M. West, Principles of Instrumental Analysis, Cengage, 6th Edition, 2014.
7. P.C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai Publication, 2018.
8. David Linden, Thomas B Reddy, Handbook of Batteries, 4th Edition, McGraw-Hill, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Exam Duration: 3Hrs.

PartA:10 Questions of 2marks each-No choice

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks

SCHB1101	PARTICULATE SCIENCE AND TECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To confer information on the systematic guideline diagrams of Unit operations involved in chemical industries.
- To learn the concepts of design, operation details and schematic of industrial equipment

UNIT 1: INTRODUCTION**9 Hrs.**

Introduction to Particulate Solids Particle Shape, Size, Mixed Particle Sizes and Size Analysis, Cumulative and Differential Analysis, Various Mean Diameters, Screen Analysis Standard Screens, [Various Industrial Screens](#)

UNIT 2: PARTICLE SEPARATION**9 Hrs.**

Particle Separation Introduction to Particle Separation, [Electrostatic Precipitation and Magnetic Separation](#), Storage of Solids [Size Reduction](#) Size Reduction, Principles of Comminution, Energy and Power Requirements in Comminution, Mechanical Efficiency, Laws of Crushing, Size Reduction Equipment, Crushers, Grinders Cutting Machines, Open and Closed-Circuit Operation

UNIT 3: SEPARATION**9 Hrs.**

Particulate Solids Flow Motion of a Particle through a Fluid, Terminal Velocity, Free and Hindered Settling. Classification: Separations Ratio, Classification Equipment, [Gravity Settling Tank](#), [Elutriator](#), [Cone Classifiers](#), [Bowl Classifier](#), [Centrifugal Classifier](#), [Cyclone Separator](#), [Wet Scrubber](#)

UNIT 4: SEDIMENTATION**9 Hrs.**

Hydro-Mechanical Separations Sedimentation: Gravity Sedimentation, Mechanism, Continuous Sedimentation, Thickener: [Design of thickener](#), [Classifier and Clarifier](#), Settling Area, Centrifugal Sedimentation Centrifuges, Hydro clones. Floatation Equipment: Modifiers, Collectors, Frothing Agents

UNIT 5: FILTRATION**9 Hrs.**

Filtration, Filter Media, Filter Aids, Principles of Cake Filtration, Constant Pressure Filtration, Constant Rate Filtration, Pressure Drop Through Filter Cake, Compressible and Incompressible Filter Cakes, Specific Cake Resistance, Filter Medium Resistance. [Filtration Equipment](#), Filter Presses, Leaf Filter, Rotary Continuous Filters. [Principles of Centrifugal Filtration-Washing of Filter Cake](#)

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Demonstrate the basic principles in unit operations
- CO2. - Calculate the size distribution of average particles
- CO3. - Discriminate the various size reduction equipment
- CO4. - Identify the suitable separation technique based on particle characteristics
- CO5. - Estimate the filtration parameters
- CO6. - Evaluate the agitation vessel based on standard design criterion

TEXT / REFERENCE BOOKS

1. W. L. McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th Ed., McGraw Hill, 2005
2. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 2 (Particle Technology & Separation Processes), 5th ed., Butterworth – Heinemann Publishing Ltd., USA, 2001.
3. Narayanan C.M., Bhattacharya B.C., Mechanical Operations for Chemical Engineers, 3rd ed., Khanna Publishers, India, 2011

. END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Exam Duration: 3Hrs.

PartA:10 Questions of 2marks each-No choice

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks

SCYB1201	INDUSTRIAL CHEMISTRY	L	T	P	C	Total Marks
		3	0	0	3	100

Course Objective:**UNIT 1: CHEMISTRY OF TRANSITION METALS****9 Hrs.**

Crystal Field Theory – CFSE – Octahedral symmetry – Tetrahedral symmetry – square planar symmetry -factors affecting CFSE – Applications of CFSE – Jahn-Teller distortion (Z in and out case) – consequences – Orgel diagrams (d^1 & d^9 , d^2 & d^8 complex) –electronic spectra of copper complex only- number of peaks -calculation of crystal field parameters for d^3 , d^8 systems – charge transfer spectra.

Introduction to Bio-Inorganic Chemistry, Metalloprotein (Hb, Mb, Transferrin) and Metalloenzyme.

UNIT 2: SOLUTIONS**9 Hrs.**

Introduction: Solid solution - Hume Rothery's rule. Types of solid solutions: Liquid solutions: Solubility of partially miscible liquids - Phenol-water system. Colligative properties: Lowering of vapour pressure. Raoult's law: Derivation - Osmotic pressure - Isotonic solution - [Relationship between osmotic pressure and vapour pressure](#). Depression in freezing point - Derivation. Elevation in boiling point - Derivation - Problems.

UNIT 3: CATALYSIS**9 Hrs.**

Introduction - Types of catalysis- [Homogeneous catalysis](#)- examples- kinetics; Heterogeneous catalysis- example- kinetics, enzyme catalysis- Michaelis-Menten kinetics- [role of catalyst in industrial process](#)- Contact process, Haber's Process, Wacker's Process, [Fischer-tropsch process](#), [cracking of hydrocarbons](#).

UNIT 4: ORGANIC REACTION MECHANISM**9 Hrs.**

Types of Reactions – Reaction Mechanism – Electrophilic substitution reactions in aromatic compounds - mechanisms of nitration - halogenation - sulphonation - [Friedel-Craft's acylation and alkylation](#) – Aliphatic nucleophilic substitutions - Mechanisms of SN_1 , SN_2 and SN_i reactions - effects of structure of substrate - solvent - nucleophile and leaving groups – Nucleophilic addition reactions – Nucleophilic addition to carbonyl groups

UNIT 5: INDUSTRIAL APPLICATIONS OF SUBSTITUTION AND ADDITION REACTIONS**9 Hrs.**

Industrial Applications of Addition Reactions – Addition reactions of $C = C$ bonds – Hydrogenation of vegetable oil – Hydrogenation of alkene – Hydrohalogenation of alkene - Addition reactions of $C = O$ bond – Synthesis of Cyanohydrin – Synthesis of hemi-acetal – Synthesis of alcohols using Grignard reagent – Industrial Applications of Substitution Reactions – Formation of Carbon – Heteroatom bond ($C - Cl$ bond, $C - N$ bond, $C - S$ bond and $C - O$ bond) – Synthesis of Aryl halides – [Synthesis of Nitro compound](#), [Synthesis of Aryl Sulphonic acid](#) and [Synthesis of paracetamol in pharma industries](#).

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Construct phase diagram for one, two and three component system
- CO2. - Deduce the molecular weight from the solubility of solutes in liquids and gases
- CO3. - Assess different separating techniques for chemical system
- CO4. - Predict the rate of chemical reactions and their mechanism
- CO5. - Examine the molecular motion in liquids and their applications
- CO6. - Relate the basic chemistry concepts in science and technology

TEXT / REFERENCE BOOKS

- 1.Puri B.R., Sharma L. R., Madan. S.Pathania, Principles of Physical Chemistry, 41st Edition , Vishal Publishing co., 2004.
2. Keith J. Laidler, Chemical Kinetics, Third Edition, Pearson education limited, 2004.
3. Atkins P. W., Physical Chemistry, 6th edition, Oxford University press, 1998.
- 4.Barrow G. M., Physical Chemistry, 5th edition, McGraw-Hill, 1988.
- 5.Glasstone S., A Text book of Physical Chemistry, Macmillan Ltd, 1976.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB2302	MECHANICAL OPERATIONS LAB	L	T	P	EL	C	Total Marks
		0	0	4	0	2	100

Course Objective:

- To understand the importance of various mechanical operations used in process industry.
- To apply principles of basic sciences and chemical engineering for designing various size reduction, size separation and conveying equipment's.

LIST OF EXPERIMENT

1. Batch Sedimentation: To study the batch setting & design of Thickener for given under-sludge concentration.
2. Particle size distribution - differential and cumulative analysis by manual method using standard screens
3. Sieve Analysis: Determination of Screen Effectiveness by Mechanical Method using Standard screens
4. Jaw Crusher: To verify the laws of crushing.
5. Ball Mill: To verify the laws of crushing.
6. Cyclone Separator: To study the separation of fine solid dust particle from the air.
7. Drop weight Crusher: Energy requirement and crushing constants determination using Drop weight crusher
8. Centrifuge: To study the separation of sludge by applying centrifugal force.
9. Magnetic Separator: To find out the efficiency of magnetic separator.
10. Leaf Filter: To find out the rate of Filtration & resistance offered by cake & filter media.
11. Sampling methods: To study different sampling method to determine the average diameter of the particle.
12. Plate & Frame Filter Press: To study batch filtration in Plate & Frame Filter Press.
13. Stoke's law: Determine the settling velocity

COURSE OUTCOMES:

On completion of the course, student will able to

- CO1. - Apply the principles of unit operations through experimentation and
- CO2. - Demonstrate the ability to understand the various equipment's used in chemical and allied process industry.
- CO3. - Estimation of filtration constants
- CO4. - Determination of minimum thickener area
- CO5. - Compute power laws using roll crusher.
- CO6. - Calculate size reduction ratio, grindability index using ball mill and jaw crusher

SCHB1401	PHASE EQUILIBRIUM THERMODYNAMICS	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- This course helps the students to be proficient in applying thermodynamic principles to various chemical engineering processes involving energy flow, phase and reaction equilibrium.

UNIT 1: PROPERTIES OF SOLUTIONS**9 Hrs.**

Introduction to ideal and non-ideal solutions, Partial molar properties, [chemical potential](#), effect of temperature and pressure on chemical potential, fugacity and fugacity coefficient in solution, Lewis Randell rule, Raoult's law, Henry's law, activity and activity coefficients in solutions, effect of temperature and pressure on activity coefficients, [Gibbs Duhem equations](#), applications, property changes on mixing, heat effects of mixing processes, excess properties, relation between excess Gibbs free energy and activity coefficient.

UNIT 2: PHASE EQUILIBRIA**9 Hrs.**

Criteria for equilibrium between phases in single and multi-component non-reacting systems in terms of chemical potential and fugacity, phase rule & its application, Duhem's theorem, [vapor-liquid equilibrium](#), [phase diagrams for homogeneous systems](#), [VLE in ideal solutions](#), [non-ideal solutions](#), positive and negative deviation, azeotropes, effect of temperature and pressure on azeotrope composition, P_{xy} and T_{xy} diagrams.

UNIT 3: CORRELATION AND PREDICTION OF PHASE EQUILIBRIA**9 Hrs.**

Simple models for VLE, VLE at low pressures, Wohls equation, Van Laar equation, Wilson equation, application of activity coefficient equations in equilibrium calculations, basic idea on NRTL, UNIQUAC and UNIFAC, [Dewpoint and bubble point calculations with Raoult's law for binary mixtures](#), [VLE by modified Raoult's law](#), [VLE from K-value Correlations](#).

UNIT 4: APPLICATION OF PHASE EQUILIBRIA**9 Hrs.**

Excess Gibbs free energy model, thermodynamic consistency of phase equilibria, [application of the correlation and prediction of phase equilibria in distillation process](#). Liquid-liquid equilibrium, binary and ternary equilibrium diagrams, use of triangular diagrams for ternary equilibrium, Different types of ternary systems and their representation on triangular coordinates. Introduction to VLLE, solid vapor equilibrium, solid liquid equilibrium.

UNIT 5: CHEMICAL REACTION EQUILIBRIA**9 Hrs.**

Chemical reaction equilibria, reactions stoichiometry, criteria of chemical equilibrium, equilibrium constant, standard free energy change, standard state, [feasibility of reaction](#), [effect of temperature on equilibrium constant](#), Giauque Functions, [evaluation of K](#), [equilibrium conversion in gas phase reactions](#), effect of pressure on equilibrium constant, [effect of pressure](#), [Inert materials](#), [excess of reactants & products on equilibrium](#) composition. phase-rule for reacting systems.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Explain the partial molar properties of solutions
- CO2. - Ability to distinguish ideal and non-ideal solution based on thermodynamic properties
- CO3. - Apply phase equilibrium
- CO4. - Analyze phase equilibria
- CO5. - Estimate of phase equilibria
- CO6. - Predict chemical reaction equilibria

TEXT / REFERENCE BOOKS

- Smith, J.M., and Van Ness, H.C., Introduction to Chemical Engineering Thermodynamics, 9th Edition Mc-Graw-Hill, 20015.
- Narayanan K.V, A Text Book of Chemical Engineering Thermodynamics, 3rd Edition Prentice Hall of India Pvt. Ltd. 2013.
- Gopinath Halder., Introduction to Chemical Engineering Thermodynamics, 3rd Edition, PHI Learning Private Limited, 20019.
- Rao Y.V.C., Chemical Engineering Thermodynamics, 3rd Edition, University Press (I) Ltd., Hyderabad, 20014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCSBDPRROJ	DESIGN THINKING AND INNOVATIONS	L	T	P	EL	C	Total Marks
		0	0	4	0	2	100

Course Objective:

- To apply knowledge in Real time problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to Engineering /Non-Engineering problems.

Activity 1:**Design thinking introduction:**

- Phases of design thinking- a study approach
 - Group Discussion on Ideation- User's perspective
- Formation of team – Thinking skills- Brain storming

Activity 2:**Problem identification (phase I)**

- Selecting user requirements
- Survey on various user's applications
- Specific Problem selection to proceed with the work – Team presentation on identified problems and various possible solutions.

Activity 3:**Problem identification (Phase II)**

- Study of an application and its importance to end user.
- Various models of an applications
- Finalize the identified problem

Activity 4:**Design ideation and various stages**

- Sketch design diagram
- Architecture or full diagrammatic study

Activity 5:**Review and upgradation**

- Review of the ideation (one to one interaction)
- Feedback
- Upgradation plan

Activity 6:**Implementation (Phase I)**

- Build the prototype using available resources
- Record Module diagrams

Activity 7:**Implementation (Phase II)**

- Display and review of the prototype.
- Record its functionality and its Usage-Technical manual

Activity 8:**Testing**

- To test the product design with real time environment
- Record Process-user manual

Activity 9:**IPR-Activity I**

- To study various IPR activities
- To prepare for IPR Process
- To file an IPR

Activity 10:**Start-ups Formation**

- To exhibit the product to public: feedback approach
- To prepare full documentation
- Start-ups registration/apply patent/publish paper/submit model/prototype/Apply for seed/submit research proposal

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Solve real world problems by applying knowledge across domains
- CO2. - Develop various design products, processes or technologies for sustainable and socially relevant applications
- CO3. - Demonstrate knowledge of resource utilization/budgets to Implement appropriate methodologies
- CO4. - Execute tasks by application of engineering standards/ requirements/ design criteria, within timelines
- CO5. - Conduct extended investigation that results in the translation of idea to product / production of a research thesis/ developing a proof of concept.
- CO6. - Communicate well organized technical and scientific findings effectively in written and oral forms, following ethical and professional norms

TEXT / REFERENCE BOOKS

1. Mueller-Roterberg, Christian. "Handbook of Design Thinking." Hochschule Ruhr West (2018).
2. Design Kit by IDEO.org. "The field guide to human centered design." (2015), ISBN: 978-0-9914063-1-9.
3. <https://www.interaction-design.org/literature/article/design-thinking-getting-started-with-empathy>
4. <https://www.interaction-design.org/literature/article/stage-4-in-the-design-thinking-process-prototype>
5. <https://www.interaction-design.org/literature/article/test-your-prototypes-how-to-gather-feedback-and-maximise-learning>
6. <https://uxplanet.org/what-are-insights-aa1f2d1b3b9c>
7. <https://labs.sogeti.com/using-design-thinking-to-design-business-models/>
<https://www.northeastern.edu/graduate/blog/implementing-business-model-innovation/>

SCHB1601	CONTINUUM MECHANICS & TRANSPORT PHENOMENA	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To provide the fundamental for the application of basic laws of mass, momentum, and energy transport in engineering analysis

UNIT 1: MOMENTUM TRANSPORT**9 Hrs.**

Importance of transport phenomena, analogous nature of transfer process, introduction of viscosity and mechanism of momentum transport: Newton's law of viscosity, [Newtonian & Non-Newtonian fluids](#), [pressure and temperature dependence of viscosity](#), [theory of viscosity of gases and liquids](#). Velocity distribution in laminar flow: Shell momentum balances of - a) Flow of falling film b) Flow through the circular tube c) Flow through an annulus d) Flow in a narrow-slit e) Adjacent flow of two immiscible fluids

UNIT 2: ENERGY TRANSPORT**9 Hrs.**

The introduction of thermal conductivity and mechanism of energy transport: [Fourier's law of heat conduction](#), [temperature and pressure dependence of thermal conductivity in gases and liquids](#). Temperature distribution in solids and in laminar flow & numerical problems: a) Shell energy balance, boundary conditions b) Heat conduction with electrical heat source c) Heat conduction with a nuclear heat source d) Heat conduction with a viscous heat source e) Heat conduction with a chemical heat source f) Heat conduction with variable thermal conductivity g) Forced and free convection h) Heat conduction in a cooling fin

UNIT 3: MASS TRANSPORT**9 Hrs.**

Introduction of [diffusivity and mechanism of mass transport](#): [Definitions of concentrations, velocities and mass fluxes](#), [Fick's law of diffusion](#), [temperature and pressure dependence of mass diffusivity](#). Concentration distribution in solids and in laminar flow & numerical problems: a) Shell mass balances, boundary conditions b) Diffusion through stagnant gas film c) Diffusion with heterogeneous chemical reaction d) Diffusion with homogeneous chemical reaction e) Diffusion through leaching.

UNIT 4: FLUID FLOW AND FRICTION**9 Hrs.**

Equations of change for isothermal system: a) [The equation of continuity](#) b) [The equation of motion](#) c) Equation of change in curvilinear coordinate systems d) Use of equation of change to set up steady flow problem e) Equation of mechanical energy f) Dimensional analysis of equation of change. Interphase transport: a) Defining friction factors b) Friction factors for flow in tube, around spheres & packed column. Macroscopic balances for Isothermal systems - a) [The macroscopic mass, momentum and mechanical energy balances](#) b) Sudden enlargement and liquid-liquid ejector c) Semi empirical expressions for Reynolds stresses

UNIT 5: MULTI COMPONENT SYSTEM**9 Hrs.**

Interphase transport in multi component system: a) Definition of binary mass transfer coefficient in one phase b) [Co-relation of binary mass transfer coefficient in one phase at low mass transfer rates](#) c) Co-relation of binary mass transfer coefficient in two phases at low mass transfer rates d) Definition of transfer coefficient for high mass transfer rates Reynold's analogy, Prandtl's analogy, Chilton and Colburn analogy & Martinelli's analogy.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will be able to

- CO1. - Solve the mechanisms of momentum transfer each at molecular, micro and macro levels.
 CO2. - Develop mathematical models to solve heat flux
 CO3. - Explain the mass transfer in gas-liquid system and in chemical reactions
 CO4. - Apply the basics to solve of momentum, mass and heat transport problems.
 CO5. - Interpret the interrelationship between the microscopic and macroscopic descriptions of transport processes
 CO6. - Formulate the analogy between transports and understand the turbulence.

TEXT / REFERENCE BOOKS

- Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, 2nd Edition, Wiley, New York, 2006,
- Roy S. C. and C. Guha., Introduction to Transport Phenomena, 1st Edition, Dhanpat Rai & Co, 2008.

3. Welty J.R., Wilson R.W. and Wicks C.W., Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007.
4. William M. Deen, Analysis of Transport Phenomena, 5th Edition, John Wiley & Sons, New York, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Exam Duration: 3Hrs.

PartA:10 Questions of 2marks each-No choice

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks

SCHB1602	PROCESS & EQUIPMENT DESIGN	L	T	P	EL	C	Total Marks
		3	1	0	0	3	100

Course Objective:

- Formulate material balances to solve for compositions and flow rates of process streams
- Perform material and energy balance calculations in various unit operation and unit process

UNIT 1: INTRODUCTION**9 Hrs.**

Design project procedure, design information from the literature, flow diagrams, preliminary design, comparison of different processes, **equipment design**, scale-up in design. Materials of construction, selection of materials, **fabrication of equipment**

UNIT 2: PRESSURE VESSELS AND SUPPORTS**9 Hrs.**

Pressure vessels – calculation of thickness of cylindrical and spherical shells subjected to internal pressure, heads or covers. Storage vessels – storage of nonvolatile liquids, storage of volatile liquids, storage of gases. Supports for vessels – bracket or lug supports, leg supports, skirt supports, saddle supports. Types of reactors, **process design of batch reactor and continuous flow reactors, selection of reactors, mechanical features of reactor design.**

UNIT 3: MASS TRANSFER EQUIPMENT'S**9 Hrs.**

Finite-stage contactors- bubble cap tray, sieve tray and valve tray units, maximum allowable vapor velocities, plate and column efficiency. Continuous contactors – types of packing, liquid distribution, pressure drop, packing efficiencies

UNIT 4: HEAT TRANSFER EQUIPMENT'S**9 Hrs.**

Design of double pipe heat exchangers, Shell and tube heat exchangers (1-2,2-4), optimum design and heat recovery, selection of suitable heat exchanger. **Design of single and multiple effect evaporators**

UNIT 5: SEPARATION EQUIPMENT'S**9 Hrs.**

Design of cyclone separators, thickeners, filters, driers. Economic Evaluation – Measures of Economic Performance.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will be able to

- CO1. - Identify various materials for fabrication of equipment
- CO2. - Estimate the thickness of thin-walled pressure vessel and heads of the pressure vessel
- CO3. - Select the suitable contactor for a given mass transfer operation
- CO4. - Evaluate the design parameters of tray tower
- CO5. - Calculate the area of multiple effect evaporator and heat exchangers
- CO6. - Compare the performance of reactors and choose the appropriate reactor for the desired process

TEXT / REFERENCE BOOKS

1. Coulson J.M and Richardson J.F, "Chemical Engineering", Vol. 6, Pergamon Press, 4th edition, 2005.
2. Process Equipment Design by M. V. Joshi, 3rd edition, Macmillan India Limited 2003.
3. Perry J.H "Chemical Engineering Handbook", 7th edition, McGraw Hill, 1999.
4. Thakore S.B. and Bhat, B.I, "Introduction to Process Engineering and Design", Tata McGrawHill Publishing Co., New Delhi, 2007.
5. Backhurst, J.R and Harker, J.H - Process Plant Design: Heinemann Chemical Engineering Series. Published by Kent: Elsevier Science, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

S19BPB61	FACTORY AUTOMATION INDUSTRY 5.0	L	T	P	EL	C	Total Marks
		2	0	2	3	4	100

Course Objective:

- To demonstrate the achievement of efficient and economically viable production without being hazardous to human health and environment.
- Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges

UNIT 1: INTRODUCTION TO INDUSTRY 5.0**9 Hrs.**

The Various Industrial Revolutions - Modeling Principles: Introduction, definition of modeling and simulation, different types of models, application of mathematical modeling. **Simulation: Introduction, Simulation Tools, Process Simulation Software Platforms and Applications, Trends in Process Simulation Engineering.**

UNIT 2: ROAD TO INDUSTRY 5.0**9 Hrs.**

Green manufacturing, Robotic Automation, Industrial Applications- Manufacturing, Control, Maintenance and Assembly, RFID- Type, RFID system, applications, RFID in health care, Embedded Systems - Embedded firmware, Platform software design, Wireless design, Embedded testing, modeling & automation, Hardware platform design, Device Management, Monitoring – **Industrial monitoring, condition monitoring, Health monitoring.**

UNIT 3: TECHNOLOGIES FOR ENABLING INDUSTRY 5.0**9 Hrs.**

Role of data, information, knowledge and collaboration in future organizations. **Big Data** - Background - Programming-Python and R - Git - Docker - Pipelines - **DNA and RNA Sequencing** - Massively parallel sequencing - Applications - Next Generation Sequencing and its future and big data analytics in healthcare - **Big Data Repositories** - Cloud platforms and computing for automation - Embedded systems in healthcare - Digitization the future of healthcare - medical cyber physical systems - Case study - Integration of Multi-Omics Big Data in Cardiovascular Risks and Diseases.

UNIT 4: BUSINESS ISSUES IN INDUSTRY 5.0**9 Hrs.**

Nanobiotechnology: Synthesis of different Nanostructures, Characterization of Nanostructures, Nanostructures in Diagnosis and Therapy. Tissue Engineering: Scaffolds: Natural and Artificial polymers, Scaffold fabrication, 3D Bioprinting; Bioreactors for Tissue Engineering: Effect of different Parameters, Conditions; **Tissue engineering for Skin**, Bone, Vasculature and Cornea; **Regulatory framework in development and marketing tissue-based products.**

UNIT 5: APPLICATIONS AND CASE STUDIES**9 Hrs.**

New ideas – centered design process – functional prototype - testing methods/ideas – prototyping and test beds – proof of concept – assembly – prototyping apps – addressing the complex problems.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will be able to

- CO1. - Articulate on the new age technologies in the modeling of biochemical engineering.
- CO2. - Integrate different emerging technologies to evolve Smart Factories
- CO3. - Deduce the components that lead to industrial digital revolution
- CO4. - Ability to assess the developments in bioengineering.
- CO5. - Criticize the professional and ethical issues in novel industrial technologies.
- CO6. - Develop a prototype/ innovative idea in the various fields of biochemical engineering.

TEXT / REFERENCE BOOKS

1. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems, 1st Edition, CRC Press, 2020
2. Sider W.D., Seader J. D., and Lewin D.R., Product and Process Design principles, Synthesis, Analysis and Evaluation, 2nd Edition, John Wiley and Sons, 2010.
3. Thomas Varghese & K.M. Balakrishna, Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, Atlantic, 2012
4. UthayanElangovan, Smart Automation to Smart Manufacturing: Industrial Internet of Things, Momentum, 1st Edition, 2019.

SCHB2701	MAT LAB AND VIRTUAL INSTRUMENTATION LAB	L	T	P	EL	C	Total Marks
		0	0	4	0	2	100
Course Objective: - To develop the knowledge on the time and frequency response of the system using MATLAB software - To measure and control various process parameters using Labview software							
LIST OF EXPERIMENT							
1. Step, Ramp, Impulse response of First and Second orders System using Matlab 2. Identification of damping in Second order System using Matlab 3. Time Domain Analysis of Second Order System using Matlab 4. Frequency Response of Second Order System - Bode Plot using Matlab 5. Frequency Response of Second Order System -Polar Plot using Matlab							
Virtual instrumentation lab 1. Arithmetic operations using Labview 2. Building VI to demonstrate conversion of Centigrade to Fahrenheit and using Labview 3. Building VI to create a subroutine for conversion of Centigrade to Fahrenheit using Labview 4. Building VI to demonstrate ON-OFF controller using Labview 5. Building VI to demonstrate level controller using Labview 6. Building VI to demonstrate waveform generator using Labview							
COURSE OUTCOMES: On completion of the course, student will able to CO1. - To analyze the response of first order and second order systems CO2. - Identify the type of damping in second order systems CO3. - Evaluate the Time domain analysis of a system CO4. - Examine the Time and Frequency response using Bode plot CO5. - Build a Virtual Instrumentation based measuring system CO6. - Develop a Virtual Instrumentation based control for various parameters							

SCHB3001	EXPLORATION AND EXPLOITATION	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To provide the fundamental of petroleum exploration, different methods of geophysical surveys & instruments used for it.
- To provide the understanding of geophysical data interpretation and analysis

UNIT 1: THE EARTH**9 Hrs.**

Introduction to origin, age, internal structure and constitution of earth; introduction to earth's lithosphere, atmosphere, hydrosphere, and biosphere; Structural Geology Domain of Structural Geology; concepts of strike and dip; [parameters controlling deformation of rocks](#); [deformation in rocks](#) – descriptions of folds, joints, faults and their classifications

UNIT 2: SEDIMENTOLOGY**9 Hrs.**

Subaerial weathering processes: physical and chemical weathering; [Transport and deposition of sediments](#); [fundamentals of fluid flow](#), particle transport by fluids and by sediment gravity flows. Sedimentary textures: grain size, particle shape, sorting and fabric and their effect on porosity and permeability of sedimentary rocks.

UNIT 3: ORIGIN AND MIGRATION OF PETROLEUM**9 Hrs.**

Introduction to petroleum system. Theories of inorganic, Organic and duplex origin of petroleum. Conversion of organic matter to petroleum: diagenesis of organic matter and formation of kerogens, pristane and phytane; classification of kerogens; catagenesis, and metagenesis of kerogens; thermal maturity indicators. Classification, [composition, and physical properties of crude oils](#); composition of natural gases. Primary, Secondary, and Tertiary Migrations

UNIT 4: PETROLEUM TRAPS AND PETROLIFEROUS BASINS OF INDIA**9 Hrs.**

Traps and their associations. [Cap rock and seal formation](#): lithological aspects and capillary characteristics of seals; diagenetic seals. Trap formation: structural – fold (anticlinal) traps, fault (sealing/non-sealing) traps; growth faults; traps associated with salt domes; stratigraphic – channel sand, up-dip wedges, sand lenses, sand bars; carbonate traps (bioherm and biostrome), etc. Classification of sedimentary basins of India. Structures, [petroleum geology of petroleum producing basins of India](#)

UNIT 5: GEOCHEMICAL ANALYSIS**9 Hrs.**

Geochemical seep, Classification of seep by Link, Weathering of seeps, a geochemical program for petroleum exploration, Surface Reconnaissance, [hydrocarbon Mud Logging](#), [Rock Pyrolysis](#), [Production Index](#), [Hydrogen Index and Oxygen Index](#), Processing and interpretation of Geochemical data.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Assess prospective and drillable prospects.
- CO2. - Understand the petroleum system along with the source analysis
- CO3. - Examining the processes of data acquisition, processing, and interpretation
- CO4. - Integrate gravity and magnetic data to understand the density and magnetic susceptibility of the subsurface.
- CO5. - Integrate seismic, well log and other geophysical data for volume estimation.
- CO6. - Examine the structural and stratigraphic data to understand the position and extent of subsurface prospects in terms of depth and aerial extent

TEXT / REFERENCE BOOKS

- Oil and Gas Exploration And Production by SHARMA DEEPAK, 2015
- Deepwater Petroleum Exploration & Production, Pennwell Books, 2011
- Dictionary of Petroleum Exploration, Drilling & Production, Pennwell Books, 2015
- ENCYCLOPAEDIA OF PETROLEUM SCIENCE AND ENGINEERING (EXPLORATION), VOL. 1, S.L.Sha, 2010
- Introduction to Petroleum Exploration and Engineering, By Andrew ClennelPalmer, Andrew Palmer, 2020

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3002	PETROLEUM REFINERY ENGINEERING	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- This course will provide an overview of a modern, integrated petroleum refinery, including its feedstocks, product lineup, and the processes used to convert crude oil and intermediate streams into finished products.
- To provide the importance of various refining processes and their applications

UNIT 1: PETROLEUM CONSTITUENTS**9 Hrs.**

Petroleum constituents, laboratory tests, refinery renewable sources, and products General Definitions, Introduction to Petroleum Refining, [Crude Oil Classification](#), [Characterization of Crude Oil](#), [Crude Composition](#), Physical Properties, Crude Analysis and Distillation, Introduction to Refining "Raw material" and Downstream processing Products

UNIT 2: CRUDE OIL**9 Hrs.**

Crude oil property evaluation and design of crude oil distillation column, crude dehydration and desalting True Boiling Point Distillation evaluation of petroleum products properties, [Petroleum Assay](#), [American Society for Testing and Material](#), American Petroleum Institute gravity for different average boiling points and mid percent curves, Property evaluation of crude oil and its fractions, Crude oil distillation column conceptual model.

UNIT 3: FURNACE DESIGN**9 Hrs.**

Naphtha, Olefins, major factors affecting total emissivity, simple furnace construction, heat transfer process inside furnace, [possible modes of heat transfer taken in furnace](#), furnace models, and various methods

UNIT 4: COKING AND THERMAL PROCESS**9 Hrs.**

Delayed coking, Catalytic cracking, Cracking reactions, Zeolite catalysts, Cracking Feedstock's and reactors, Effect of process variables, Fluid catalytic cracking, Catalyst coking and regeneration, Design concepts, [New Designs for Fluidized-Bed Catalytic Cracking units](#)

UNIT 5: CATALYTIC REFORMING**9 Hrs.**

Process reforming catalysts, reformer feed, reforming reactor design, continuous and semi regenerative process, hydro cracking feed stocks, modes of hydro cracking, effects of process variables, hydro treating process and catalysts, residue hydro processing, effects of process variables, [reactor design concepts for hydro processing](#). Isomerization & Polymerization: Objectives, process, reactions, catalysts, and effect of process variables, Lube oil processing, propane deasphalting, [solvent extraction](#), [dewaxing](#), additive production from refinery feedstocks. Environmental issues and new trends in petroleum refinery operations, Environmental considerations in petroleum refinery, waste water treatment (TTP/ETP/STP), air pollution control (models), [Alternative energy sources](#) (biomass/waste materials/ renewable process)

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Introductory information about origin, exploration and production of petroleum crude and analyze their properties with the help of standard testing protocols.
- CO2. - Recognize various primary crude processing techniques like distillation, de-asphalting, hydrocracking, hydrotreating, and their supporting processes.
- CO3. - Recognize various secondary thermal cracking, catalytic cracking and reforming and coking and their supporting processes.
- CO4. - Understanding the process technologies for reforming, isomerization, alkylation and polymerization unit process.
- CO5. - Evaluate various residue processing schemes.
- CO6. - Apply the finishing processes to petroleum products for meeting the market specifications in view of fuel quality and environmental regulations

TEXT / REFERENCE BOOKS

1. Introduction to Petroleum Exploration and Engineering, by Andrew ClennelPalmer , Andrew Palmer, 2020
2. Oil and Gas Engineering for Non-Engineers, by Quinta NwanosikeWarren , 2022
3. Encyclopedia of Petroleum Science and Engineering Processing, Interpretation And Reservoir Engineering, Vol.2 by S.L.Sha, 2003.
4. R. N. Watkins, Petroleum Refinery distillation - Gulf Publishing Co.1979

5. Elements of Petroleum Refinery Engineering, OP Gupta, Khanna Publishers, 2022

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks



SCHB3003	PETROCHEMICAL TECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- Develop skill to identify petroleum potential of an area
- To introduce the concepts that will enable the transition from science to petrochemical engineering

UNIT 1: OIL & GAS EXPLORATION METHODS**9 Hrs.**

Nature of Petroleum- composition & properties; Overview of Petroleum geology & basic rock properties: Source, migration and accumulation of petroleum, Seal and trap; Overview of Petro physical properties of rock and fluid; Overview of drilling operation: [Rig Components](#), [Drill String](#), [Casing policy](#), [Drilling fluid and Cementing](#)

UNIT 2: INTRODUCTION & ROLE OF PETROCHEMICAL TECHNOLOGY**9 Hrs.**

History and Overview of petrochemical industry, Role of Petrochemical Engineer. Major companies in India & abroad. Prospects & Future. Composition of crude oil, Physical properties of oil. Petroleum Materials – Native Materials, Manufactured Materials, Derived Materials. Introduction, petrochemical engineering in everyday life, [Lab scale to plant scale](#), [Versatility of a Chemical/Petrochemical Engineer](#), [Role of petrochemical Engineers in Petroleum refinery](#), Chemical, Petrochemical, Nanotechnology, Energy and environment.

UNIT 3: HYDROGEN PRODUCTION AND PURIFICATION**9 Hrs.**

Steam reforming of hydrocarbons: Reactions, catalysts and processes; Arrangement of steam reformer: Low temperature and high temperature shift convertors and operating conditions; [Auto-thermal reforming](#); Water gas shift reaction, [production of hydrogen by partial oxidation, reactions and technology](#); Purification of hydrogen.

UNIT 4: STEAM CRACKING**9 Hrs.**

Steam cracking of Gas and Naphtha to produce Olefins, Diolefins and Production of Acetylene. Steam reforming of Natural gas – [Naphtha and Heavy distillate to produce Hydrogen and Synthesis gas](#) – Production of Methanol – Oxo process.

UNIT 5: ALKYLATION – OXIDATION – NITRATION AND HYDROLYSIS**9 Hrs.**

Fundamental and Technological principles involved in Alkylation – Oxidation – Nitration and Hydrolysis. Sulphonating, Sulfation and Isomerization. Halogenation and Esterification. [Alternate routes with flow diagram for production of ethylene glycol](#), VCM, acrylonitrile, phenol, DMT, TPA, maleic anhydride, styrene. ABS plastic, nylon-6, polycarbonate, [epoxy resin](#), unsaturated polyester resin, rubber, polystyrene, PVC, polyethylene, LLDPE, HDPE, polypropylene

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will be able to

- CO1. - Understand the structure of petrochemical processes.
- CO2. - Understand and realize the effect of feedstocks on petrochemical processes.
- CO3. - Analyze the effect of various factors on hydrogen and synthesis gas production.
- CO4. - Illustrate the importance of alkylation and oxidation technologies.
- CO5. - Evaluate the various technologies for ethanol and its derivatives.
- CO6. - Design and apply concepts to the recent developments in C1 technologies.

TEXT / REFERENCE BOOKS

1. Moulijn, J., Makkee, M. and Van Diepen, A. "Chemical Process Technology", 2nd Edition, Wiley, (2013).
2. Chauvel, A. and Lefebvre, G., "Petrochemical Processes I", Technip, (2001)
3. Olah, GA, Goeppert, A and Prakash, GKS, "Beyond Oil and Gas: The Methanol Economy", 3rd Edition, Wiley VCH, (2018).
4. Bhaskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
5. Sukumar Maiti, "Introduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3004	UNCONVENTIONAL OIL AND GAS TECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To provide basic knowledge related to unconventional energy resources, its properties and its exploitation techniques.
- To familiarize students with the unique aspects of unconventional gas and oil reservoirs, including their (1) Resources and Economic significance (2) geologic occurrences, (3) controls on production rates, (4) drilling and completion practices, (5) reservoir management, and (6) present activity

UNIT 1: INTRODUCTION**9 Hrs.**

Energy Facts Global vs Indian energy scenario – demand and supply, and future projection; relation between GDP and energy demand; introduction to conventional, unconventional, renewable, non-renewable energy resources in general, and unconventional hydrocarbon energy resources in particular; climate – Keeling curve; [clean and sustainable energy resources](#); comparison between formations and mode of occurrences of various conventional and unconventional energy resources. Introduction Coal Bed Methane: Geological controls in CBM play, Resource estimation, Drilling, [completion and production performance of a CBM well](#)

UNIT 2: OIL SHALE, SHALE GAS, AND TAR SAND OIL SHALE**9 Hrs.**

Definition and prospect, geological conditions for formation of oil shale, oil shale recovery technology, ex-situ and in-situ extraction processes of shale oil, various retorting processes, processes leading to maximization of shale oil production Shale Gas: Definition and prospect, the conditions of formation of shale gas, debate over extraction of shale gas from the subsurface, environmental issues, [hydro fracturing, composition of fracking fluid](#), water management, shale gas – Indian perspective; Tar Sand: Definition and prospect, distinction between heavy oil and bitumen, mineralogy and properties of oil sand, elemental composition and properties of bitumen, methods of recovery of bitumen by mining and advanced in-situ processes.

UNIT 3: DEEPWATER OIL AND GAS TECHNOLOGY**9 Hrs.**

Deepwater exploration and production in the world, role of geophysical methods, technological challenges in Deepwater drilling and production. Heavy oil: world resources of heavy oil, [production technology and challenges](#). Gas Hydrate Definition, [History of Hydrate R&D](#), prospect, types of methane hydrate deposits, chemistry and structure of natural methane hydrate, Necessary Conditions for Methane Hydrate Formation, typical conditions of methane hydrate formation in nature vs different gas hydrate stability zones, physical properties of hydrates and ice, geology of methane hydrates, [exploration for methane hydrates](#) – geological, geochemical and geophysical, gas hydrate – Indian perspective.

UNIT 4: COAL BED METHANE**9 Hrs.**

Introduction to Coal Bed Methane Definition and prospect, CBM, CMM, and AMM; an Overview on CBM vs. Conventional Reservoir –Gas Composition, Adsorption, Water Production, Gas Flow, Rock Physical Properties, [Gas Content, Coal Rank, Gas Production. Fundamentals of Coal Geology: Genesis of Coal](#); Major Stratigraphic Periods of Coal Formation; Gondwana and Tertiary Coals of India

UNIT 5: COAL**9 Hrs.**

Influence of Coal Properties; Coal Chemistry – Molecular Structure, Macerals, Lithotypes, Functional Groups, Proximate Analysis, Ultimate Analysis; Significance of Rank – Definition and Measurement, Vitrinite Reflectance Measurement, Physical Properties, Volatiles Generated, Micropores; [Cleat System and Natural Fracturing. Sorption](#): Principles of Adsorption – different types of isotherms, Langmuir Isotherm, Methane Retention; Effects of Ash and Moisture on Methane Adsorption. Decline Curves. Hydraulic Fracturing of Coal seams

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Understand the present global energy scenario, future need and various unconventional hydrocarbon resources
- CO2. - Analyze the Geo-mechanical properties of unconventional reservoirs
- CO3. - Outline the fundamental of hydraulic fracturing
- CO4. - Characterize the unconventional reservoirs and discuss available production methods
- CO5. - Apply safety and environmental features in hydraulic fracturing, gas production, and water production

CO6. - Critical-thinking and problem-solving approach towards unconventional resources and recovery

TEXT / REFERENCE BOOKS

1. Zou, C et al (2013) Unconventional Petroleum Geology, Elsevier;
2. Max, M. D. (2003) Natural Gas Hydrate in Oceanic and Permafrost Environments, Kluwer Academic Publication
3. Petroleum and Petrochemical Technology by Yokesh A. Karpe, 2020
4. A Text on Petro Chemical, Dr. B.K. Bhaskararao, 2004

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3005	BIOREFINERY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To give an outline of various sorts of feedstocks and fundamental data of change of energizes.
- Supply new structure blocks for the development of novel materials with problematic attributes

UNIT 1: INTRODUCTION**9 Hrs.**

World energy scenario, consumption pattern, fossil fuel depletion and environmental issues, **Biomass**: Availability, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, **enhancing biomass properties for biofuels**, challenges in conversion.

UNIT 2: BIOREFINERY**9 Hrs.**

Basic concept, types of biorefineries, biorefinery feedstocks and properties, economics, **Biomass Pretreatment**: Barriers in lignocellulosic biomass conversion, pretreatment technologies such as acid, alkali, autohydrolysis, hybrid methods, **role of pretreatment in the biorefinery concept**.

UNIT 3: PHYSICAL AND THERMAL CONVERSION PROCESSES**9 Hrs.**

Types, fundamentals, equipment's and applications; thermal conversion products, commercial success stories, Microbial Conversion Process: Types, **fundamentals, equipment's and applications**, products, commercial success stories.

UNIT 4: BIODIESEL**9 Hrs.**

Diesel from vegetable oils, microalgae, transesterification; catalysts; biodiesel purification, fuel properties. **Bioethanol and Biobutanol**: Corn ethanol, lignocellulosic ethanol, microorganisms for fermentation, current industrial ethanol production technology, cellulases and their role in hydrolysis, product recovery technologies.

UNIT 5: BIOFUEL**9 Hrs.**

Hydrogen, Methane and Methanol: Biohydrogen generation, basics, feedstocks, integration of biohydrogen with fuel cell; **fundamentals of biogas technology**, fermenter designs, biogas purification, **methanol production and utilization**. **Integrated Biorefinery**: Concept, corn/soybean/sugarcane biorefinery, lignocellulosic biorefinery, aquaculture and algal biorefinery, waste biorefinery, hybrid chemical and biological conversion processes, techno- economic evaluation, life-cycle assessment

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - To recall and gain proficiency with the outline of world energy circumstance, treatment facility and Biorefinery idea.
 CO2. - To compare and apply energy adjusts, and thermodynamics in biomass change
 CO3. - To develop unit processes/activities engaged with biofuel/bioenergy creation
 CO4. - To survey the significant advancements in first and second era biofuel through contextual analyses and field visits
 CO5. - To evaluate techno-financial examination of different biofuel transformation advances and their natural ascribes.
 CO6. - To compile CO₂ captures using algae and its conversions to fuels.

TEXT / REFERENCE BOOKS

1. Donald L. Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006.
2. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.
3. A.A. Vertes, N. Qureshi, H.P. Blaschek, H. Yukawa, Biomass to Biofuels: Strategies for Global Industries, Wiley, 2010.
4. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers, Wiley, 2013.
5. Shang-Tian Yang (Ed.), Bioprocessing for Value Added Products from Renewable Resources, Elsevier, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

Exam Duration: 3Hrs.

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks

SCHB3006	EOR TECHNIQUES	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To impart knowledge on how residual oil is recovered and the problems associated with Enhanced Oil Recovery.
- Evaluate performance analysis of field scale implementation of EOR

UNIT 1: FUNDAMENTALS**9 Hrs.**

Pore Geometry, Microscopic aspects of displacement. Residual oil magnitude and mobilization. [Buoyancy forces and prevention of trapping](#), Wettability, Residual oil and Oil recovery. Macroscopic aspect of displacement.

UNIT 2: INTRODUCTION TO EOR PROCESSES**9 Hrs.**

Definition, Difference of IOR and EOR, Target oil resource for EOR, General Classification. [Description and potential of different EOR processes](#). [Microscopic and macroscopic displacement of fluids in a reservoir](#), Displacement efficiency in different system – linear, areal, volumetric, Definition and discussion of mobility ratio and mobility control processes for different types of fluids

UNIT 3: EOR - 1**9 Hrs.**

Processes and Selection Criteria Miscible/Immiscible displacement processes - water flooding, Chemical Flooding - polymer flooding, Surfactant flooding, [Thermal recovery processes- in situ combustion](#), hot-water injection, steam flooding, SAGD Microbial EOR.

UNIT 4: SELECTION CRITERIA FOR EOR**9 Hrs.**

Determination of residual oil (well test, reservoir performance, core analysis, cased /open hole logs, single well tracer), Laboratory studies, Field pilot test and evaluation, Techno economic feasibility, [Full scale implementation](#), Monitoring and review

UNIT 5: EOR – 2**9 Hrs.**

Gas injection, in-situ combustion technology, microbial method. Problems in EOR: Precipitation and deposition of Asphaltenes and Paraffin's, Scaling problems, [Formation of damage due to migration of fines](#), Environmental factors. Global Scenario of EOR and Some Case Studies Field scale implementation and their performance of various EOR schemes of local and global context

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Relate an EOR operation with their knowledge
- CO2. - Illustrate the need of EOR in oil field
- CO3. - Identify the effect of different EOR fluids on the recovery of reservoir
- CO4. - Analyze the feasibility of EOR
- CO5. - Design a plan to implement EOR
- CO6. - Validate EOR by performing Pilot studies

TEXT / REFERENCE BOOKS

- Donaldson, E.C. and G. V. Chilingarian, T. F. Yen, "Enhanced oil Recovery – I & II", Fundamentals and Analysis, Elsevier Science Publishers, New York, 1985.
- Handbook of Petrochemical Processes, James G. Speight, 2021
- Schumacher, M.M., "Enhanced oil recovery: Secondary and tertiary methods", Noyes Data Corp., 1978.
- Petroleum Refining Technology, Dr. Ram Prasad, 1998

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Exam Duration: 3Hrs.

PartA:10 Questions of 2marks each-No choice

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks

SCHB3010	RENEWABLE ENERGY AND SUSTAINABLE TECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To understand the status of renewable energy
- To enable the students to understand sustainable development

UNIT 1: ALTERNATIVE ENERGY**9 Hrs.**

Renewable Sources: Hydropower, wind energy, geothermal energy, tidal power, ocean wave power, ocean thermal power, solar Energy, biomass energy; [Issues and challenges in using the renewable energy sources](#)

UNIT 2: ENERGY CONSUMPTION AND AUDIT**9 Hrs.**

Various types of Energy audit, Advantages of each type; Bureau of Energy Efficiency; Energy Conservation act of 2001. Concept of monitoring and targeting, energy targets, reporting techniques, waste avoidance, prioritizing. [Energy Analysis](#)

UNIT 3: OPTIMIZATION TECHNIQUES IN ENERGY MANAGEMENT**9 Hrs.**

Recovery of waste heat using recuperative and regenerative heat exchangers; [optimum shell and tube exchanger](#) networks, evaporator systems, boiler turbo generator system.

UNIT 4: SUSTAINABLE DEVELOPMENT**9 Hrs.**

Technology; concepts and definitions; Concepts of sustainability and sustainable development; Components of sustainability (Social, Economic, Environmental). [Interactions between energy and technology](#), and their implications for environment and sustainable development; Technology diffusion and commercialization; Business and sustainability

UNIT 5: SUSTAINABILITY TRANSITIONS**9 Hrs.**

Sustainability proofing; Frameworks for measuring sustainability; Indicators of sustainability, Sustainability transition, Case Studies; [Sustainable innovations Drivers and Barriers](#); Policy and institutional innovations for sustainability transition

Max.: 45 Hrs**COURSE OUTCOMES:**

- CO1. - Describe the importance of harnessing energy from alternative resources and criticize the issues and challenges involved
- CO2. - Monitor the energy consumption patterns and perform energy audit to ensure efficient utilization of energy
- CO3. - Develop techniques for effective utilization of renewable energies
- CO4. - Analyzing and controlling techniques for sustainable development
- CO5. - Understanding the interaction between energy and technology
- CO6. - Ability to understand the key principles that support sustainability transitions.

TEXT / REFERENCE BOOKS

1. Twidell John and Weir Tony, "Renewable Energy Sources", Second Edition, Taylor & Francis, New York, 2006
2. Fay James A. and Golomb Dan S., "Energy and the Environment", Oxford University Press, Inc., New York, 2002
3. Beggs Clive, "Energy: Management Supply and Conservation", Butterworth-Heinemann, Oxford, 2002
4. Dorf, Richard C., Technology, humans, and society: toward a sustainable world, Academic Press, 2001.
5. Rogers, P.P., Jalal, K.F. and Boyd, J.A., An Introduction to Sustainable Development, Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.
6. Weaver, P., Jansen, L., Grootveld, G.V., Spiegel, E.V. and Vergragt, P., Sustainable Technology Development, Greenleaf Publishing, Sheffield, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3011	RISK AND SAFETY MANAGEMENT IN PROCESS INDUSTRIES	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To understand risk, uncertainty and analyze risk
- To analyze safety management procedures in process industries

UNIT 1: RISK ASSESSMENT**9 Hrs.**

Fundamentals of Risk identification, rapid and comprehensive risk analysis; Risk due to radiation, explosion due to over pressure, plant layout, Cause-Consequence Analysis

UNIT 2: RISK ANALYSIS**9 Hrs.**

Preliminary Hazard Analysis, Hazards and Operability Analysis, Job Safety Analysis, Failure Modes and Effects Analysis, Fault Tree Analysis, Event Tree Analysis, Decision Trees

UNIT 3: RISK MANAGEMENT**9 Hrs.**

Avoidance, Separation, Reduction, Transfer, Acceptance, Detection, Control, Response and Recovery, Performance Monitoring

UNIT 4: SAFETY PROCEDURES**9 Hrs.**

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

UNIT 5: SAFE MANAGEMENT IN INDUSTRIES**9 Hrs.**

Safe Handling and Operation of materials and Machinery; periodic inspection and replacement. maintenance of pumping system-reactor-mass transfer system

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Apply basic concepts of risk identification
- CO2. - Demonstrate rapid and comprehensive risk analysis
- CO3. - Management of risk through Performance Monitoring
- CO4. - Analyse and implement the engineering response to health hazards
- CO5. - Determine the impact of the consequences of accidents and incidents
- CO6. - Demonstrate the awareness of plant safety in selection and layout of chemical plants and the usage of safety codes.

TEXT / REFERENCE BOOKS

1. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, 1st ed., CRC Press, USA, 2003.
2. N. J. Bahr, System Safety Engineering and Risk Assessment: A Practical Approach, Taylor and Francis, NY, 1997
3. Ericson C.A., Hazard Analysis Techniques for System Safety, 2nd ed., Wiley, USA, 2015
4. Daniel A. Crowl, Joseph F. Louver., Chemical Process Safety Fundamentals with Applications, 3rd Edition, Prentice Hall Inc., New Jersey, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3012	HAZARD ANALYSIS	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To enable the students to identify the potential hazards in process industries
- To emphasize the importance hazard analysis in industries

UNIT 1: HAZARDS**9 Hrs.**

Chemical hazards classification, hazards due to fire, explosion and radiation, various explosions: VCE, UVCE and BLEVE. Potential hazards, Chemical and Physical job-safety analysis, Safety in High-pressure and high temperature operations, toxic effects, highly radioactive materials, [Safe handling and operation of materials and machineries](#).

UNIT 2: HAZAN**9 Hrs.**

Types of hazard analysis, hazard identification, Material safety data sheet, specifications, Safety Audit, Hazard and Operability studies Steps involved and significance, [Fault tree analysis](#), [Event tree analysis](#), [Failure Mode Effect Analysis](#) procedure and Illustrated examples

UNIT 3: HAZOP**9 Hrs.**

HAZOP study - case studies-pumping system-reactor-mass transfer system. [Hazard Identification and Assessment; Involvement of Human factors and Errors](#)- Hazard Quantifications-disaster management; Occupational and Industrial Health Hazards; Safety Systems

UNIT 4: HEALTH HAZARDS AND LEGAL ASPECTS**9 Hrs.**

[OSHA Regulations and Significance](#), Health hazards -occupational, Industrial health hazards. Health standards and rules, Safe working environment, Factories act, Labor welfare act, ESI act, Workmen compensation act, Provisions and features.

UNIT 5: CASE STUDIES**9 Hrs.**

Domino's effect, Worst case scenario, Fire, Accidents, Chemical release, Explosion, Petroleum, Commercial, Natural disasters, EMS models case studies

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - To understand the basic rules and requirements which govern chemical industries
- CO2. - To analyze the various hazards and their implications
- CO3. - To identify hazards and analyze their impact and prevention by various safety techniques
- CO4. - To understand the importance of safety audit and periodic appraisal for prevention of accidents
- CO5. - To compare various fire extinguishing solutions and to ensure fire prevention
- CO6. - To analyze the various acts available for employee safety and maintain periodic OSHA regulations

TEXT / REFERENCE BOOKS

1. Daniel A. Crowl, Joseph F. Louvar., Chemical Process Safety: Fundamentals with applications, 3rd Edition, Prentice Hall Inc., New Jersey, 2011.
2. Deshmukh. L.M., Industrial Safety Management, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.
3. Jain R. K and Sunil Rao., Industrial Safety, Health and Environmental Management Systems, 1st Edition, Khanna Delhi 2006.
4. Shrikant Dawande, Chemical Hazards and Safety, 2nd Edition, Khanna publishers, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3013	DRUGS AND PHARMACEUTICAL TECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE:

- To impart knowledge on the various processes involved in a pharmaceutical industry along with formulation and quality control.

UNIT 1: INTRODUCTION**9 Hrs.**

Pharmaceutical Industry, Drug discovery and Development of Drugs, Organic Therapeutic agents uses and Economics, Physio chemical principles, [Drug Metabolism and pharmacokinetics](#), Kinetic Studies and Action of drugs on Human Bodies, antibiotics types.

UNIT 2: UNIT PROCESSES AND THEIR APPLICATIONS**9 Hrs.**

Chemical Conversion Processes - Alkylation, Carboxylation, Condensation, Cyclisation, Dehydration, Esterification, Halogenation Oxidation, Sulfonation, [Complex Chemical Conversions and Fermentation](#).

UNIT 3: MANUFACTURING PRINCIPLES**9 Hrs.**

Compressed Tablets, Wet Granulation, Dry Granulation or Slugging, Direct Compression, Tablet Presses, Formulation, Coating Pills, Parental Solutions, Oral Liquid, Injections, Ointments, Standard of Hygiene and Manufacturing Practice (GMP), [Packing techniques and quality control](#).

UNIT 4: PRODUCT FORMULATION**9 Hrs.**

[Vitamins and other nutrients](#), Cold Remedies, Laxatives, Analgesics, External Antiseptics, Antacids, Biologicals, Hormones.

UNIT 5: ANALYSIS & QUALITY CONTROL**9 Hrs.**

Analytical Methods and Tests for various Drugs & Pharmaceuticals- principle, [instrumentation and applications of UV/VIS and IR spectroscopy](#), [X-ray diffraction analysis](#), [Fourier transform spectroscopy](#), chromatography principle and its types, [fluorimetry, polarimetry](#).

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. Understanding the drug metabolism, pharmaco-dynamic and pharmaco-kinetic principles
- CO1. Understanding knowledge of various drugs on different disease
- CO2. Demonstrate statistical quality control procedure
- CO3. Analyze the quality assurance programmes in various stages of pharmaceutical process
- CO4. Apply the principles on choosing active ingredients for finished product
- CO5. Develop new process and product formulations.

TEXT / REFERENCE BOOKS

- Rawlne, E.A., Bentley's Text Book of Pharmaceuticals, 7th Edition, Bailliere Tindalls, London, 2009.
- Remington, Pharmaceutical Sciences, 20th Edition, Mach Publishing Co., 2001.
- Nita panditK, Introduction to pharmaceutical sciences, 4th Edition, Lippincott Williams & wilkins, 2013.
- James swarbrick, Encyclopedia of pharmaceutical technology, 3rd Edition, informa healthcare distribution, 2006.
- Mark Saltzman.W., Drug delivery, engineering principles for drug therapy, 3rd Edition, oxford university press, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3018	FERMENTATION TECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE:

- To impart knowledge on the fermentation technology, growth kinetics, fermenter control process and various downstream process techniques

UNIT 1: INTRODUCTION TO FERMENTATION PROCESS**9 Hrs.**

The range of fermentation processes-Bacteria and fungi isolation techniques, Strain, culture collection management, Inoculum preparation, Scale up of the inoculum for Bacteria and fungi-Sterilization, [Batch and Continuous sterilization of medium](#), Filter sterilization, Aseptic operation.

UNIT 1: RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS**9 Hrs.**

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, [design of various commercial media for industrial fermentations](#) – medium optimization methods

UNIT 2: INSTRUMENTATION AND CONTROL**9 Hrs.**

Fermentation control systems – manual and automatic control in fermentation processes. Architecture of Fermentation systems, temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen and concentration sensors, [Computer applications in fermentation technology](#). [Artificial neural network](#)

UNIT 4: DOWNSTREAM PROCESSING**9 Hrs.**

Separation and recovery of fermented products- [sedimentation](#), [foam separation](#), [precipitation](#), [filtration](#), [centrifugation](#), [flocculation](#), [coagulation](#)- cell disruption –physical and chemical methods, liquid - liquid extraction - solvent recovery, two phase aqueous extraction, [supercritical fluid extraction](#).

UNIT 5: PURIFICATION PROCESSES**9 Hrs.**

Membrane separation processes, [crystallization](#), drying, whole broth processing, [Chromatography](#) - Adsorption Chromatography, gel permeation, Affinity Chromatography, High performance liquid. Chromatography. Lyophilization.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Introduce basic knowledge on fermentation process.
- CO2. - Discuss about various types medium sterilization
- CO3. - Design and develop instrumentation and control system
- CO4. - Understand the knowledge of various primary isolation techniques
- CO5. - Evaluate an appropriate technique for novel downstream processing and its applications
- CO6. - Compare diverse biomolecules technique and principle of various chromatography techniques

TEXT / REFERENCE BOOKS

- Peter F.Stanbury, Stephen J.Hall& A. Whitaker, Principles of Fermentation Technology, 2nd edition, Science and Technology Books.
- Belter P.A., Cursler E.L, and Hu W.S., Bioseparation -Downstream Processing for Biotechnology, John Wiley & Sons, Publishers, 1990
- Bailey, James E .and David F.Oils, "Biochemical Engineering Fundamentals", II Edition. McGraw Hill, 1996.
- Harvey W.Blanck, Douglas S.Clark, Biochemical Engineering, Marcel Dekker, Inc

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3019	NANOTECHNOLOGY AND NANO BIOTECHNOLOGY	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE:

- To impart knowledge on the Nanotechnology and nanobiotechnology, synthesis and application of diverse nanomaterials.

UNIT 1: INTRODUCTION TO NANOBIOTEHNOLOGY**9 Hrs.**

History, development and generations of nanotechnology, [MEMS and NEMS](#), Application of nanoscience and NANOTECHNOLOGY. Properties of nanomaterials, characterization methods-Diverse nanomaterials, CNT's, Fullerenes, quantum dots.

UNIT 3: FABRICATION METHODS**9 Hrs.**

[Top down and bottom-up methods](#), self-assembly, lithography methods, Principle, working mechanism, instrumentation and application of lithography methods, Synthesis of nanomaterials-Physical, chemical and biological methods.

UNIT 4: NANO IN BIOPERSPECTIVE**9 Hrs.**

Overview of nanostructures in protein and nucleic acids-cellular nanostructures-cell surface layers-bio molecular motors-Actin Fibers-Microbial nanoparticles-bacterial nano magnetosomes-bacterial cell-surface layer (S-layer), Biological nanopores-protein nanopores, liposome nano-containers, [biopolymer nanocontainers-nano capsules-application in drug and gene target delivery](#).

UNIT 5: NANOAMATERIALS**9 Hrs.**

DNA-protein conjugative nanostructure-oligonucleotide-enzyme conjugates, non-covalent DNA-streptavidin conjugates, DNA-gold nano conjugates-Introduction to [bioelectronics and biosensing devices](#).

UNIT 6: APPLICATION AND TOXICITY OF NANOMATERIALS**9 Hrs.**

Nano analytics-[Nano lab-on chip devices-Micro contact printing](#)-DNA array-Nano molecular labels-Quantum Dots, protein labels. Molecular Beacons-Nanotoxicity, environmental and biological and toxicity assessments.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Understanding the basic principles of nano and micro system
- CO2. - Study the routes for the nanomaterial synthesis
- CO3. - Explore the nanotechnology principles in nanodevices design and applications
- CO4. - Analyze the specific interactions of biological molecules in nanodevices development
- CO5. - Determine the toxicity assessment and application of nanotechnology
- CO6. - Establish nanoparticles for the welfare of society.

TEXT / REFERENCE BOOKS

- CM Niemeyer & CA Mirkin, Nanobiotechnology-concepts, applications and perspectives, WILEY-VCH Verlag GmbH & Co. KGaA, 2004.
- Nanobiotechnology Molecular Diagnostics: Current Techniques and Applications (Horizon Bioscience) by K.K. Jain Publisher, Taylor and Francis, 2006
- Suresh S. and Amit Keshav, Text book of Separation Processes, Studium Press India Ltd., 2012
- Coulson J.M. and Richardson J. F., Chemical Engineering, Vol. II, 4th Edition, Butterworth, Heinemann, London, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3023	PROCESS PLANT UTILITIES	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- Equip the students with the basic understanding and effective operation of utilities viz. water, steam, compressor, vacuum pumps, refrigeration and cooling units, insulator, inert gases in process industries
- Impart insights in relation to the different types of fuels and boilers used in process industries for the generation of steam, types of compressors and blowers for handling air and inert gases
- Expose students to different methods of treatment of wastewater and drinking water

UNIT 1: WATER AND STEAM**9 Hrs.**

Requisites of Industrial Water and its uses; [Water treatment methods](#) - ion exchange, demineralization, membranes technology, reverse osmosis. Water resources management. Properties of steam, Boiler types and mountings, boiler accessories, Indian Boiler Act, 1923. Steam distribution and utilization, steam economy, [waste heat utilization](#)

UNIT 2: INDUSTRIAL FUELS AND COMPRESSED AIR**9 Hrs.**

Solid, liquid and gaseous fuels used in chemical process industries for power generation. Types of fans, [axial, reciprocating and centrifugal compressors](#), [rotary blowers and vacuum pumps](#) and their performance characteristics. Methods of vacuum development, ejectors and their limitations, materials handling under vacuum, piping systems.

UNIT 3: HUMIDIFICATION AND DEHUMIDIFICATION**9 Hrs.**

Properties of Air–Water Vapors and use of Humidity Chart, [Equipment's used for Humidification](#), Dehumidification and Cooling Towers

UNIT 4: REFRIGERATION & VENTILATION**9 Hrs.**

Principle of refrigeration, Refrigeration system like compression refrigeration, absorption refrigeration, and chilled water system; Types of refrigerants; [Concept of cryogenics and cryogenics characteristics](#). Air blending, exhaust ventilation and flaring

UNIT 5: INDUSTRIAL INSULATION AND INERT GASES**9 Hrs.**

Importance of insulation, [insulation material and their effect on various materials of equipment piping, fitting and valves](#), insulation for high, intermediate, low and subzero temperatures including cryogenic insulation. Introduction, properties of inert gases & their use, sources and methods of generation, general arrangement for inserting system; operational, maintenance and safety aspects

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Explain the importance of water and various methods for water softening and purification
- CO2. - Classify the different types of fuels and boilers used in process industries for the generation of Steam
- CO3. - Identify the different types of compressors and blowers for handling air and inert gases
- CO4. - Summarize the different types of equipment used for humidification, and dehumidification
- CO5. - Select a suitable refrigeration system for a typical application in process industries
- CO6. - Interpret the application of correct type of insulation system for control of heat losses and learn about proper utilization of inert gases on the process plants

TEXT / REFERENCE BOOKS

1. Perry, R.H., Green, D. W., Perry's Chemical Engineers Handbook, 8th ed., McGraw Hill, USA, 2007.
2. Mujawar B.A., A Textbook of Plant Utilities, 3rd ed., NiraliPrakashan Publication, India, 2017.
3. Poling B.E., Prausnitz J.M., O'Connell J., The Properties of Gases and Liquid, 5th ed., McGraw Hill, USA, 2008.
4. Broughton J., Process Utility Systems, 3rd ed., Institution of Chemical Engineers, U.K., 2014

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3027	PROCESS FLOW SHEETING, DESIGN AND SYNTHESIS	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To understand the process involving in a chemical plant
- Perform material and energy balance calculations in various unit operation and unit process

UNIT 1: INTRODUCTION**9 Hrs.**

Overview of flowsheet synthesis, decomposition strategies for process flowsheet synthesis, precedence ordering, recycle partitioning, tearing, [process flow sheet optimization](#). [Optimal design and scheduling of batch plants](#), characteristics of batch processes, scheduling of products and operations, multiproduct batch plants, multipurpose batch plants.

UNIT 2: OPTIMIZATION**9 Hrs.**

Algorithmic flow sheet generation using P-graph theory, Sequencing of operating units, [Feasibility and optimization of flow sheet using various algorithms](#) viz, Solution Structure Generation (SSG), Maximal Structure Generation (MSG), Simplex, Branch and bound etc.

UNIT 3: HEAT TRANSFER UNITS**9 Hrs.**

Basic concepts in process synthesis, heat exchanger network synthesis, Grand composition curves, pinch design approach to a network, stream splitting at the pinch, using grand composition curves to design refrigeration cycles. [Heat integrated distillation processes](#), synthesis of distillation sequences.

UNIT 4: PROCESS REACTORS**9 Hrs.**

Hierarchy of chemical process design; Nature of process synthesis and analysis; Developing a conceptual design and flow sheet synthesis. Synthesis of reaction-separation systems; [Heat integration of reactors](#), [Process changes for improved heat integration](#). Heat and mass exchange networks and network design.

UNIT 5: NETWORKS**9 Hrs.**

Reactor network synthesis - geometric techniques for the synthesis of reactor networks, [multiple reactions](#), [recycle reactors](#), reactor network synthesis with target formulations, heat integration of reactors.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Analyze, synthesize and design processes for manufacturing products
- CO2. - Integrate and apply the concepts to design heat exchangers, plate and packed columns and engineering flow diagrams
- CO3. - Use commercial flow sheeting software to simulate processes and design process equipment
- CO4. - Recognize economic, construction, safety, operability and other design constraints
- CO5. - Estimate fixed and working capitals and operating costs for process plants
- CO6. - Apply the established engineering methods to complex engineering problem solving

TEXT / REFERENCE BOOKS

1. L.T. Biegler, "Systematic methods of chemical process design", I. E. Grossmann and Westerberg, Prentice Hall, 1997.
2. J.M. Douglas, "Conceptual Design of Chemical Processes", Mc. Graw Hill, 1998.
3. Stankiewicz, A.; Moulijn, J.A. "Re-engineering the chemical processing plant: process intensification" Marcel Dekker, Inc., New York, 2004.
4. Robin Smith, "Chemical Process Design", Mc. Graw Hill, 1995.
5. Smith, "Chemical Process Design and Integration", Wiley Publication, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3029	AI AND ML FOR CHEMICAL ENGINEERS	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective

- To gain knowledge in the available bio energy and the present conversion techniques.
- To develop rigorous logical thinking and analytical skills by graph theoretic concepts for solving real time engineering problems

UNIT 1: FLC**9 Hrs.**

Need for FLC, Mamdani type FLC, steps in the design of FLC, Fuzzification, Decision making Logic, Rule based logic and de-fuzzification interface. Simulation examples, FLC of a reactor, Development of Fuzzy Estimator, **Multi-level control using Fuzzy Logic. Fuzzy logic tuned PI controller.**

UNIT 2: T-S FUZZY MODEL**9 Hrs.**

Model structure, TS model from input output data, TS model from model using linearization method, TS model-based control Graph coloring - Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – **Construction of spanning tree: BFS algorithm – DFS algorithm** – Finding all spanning trees of a graph – Fundamental circuits

UNIT 3: ANN**9 Hrs.**

Architecture of ANN, supervised learning, Weights and Hidden Layers, Back Propagation algorithm, Control scheme based on ANN. Simulation examples. Application of ANN in Chemical Engineering. Graph theoretical algorithms - shortest paths – **Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm** – The Chinese Postman Problem – Fleury's Algorithm – Travelling salesman problem – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Kruskal's algorithm – Optimal assignment – Kuhn and Munkres algorithm.

UNIT 4: RADIAL BASIS FUNCTION**9 Hrs.**

Radial basis function, Learning in RBFN, Pseudo inverse technique, Gradient descent algorithm, examples, RBFN versus **Multi stage network Controller Design for a T-S Fuzzy model; Linear controllers using T-S fuzzy model.**

UNIT 5: LEARNING AUTOMATA**9 Hrs.**

Principles of learning Automata, Steps in Learning Automata (LA) based control, Performance specification, Initial Probability assignment, Reward and penalty. Probability modification, **Simulation application on a reactor, LA tuned PI controllers. Automata application in Chemical Engineering.**

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Understand the concept of Fuzzy Logic Control and T-S model-based control
- CO2. - Compute the Chromatic partition, Chromatic polynomial and matching of a given graph and identify the maximal flow in network by means of algorithms.
- CO3. - Develop ANN model and its use for controller
- CO4. - Apply various graph theoretic algorithms to communication and network problems
- CO5. - Development of Radial basis function NN
- CO6. - Design controllers using Learning automata

TEXT / REFERENCE BOOKS

1. Behera, L. and Indirani Kar, "Intelligent systems and control: principles and applications", Oxford University Press, New Delhi, 2009.
2. Chidambaram, M., "Applied Process Control", Allied Publishers, New Delhi, 1998
3. Cai, Z-X, "Intelligent Control: Principles, Techniques and Applications", World Scientific, Singapore 1997.
4. Chidambaram, M. "Computer Control of Processes", Narosa Publications, New Delhi, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Part A: 10 Questions of 2 marks each-No choice

Exam Duration: 3Hrs.

20 Marks

PartB:2 Questions from each unit of internal choice, each carrying 16marks

80 Marks

SCHB3030	PIPING ENGINEERING	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- This course is structured to raise the level of expertise in piping design and to improve the competitiveness in the global markets.
- This course provides various piping system designs, development skills and knowledge of current trends of plant layout.
- The students are given case studies to develop their professional approach.

UNIT 1: FUNDAMENTALS OF PIPING ENGINEERING**9 Hrs.**

Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping.

UNIT 2: PIPE HYDRAULICS AND SIZING**9 Hrs.**

Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipedrawing basics, development of piping general arrangement drawing, dimensions and drawing of piping.

UNIT 3: PLOT PLAN**9 Hrs.**

Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout.

UNIT 4: STRESS ANALYSIS**9 Hrs.**

Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, flexibility analysis.

UNIT 5: PIPING SUPPORT AND P&I DIAGRAMS**9 Hrs.**

Different types of support based on requirement and its calculation. Typical P&I diagrams for Vessels, Pumps, Compressor and Fire Heaters.

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. - Demonstrate the basic principles piping Systems
- CO2. - Estimate pressure drop calculation flow through pipe
- CO3. - Evaluate stress analysis and impacts on piping
- CO4. - Execute the complex chemical engineering processes using software tools
- CO5. - Identify the different types of piping support system
- CO6. - Analyze transient fluid flow analysis and understand the P&I diagrams

TEXT / REFERENCE BOOKS

1. Piping Handbook, 6th edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc
2. Piping Design Handbook edited by Johan J McKetta, CRC Press, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SBAB4002	VENTURE CREATION	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- To develop an entrepreneurial mindset, understand the concept of entrepreneurship and identify personal strengths and weaknesses
- To understand the design thinking process and apply design thinking to real-world problems
- To identify problems and opportunities and develop ideas for new ventures by assessing market potential
- To develop a value proposition, business model canvas, build MVP to create sustainable differentiation for the venture with a well-structured business plan, unit economics, go-to-market strategies and funding plan for managing business growth
- To build an idea pitch and deliver it with confidence to potential stakeholders

UNIT 1: INTRODUCTION TO ENTREPRENEURSHIP**9 Hrs.**

Defining Entrepreneurship, evolution the concept & Emerging Trends in Entrepreneurship (Domain specific), understanding the unique opportunities; Why be an Entrepreneur? Entrepreneurship in Indian Scenario & Its role in economic development; **Success stories of Entrepreneur** (Domain specific); Entrepreneurial style assessment tool; Developing the Entrepreneurial mindset- Attributes & skills, recognizing your sweet spot for starting up; Principles of Effectuation; Myths about Entrepreneurship; Types of Entrepreneurs; Entrepreneur vs Intrapreneur; **Role of Entrepreneurial Teams**

UNIT 2: DESIGN THINKING & OPPORTUNITY DISCOVERY**9 Hrs.**

Introduction to Design Thinking for startups; Design Thinking principles & process; Define the problem using Design thinking principles and validate Problem; **Generation of ideas, Idea generation techniques and evaluating creative ideas; Identify problem worth solving; Sharpen your Problem Pitch**

UNIT 3: CUSTOMER, MARKETS AND CREATING A SUSTAINABLE DIFFERENTIATION**9 Hrs.**

Differentiate between a customer and a consumer; Who is your customer and what is your segment ; Customer Job, Pains, and Gains using Value proposition Canvas; Build solution using Value Proposition Canvas; Market Estimation- TAM, SAM, SOM; Competitive analysis; Minimum viable product – what is MVP: Build - Measure - Learn, differentiate between solution Demo & MVP; **How to validate MVP- Achieve a Product – Market fit**

UNIT 4: BUSINESS MODEL, BUSINESS PLANNING AND GO TO MARKET STRATEGIES**9 Hrs.**

Introduction to Business model, Business plan ; Lean approach 9 block lean canvas model; **Financial feasibility: Costs, revenue streams, Pricing, Financial Projections**, Key Financial Metrics using financial template, Managing growth & targeting scale, Unit economics; Selecting the Right Channel; **Introduction to Digital Marketing and tools; Branding strategy**

UNIT 5: FUNDING STRATEGY**9 Hrs.**

Sources of funds: Debt & Equity ; Map the Start-up Lifecycle to Funding Options; Build an Investor ready pitch deck

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

- CO1. To define entrepreneurship and explain emerging trends in entrepreneurship.
- CO2. To identify and evaluate business opportunities and assess market potential
- CO3. To conduct customer discovery, market research, build a lean canvas, develop a business plan and marketing strategies
- CO4. To identify sources of funding and develop a funding strategy, understand basic legal requirement for starting and running a business
- CO5. To build an idea pitch and deliver it with confidence to various stakeholders To develop planning and decision-making strategies in an organization.

TEXT / REFERENCE BOOKS

1. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). Entrepreneurship (10th ed.). McGraw-Hill Education.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
3. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.

4. Roy, R. (2017). Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press.
5. Chandan, J. S., & Rana, S. S. (2019). Entrepreneurship Development and Management. New Delhi: McGraw Hill Education.
6. Sinek, S. (2011). Start with Why: How Great Leaders Inspire Everyone to Take Action. Portfolio.
7. Choudhary, R., & Mehta, N. (2019). From Zero to One: How to Build a Successful Startup in India. Notion Press.
8. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.
9. Mitra, P., & Banerjee, A. (2019). Startup Minds: The Entrepreneur's Journey from Idea to Success. SAGE Publications India.
10. Thiel, P. (2014). Zero to One: Notes on Startups, or How to Build the Future. Crown Business.
11. Zappos, T. (2010). Delivering Happiness: A Path to Profits, Passion, and Purpose. Business Plus.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB3031	INDUSTRIAL ECONOMICS AND PROFESSIONAL ETHICS	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

Course Objective:

- Explain the problem of resource scarcity and consumer behavior, as well as evaluate the impact of government policies on overall economic welfare.
- Investigate the overall performance of the economy, as well as the regulation of economic fluctuations and their impact on various segments of society.

UNIT 1: BASIC CONCEPTS AND DEMAND AND SUPPLY ANALYSIS**9 Hrs.**

Scarcity and choice - Basic economic problems, PPC – Firms and its objectives, types of firms, Utility, Law of diminishing marginal utility, Demand and its determinants, law of demand, elasticity of demand, measurement of elasticity and its applications, Supply, law of supply and determinants of supply, Equilibrium – [Changes in demand and supply and its effects](#), Consumer surplus and producer surplus (Concepts), Taxation and deadweight loss.

UNIT 2: PRODUCTION AND COST**9 Hrs.**

Production function, law of variable proportion, economies of scale, internal and external economies, Isoquants, iso-cost line and producer's equilibrium, Expansion path, [technical progress and its implications](#), Cobb-Douglas production function, cost concepts, social cost: private cost and external cost, Explicit and implicit cost, sunk cost, short run cost curves, long run cost curves, Revenue (concepts), [shutdown point](#), [Break-even point](#).

UNIT 3: MARKET STRUCTURE**9 Hrs.**

Perfect and imperfect competition, monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm), oligopoly, Kinked demand curve, Collusive oligopoly (meaning), non-price competition, product pricing, cost plus pricing, target return pricing, [penetration pricing – predatory pricing, going rate pricing, price skimming](#).

UNIT 4: MACROECONOMIC CONCEPTS**9 Hrs.**

Circular flow of economic activities, stock and flow, final goods and intermediate goods, Gross Domestic Product, National Income, three sectors of an economy, methods of measuring national income, inflation- causes and effects, measures to control inflation, [monetary and fiscal policies, business financing, bonds and shares, money market and capital market, stock market, DEMAT account and Trading account, SENSEX and NIFTY](#).

UNIT 5: VALUES AND ETHICS**9 Hrs.**

Human Values – Natural acceptance - Ethics – Definition- Objectives - Virtues – Challenges in the work place - Engineering

Ethics - Scope - Moral issues and judgment - Moral development theories – [Engineers as responsible experimenters](#) - Codes of ethics - Industrial standards - Global Issues: Environmental ethics- [Computer ethics](#) - [Ethics and codes of business conduct in MNC](#).

Max.: 45 Hrs**COURSE OUTCOMES:**

On completion of the course, student will able to

CO1. - To recall the basic concepts and supply of demands

CO2. - Explain and evaluate the problem of resource scarcity and consumer behavior the impact of government policies on the general economic welfare.

CO3. - Determine appropriate output volume decisions and assess the social cost of production.

CO4. - Examine the functional requirements of a firm under various competitive conditions.

CO5. - Compare the overall performance of the economy, and the regulation of economic fluctuations and its impact on various sections of society.

CO6. - Elaborate the importance of the ethical dimension in workplace

TEXT / REFERENCE BOOKS

1. Gregory N Mankiw, 'Principles of Micro Economics', Cengage Publications, 2014
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications, 2016.
3. Francis Cherunilam, 'International Economics', McGraw Hill, New Delhi, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PartA:10 Questions of 2marks each-No choice

PartB:2 Questions from each unit of internal choice, each carrying 16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB4002	INDUSTRIAL POLLUTION PREVENTION AND CLEANER PRODUCTION	L	T	P	C	Total Marks
		3	0	0	3	100

Course Objective:

- Cleaner production is the continuous application of an integrated preventive environmental strategy applied to process, products and services to increase overall efficiency and reduce risks.
- To impart the knowledge on these principles are implied under the conception of cleaner production.

UNIT 1: INTRODUCTION**9 Hours**

Industrial Activity and Environment – Industrialization and Sustainable Development – Indicators of Sustainability- Sustainability Strategies – Barriers to Sustainability – Industrial Ecology – Pollution Prevention (PP) and Cleaner Production (CP) in achieving Sustainability- Prevention versus Control of Industrial Pollution - [Environmental Policies and Regulations to encourage Pollution Prevention and Cleaner Production](#) – Regulatory versus Market-based approaches.

UNIT 2: CONCEPT OF POLLUTION PREVENTION AND CLEANER PRODUCTION**9 Hours**

Definition – Importance - Historical Evolution – Benefits - Promotion - barriers – Role of Industry, Government and Institutions - Environmental Management Hierarchy – Source Reduction techniques – [Process and Equipment Optimization, Reuse, Recover, Recycle, Raw material substitution](#) - Internet information and Other PP and CP Resources

UNIT 3: PP & CP MANAGEMENT**9 Hours**

Pollution Prevention and Cleaner Production Project development and implementation – Overview of CP Assessment steps and skills, Preparing the site, Information gathering, and Flow diagram, Material balance, PP and CP Option generation, [Technical and Environmental Feasibility analysis, Total Cost analysis - PP and CP Financing](#)

UNIT 4: MANAGEMENT PROGRAM**9 Hours**

Establishing a Program - Organizing a Program- Preparing a program plan - Measuring progress – Pollution Prevention and Cleaner Production Awareness Plan - [Waste Audit](#)- Environmental Statement - Environmental Management Program – Economic incentive and disincentives as instruments for environmental management – [Tax, subsidies, fee, tradable permits](#).

UNIT 5: CASE STUDIES**9 Hours**

Industrial Applications of PP and CP, LCA, EMS and Environmental Audits.

Total hours: 45**COURSE OUTCOMES:**

- CO1. - Understand Industrialization, Sustainable Development and Environmental Policies and Regulations
- CO2. - Apply concept of pollution prevention and role of industry
- CO3. - Estimate Source Reduction techniques and apply cleaner production.
- CO4. - Analyze Pollution Prevention management
- CO5. - Analyze Cleaner Production and cost analysis
- CO6. - Carry out material balance and various audits

TEXT / REFERENCE BOOKS

1. Paul L. Bishop, "Pollution Prevention: Fundamentals and Practice", McGraw-Hill International, 2016.
2. World Bank Group, "Pollution Prevention and Abatement Handbook-Towards Cleaner Production", World Bank and UNE, Washington D.C., 1998.
3. Prasad Modak, C. Visvanathan and Mandar Parasnis, "Cleaner Production Audit Environmental System Reviews", No. 38, Asian Institute of Technology; Bangkok, 1995.
4. Freeman, H.M, Industrial Pollution Prevention Handbook", McGraw Hill", 2005.
5. James G. Mann and V.A. Liu, "Industrial Water Reuse and Wastewater Minimization", McGraw Hill, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

Exam Duration: 3Hrs.

PART A: 10 Questions of 2 marks each – No choice

20 Marks

PART B: 2 Questions from each unit of internal choice each carrying 16 marks

80 Marks

SCHB4003	AIR POLLUTION AND CONTROL ENGINEERING	L	T	P	C	Total Marks
		3	0	0	3	100

Course Objective:

- To confer information on the guideline and plan of control of Indoor/particulate/vaporous air contamination and its arising patterns.
- To give general comprehension of nature of air and effect on neighborhood and worldwide impacts of air contamination on human, materials, properties and vegetation.

UNIT 1: INTRODUCTION**9 Hours**

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.

UNIT 2: METEOROLOGY**9 Hours**

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

UNIT 3: PARTICULATE CONTAMINANTS**9 Hours**

Control of Particulate Contaminants: Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

UNIT 4: GASEOUS CONTAMINANTS**9 Hours**

Control of Gaseous Contaminants: Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

UNIT 5: AIR QUALITY MANAGEMENT**9 Hours**

Indoor Air Quality Management: Sources, types and control of indoor air pollutants, sick building syndrome and building related illness. Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

Total Hours: 45**COURSE OUTCOMES:**

- CO1. - Identify the sources of air pollutants in a city
- CO2. - Estimate the damage due to air pollutants
- CO3. - Associate air pollution with meteorology
- CO4. - Calculate the concentrations of various air pollutants
- CO5. - Predict the concentrations of various air pollutants
- CO6. - Design air pollution control framework

TEXT / REFERENCE BOOKS

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, Springer science + science media LLC, 2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press, Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.
4. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
5. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
6. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PARTA: 10Questionsof2markseach–No choice

PARTB: 2Questionsfromeachunitofinternalchoiceeachcarrying16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB4004	INDUSTRIAL WASTEWATER TREATMENT	L	T	P	C	Total Marks
		3	0	0	3	100

Course Objective:

- To understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater

UNIT 1: WATER POLLUTION**9 Hours**

Nature and types of water pollutants, organic and inorganic water pollutants - [Water treatment](#)- municipal sewage and industrial water treatment, Preliminary primary, secondary and tertiary treatment methods water reuse and recycling. General Characteristics of Industrial Effluents, Effects on Environment - ISI tolerance limits for discharging industrial effluents into surface water, into public sewers and onto land for irrigation - [Toxic chemicals from industry](#).

UNIT 2: INDUSTRIAL WASTEWATER MANAGEMENT**9 Hours**

Basic theories, Industrial waste survey -[Measurement of industrial wastewater Flow-generation rates](#) -Industrial wastewater sampling and preservation of samples for analysis -Wastewater Characterization-Toxicity of industrial effluents

UNIT 3: TREATMENT OF WASTEWATER**9 Hours**

Unit operations and processes-Volume and Strength reduction -Neutralization and Equalization, [Segregation and proportioning-recycling, reuse and resources recovery](#)

UNIT 4: INDUSTRIAL EFFLUENTS TREATMENT**9 Hours**

Pretreatment of Industrial effluents - Necessity of pretreatment - Equalization - Segregation - Process Changes Salvaging - By product Recovery. Removal by Reverse Osmosis, Ion Exchange, [Electrodialysis](#), Solvent Extraction, Floatation. Removal of Refractory Organics - Removal of Nitrogen and Phosphorus.

UNIT 5: COMMON EFFLUENT TREATMENT PLANTS (CETP)**9 Hours**

Location, Design, Operation and Maintenance Problems – Economical aspects. Major Industrial Effluents: Sources, Characteristics and Treatment. [Food Industries: Sugar, Dairy, Distilleries, Chemical Industries: Paper and Pulp, Tanneries, Textiles, Fertilizers, Pharmaceuticals, Cement and Steel industry](#)

Total hours: 45**COURSE OUTCOMES:**

- CO1. - Analyze the characteristics of waste water
 CO2. - Examine the manufacturing process of various industries
 CO3. - Design treatment methods for any industrial wastewater
 CO4. - Develop a component, system or process or technology to meet desired needs and imposed constraints.
 CO5. - Ability to analyze the data, interpret results and draw conclusions
 CO6. - Assess need for common effluent treatment plant for an industry

TEXT / REFERENCE BOOKS

- M. N. Rao and A. K. Dutta, "Wastewater Treatment", Oxford & IBH, New Delhi.
- K.V. S. G. Murali Krishna, "Industrial Water and Wastewater Management".
- A. D. Patwardhan, "Industrial Wastewater treatment", PHI Learning, Delhi.
- Metcalf and Eddy Inc., "Wastewater Engineering", Tata McGraw Hill co., New Delhi.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PARTA: 10Questionsof2markseach–No choice

20 Marks

Exam Duration: 3Hrs.

PARTB: 2Questionsfromeachunitofinternalchoiceeachcarrying16marks

80 Marks

SCHB4005	PROCESS SAFETY MANAGEMENT	L	T	P	C	Total Marks
		3	0	0	3	100

Course Objective:

- To enable the students to understand the importance of safety in process industries
- To assess and identify the potential hazards in process industries

UNIT 1: INTRODUCTION**9 Hours**

Need for safety in industries, Safety Programmes, components and realization; Potential hazards, extreme operating conditions, toxic chemicals, safe handling

UNIT 2: SAFETY PROCEDURES**9 Hours**

Implementation of safety procedures, periodic inspection and replacement, Accidents, identification and prevention, promotion of industrial safety

UNIT 3: RISK ANALYSIS**9 Hours**

Overall risk analysis, emergency planning-on site & off-site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis, Risk due to radiation, explosion due to over pressure, jet fire-fire ball.

UNIT 4: HAZARD ANALYSIS**9 Hours**

Hazard identification safety audits, checklist, vulnerability models event tree analysis, fault tree analysis, Hazan past accident analysis Flixborough-Mexico-Madras-Vizag-Bhopal analysis

UNIT 5: SAFE MANAGEMENT IN INDUSTRIES**9 Hours**

Safe Handling and Operation of materials and Machinery, periodic inspection and replacement, maintenance of pumping system-reactor-mass transfer system

Total hours: 45**COURSE OUTCOMES:**

- CO1. - Assess the risk in a process plant by hazard identification
- CO2. - Determine the impact of the consequences of accidents and incidents
- CO3. - Analyze a safety audit in a process plant with case studies
- CO4. - Demonstrate the awareness of plant safety in selection and layout of chemical plants and the usage of safety codes.
- CO5. - Exhibit the skill in classifying chemical, fire, explosion hazards and to understand the occupational diseases
- CO6. - Analyse and implement the engineering response to health hazards

TEXT / REFERENCE BOOKS

1. Daniel A.Crowl, Joseph F. Louvar., Chemical Process Safety Fundamentals with Applications, 3rd Edition, Prentice Hall Inc., New Jersey, 2011.
2. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004
3. Ericson C.A., Hazard Analysis Techniques for System Safety, 2nd ed., Wiley, USA, 2015
4. Fawcett H.H. and Wood W.S., Safety and Accident Prevention in Chemical Operation, 2nd Edition, Inter Science, 1982

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PARTA: 10Questionsof2markseach–No choice

PARTB: 2Questionsfromeachunitofinternalchoiceeachcarrying16marks

Exam Duration: 3Hrs.

20 Marks

80 Marks

SCHB4006	SUSTAINABLE ENGINEERING	L	T	P	C	Total Marks
		3	0	0	3	100

Course Objective:

- To establish clear understanding and the role on the various impacts and issues related to sustainability

UNIT 1: SUSTAINABILITY**9 Hours**

Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, [Nexus between Technology and Sustainable development](#); Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

UNIT 2: WASTE MANAGEMENT**9 Hours**

Zerowaste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

UNIT 3: STANDARD**9 Hours**

Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

UNIT 4: RESOURCES AND ITS UTILIZATION**9 Hours**

Basic concepts of Conventional and non-conventional energy, General idea about solar energy, [Fuel cells](#), [Wind energy](#), [Small hydro plants](#), [bio-fuels](#), Energy derived from oceans and Geothermal energy.

UNIT 5: SUSTAINABILITY PRACTICES**9 Hours**

Basic concept of sustainable habitat, Methods for increasing [energy efficiency in buildings](#), Green Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport

Total hours: 45**COURSE OUTCOMES:**

- CO1. - Understand the relevance and the concept of sustainability and the global initiatives
- CO2. - Explain the different types of environmental pollution problems and their sustainable solutions
- CO3. - Discuss the environmental regulations and standards
- CO4. - Demonstrate the broad perspective of sustainable practices
- CO5. - Analyze the problem and to develop the solutions in the area of sustainability for research and education
- CO6. - Ability to quantify resource availability and rationalize the sustainability based on scientific merits

TEXT / REFERENCE BOOKS

- W. Wimmer, and Joanne Kauffman (Eds.), Handbook of Sustainable Engineering Springer (Available in June 2011).
- Daniel A. Vallero and Chris Brasier. Wiley-Blackwell (2008). Sustainable Design: The Science of Sustainability and Green Engineering Sustainable Engineering Practice: An Introduction
- Committee on Sustainability, American Society of Civil Engineers (2004).
- Systems Analysis for Sustainable Engineering: Theory and Applications Ni-Bing Chang, McGraw-Hill (2010).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100

PART A: 10 Questions of 2 marks each – No choice

PART B: 2 Questions from each unit of internal choice each carrying 16 marks

Exam Duration: 3Hrs.

20 Marks

80 Marks