SMTB1101	MATRICES AND CALCULUS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- The purpose of this course is for Modeling the Engineering problems and obtaining its solutions mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 MATRICES 9 Hrs.

Characteristic equation of a square matrix – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen Vectors – Cayley - Hamilton theorem (without proof) – verification, finding inverse and power of a matrix – Diagonalization of a matrix using orthogonal transformation – Quadratic forms – Nature of quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS 9 Hrs.

Definitions – Derivative of standard functions (Results only) - Differentiation of function of function – Logarithmic differentiation – Derivatives of implicit function- Curvature – Centre, Radius and Circle of Curvature in Cartesian co-ordinates – Evolutes.

UNIT 3 FUNCTIONS OF SEVERAL VARIABLES 9 Hrs.

Partial derivatives (Definition) – Total derivative – Jacobian - Taylor's expansion – Maxima and minima of functions of two variables – Constrained maxima and minima using Lagrange's multiplier method.

UNIT 4 INTEGRAL CALCULUS I 9 Hrs.

Beta and Gamma integrals – Relation between Beta and Gamma integrals – Properties of Beta and Gamma integrals with proofs – Evaluation of definite integrals in terms of Beta and Gamma function.

UNIT 5 INTEGRAL CALCULUS II 9 Hrs.

Double integrals in Cartesian and Polar co-ordinates – Change of order of integration – Change of variables from Cartesian to Polar coordinates – Area of plane curves using double integrals. Triple integrals – Volume using triple integrals in Cartesian co-ordinates -Simple Applications.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Convert the quadratic form to canonical form by orthogonal transformation
CO2 - Construct the Circle of Curvature and Evolute of any curve.
CO3 - Examine the maxima and minima of function of several variables.
CO4 - Analyze the relationship between Beta and Gamma functions and its applications
CO5 - Evaluate double integrals in various coordinate systems
CO6 - Apply the concept of triple integrals in engineering problems

TEXT / REFERENCE BOOKS

1. Bali and Manish Goyal, A Text book of Engineering Mathematics, Laxmi publications, Reprint, 2008
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.

3. Grewal B.S., Higher Engineering Mathematics, 41st Edition, Khanna Publications, Delhi, 2011.
4. Kandaswamy P & Co., Engineering Mathematics for First Year, IX revised edition, S. Chand & Co Pub., 2010.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill, New Delhi, 11th Reprint, 2010.
6. Veerarajan T., Engineering Mathematics for First Year, II Edition, Tata McGraw Hill Publishers, New Delhi, 2008.
7. Venkataraman M.K., Engineering Mathematics – First Year (2nd edition), National Publishing Co., 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

S11BLH12	PROBLEM SOLVING TECHNIQUES USING C	L	T	P	EL	Credits	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 & Colum 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 HETROGENOUS 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.
3. Eligibility criteria: more than 60 percent in 10th and 12th, age>=17, state==TN.
4. 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
5. 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. 1.YashavantKanetkar, 'Let us C', BPB Publications, Fourteenth Edition
2. 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:3 Hrs.**

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	Credits	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 H_2 – 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 (CO_2 and H_2O) – 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/$SOCl_2$ cell - Li/I 2 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:3 Hrs.**

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	Credits	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), 5 th 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:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1102	MATERIAL SCIENCE AND ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To acquire basic understanding of advanced materials, their functions and properties for technological applications and emphasize the significance of materials selection in the design process.

UNIT 1 INTRODUCTION 9 Hrs.

Atomic structure and bonding in materials. Properties of atoms. Structure of atoms, Quantum states. CRYSTALS - Crystal structure of materials, crystal systems, unit cells and space lattices. ENGINEERING MATERIAL - Chemical and physical properties of materials, Mechanical properties, thermal properties, physical/chemical and electrical properties, Technological properties. Selection process of engineering materials (General aspects). Heat treatment process: annealing, hardening, tempering, normalizing and gas carburizing.

UNIT 2 POLYMER & BIOMATERIALS 9 Hrs.

Classification of polymers. Application of polymer in engineering, Classification of polymerization process, Chemistry and Kinetics of step growth and chain growth polymerization, polymerization techniques. Polymer composites, Types of composites, particle reinforced, fiber reinforced, structural composites. Matrix materials, reinforcement materials.

Classification of bio-materials (based on tissue response), Comparison of properties of some common biomaterials, Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys), Polymeric implant materials (Polyamides, polypropylene, acrylic resins and Hydro gels), Elastomeric composites in tyre technology, polymers in fiber, manmade fibers, acetate fiber, acrylic, nylon, olefin, polyester, rayon, synthetic adhesives. Bio-Polymer degradation.

UNIT 3 INTRODUCTION TO SPECTROMETRY 9 Hrs.

Properties of electromagnetic radiation, wave properties, components of optical instruments, Sources of radiation, wavelength selectors, sample containers, radiation transducers, Molecular absorption spectrometry, Measurement of Transmittance and Absorbance, Beer's law, UV spectrometer, Fluorescence and Phosphorescence spectroscopy, Raman spectroscopy, Fourier Transform infrared spectroscopy and its applications.

UNIT 4 MAGNETIC RESONANCE SPECTROSCOPY AND CHROMATOGRAPHY 9 Hrs.

Nuclear Magnetic Resonance, NMR spectra, chemical shift, ^{1}H, ^{13}C, ^{19}F, ^{31}P, ^{33}S NMR. Chromatography, High-performance liquid chromatography, Partition chromatography, Thin-layer chromatography, Adsorption chromatography, Ion exchange chromatography, size exclusion chromatography, Gas chromatography–mass spectrometry.

UNIT 5 NON-DESTRUCTIVE METHODS OF TESTING FOR MATERIAL 9 Hrs.

Scanning electron microscopy, energy dispersive X-ray analysis, Transmission electron microscopy, Thermogravimetric analysis, Brunauer-Emmett-Teller (BET) analysis, Barrett-Joyner-Halenda (BJH) analysis, X-Ray diffraction analysis.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Conceptually explain the classification schemes that are used to categorize engineering materials.

CO2 - Develop the principle, working and applications of various polymers and biomaterials

CO3 - Assess the application of spectroscopy in examining the composition of compound
CO4 - Investigate the use of magnetic resonance to evaluate the structure of materials.
CO5 - Explain how chromatography is used in purification process
CO6 - Monitor exactly how non-destructive methods are used to study the makeup of an unknown substance.

TEXT / REFERENCE BOOKS

1. Thiruvadigal. J.D., Ponnusamy, S. D. and Krishnamohan. M., Materials Sciences, 2nd Edition, Vibrant Publication, 2013.
2. Rajendran. V., Materials Science, 3rd Edition, Tata McGraw Hill, New Delhi, 2011.
3. Khanna. O.P., A Text book of Material science and Metallurgy, 5th Edition, Danpat Rai Publications, 2003.
4. Dara. S.S., A text book of Engineering Chemistry, 2nd Edition, S. Chand and Company Ltd., 2003.
5. Rajput. R.K., A Text book of Material Science and Engineering, 3rd Edition, S.K Kataria & Sons, Delhi, 2003.
6. Callister, Jr. W.D., Materials Science and Engineering an Introduction, John Wiley and Sons, 5th Edition, Tata McGraw Hill, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCYB2101	CHEMISTRY LAB	L	T	P	EL	Credits	Total Marks
		0	0	2	0	1	100

COURSE OBJECTIVE

- To understand the basic principle involved in volumetric and instrumental analysis.
- To acquire practical knowledge in pH metry, potentiometry and conductometry.
- To develop the skill in water analysis.

LIST OF EXPERIMENT

1. Estimation of mixture of acids by conductometry.
2. Estimation of ferrous ion by potentiometry.
3. Determination of pKa value of glycine by pH metry.
4. Estimation of hardness of water by EDTA method.
5. Determination of alkalinity of water
6. Estimation of Iron by photocolorimetry.
7. Estimation of copper in brass
8. Determination of high molecular weight polymer using Ostwald viscometer.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Estimate the ionic conductance of mixture of acids.
CO2 - Construct a redox cell for the emf measurement.
CO3 - Interpret the concept of Zwitter ion in amino acids
CO4 - Predict the quality of water sample for domestic and industrial applications.
CO5 - Demonstrate the validity of Beer-Lambert's law.
CO6 - Apply Poiseuille's law for molar mass measurement.

SCHB2101	TECHNICAL ANALYSIS AND INSTRUMENTATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To have a thorough understanding on the estimation and analysis of chemical compounds.
- To have a practical hands-on experience on analytical instruments

LIST OF EXPERIMENT ANALYSIS

1. Sugar analysis using Benedict's reagent: To determine concentration of reducing sugar in an unknown sample
2. Water analysis - Determination of total residual chlorine, dissolved oxygen and hardness.
3. Determination of Chlorine content in bleaching powder:
4. To determine the percentage of available chlorine present in bleaching powder.
5. Estimation of TFM
6. Estimation of Acid value of oil
7. Estimation of iodine value of oil
8. Estimation of Saponification value of oil

INSTRUMENTATION

9. pH meter
10. Conductivity meter
11. Turbidity meter
12. Colorimeter
13. Refractometer
14. Polarimeter

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Estimate the properties of water
CO2 - Develop the skills in gravimetric and potentiometric analysis.
CO3 - Determine the quality of the soap, bleaching powder.
CO4 - Analyze the properties of oil.
CO5 - Interpret the theory of methods by hands on experiments
CO6 - Precision and validity in an experiment using instrumentation

SHSB1101	TECHNICAL ENGLISH	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand specialized subject areas and skills included for their study.
- To comprehend and react in oral and written forms to the specialized texts
- To respond to listening, reading and writing tasks by using digital tools
- To enhance communication, collaboration and critical thinking skills
- To explore creativity through blended learning contexts

UNIT 1 **9 Hrs.**

Listening : Listening to choose the correct answer from the options given (MCQ)
Speaking : Self Introduction, talking about likes and dislikes
Reading : Comprehending a passage- Skimming, scanning, detailed reading
Writing : Letter of Job Application, Resume, Letter to the Editor (problems and solutions)
Vocabulary: Kinds of Sentences, Affixes, Collocations, Sequence words, contextual guessing of words
Language Focus: Parts of Speech, Tense and its types, Voice - Impersonal Passive
Language Lab work: Focus Digital literacy: students join zoom platform/ using online tools

UNIT 2 **9 Hrs.**

Listening: Listening to advertisements about a product, say true or false
Speaking: JAM on current topics, mini presentations
Reading: Identifying topic sentences by reading content
Writing: Writing compare/ contrast paragraphs, process description, E-Mail Writing
Vocabulary: Verbal phrases, Prepositions and Prepositional phrases, Concord, Discourse Markers
Language Focus: Clauses, Conjunctions, Sentence Types - Simple, Compound & Complex
Language Lab: Digital literacy: Responding to quiz using Kahoot application

UNIT 3 **9 Hrs.**

Listening: Listening to summarize the information, debates/ discussions.
Speaking: Group discussion on a given topic
Reading: To find specific information and to prepare notes using the format
Writing: Framing open ended questions- Survey Report- Arranging the sentences in the right order
Vocabulary: Paired expressions, Adjectives/ adverbs, technical definitions, Compound Nouns
LanguageFocus: Punctuation, Editing, Same words used as different parts of speech
LanguageLab: Digital literacy: Power point tools –Slide share to make presentation on the survey report

UNIT 4 **9 Hrs.**

Listening: Listening to differentiate instructions and recommendations
Speaking: Debate on current issues
Reading: Reading to understand and classify the information
Writing: Instructions, Recommendations, Preparation of User Manual
Vocabulary: Classification of words, Abbreviations, Acronyms,
Language Focus: Reported Speech, Causatives, Basic Sentence Patterns
Language Lab: Digital literacy: Using online discussion forum

UNIT 5 **9 Hrs.**

Listening and summarizing: Listening to identify the structure of sentences, small talks, TED talks
Speaking: Giving impromptu talks, Speech Writing
Reading: Read argumentative essays and paragraphs

Writing: Essay writing, Checklist preparation, Note making
Vocabulary: Homophones/Homonyms, Idioms and Phrases
LanguageFocus: Negatives, Tag questions, Similes and Metaphors
LanguageLab: Digital literacy: Creating own Blogs and interactive exercises and quizzes online

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Classify technical words to use them in sentences framing, compose problem solving paragraphs.
CO2 - Categorize information based on the understanding of reading materials to prepare notes.
CO3 - Prepare and document to report, identify elements of editing.
CO4 - Interpret technical definitions related to the text and design a user manual using instructions.
CO5 - Summarize reading materials and outline an essay on any topic given.
CO6 - Demonstrate their language learning activities in the classroom/ online group environment.

TEXT / REFERENCE BOOKS

1. Technical English [2019], Department of English, Sathyabama Institute of Science; Technology.
2. Beer, David F., and David McMurrey. A Guide to Writing as an Engineer. 4th ed., Wiley, 2013
3. Alred, Gerald J., et al. Handbook of Technical Writing. 11th ed., Bedford/St. Martins, 2019.
4. Pearsall, Thomas Edward. Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals. McGraw-Hill Education, 2017.
5. Straus, Jane. The Blue Book of Grammar and Punctuation. John Wiley Sons, 2014.
6. Conner, Patricia T. Woe is I: The Grammar phobes Guide to Better English in Plain English. Riverhead Books, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SMTB1201	ADVANCED CALCULUS AND STATISTICS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- The purpose of this course is for modeling the Engineering problems and obtaining its solutions mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 DIFFERENTIAL EQUATIONS 9 Hrs.

Higher order linear differential equations with constant coefficients – Particular Integral for eax, sinax or cosax, xn, xneax, xsinax, xcosax, eaxsinbx or eaxcosbx – Method of Variation of Parameters – Homogeneous equation of Euler's and Legendre's type.

UNIT 2 VECTOR CALCULUS 9 Hrs.

Vector Differentiation - Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields - Vector Integration – Simple problems on line, surface and volume Integrals – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (without proofs)– Simple applications involving cubes and rectangular parallelopipeds.

UNIT 3: LAPLACE TRANSORMATION

9 Hrs.

Laplace transform – Transforms of standard functions – properties – Transforms of derivatives and integrals – Transforms of the type eatf(t), tf(t), f(t)/t – Transform of periodic functions – Transform of unit step function and impulse function – Inverse Laplace transforms – Convolution theorem – Initial and final value theorems – Applications - Linear ordinary differential equation with constant coefficients

UNIT 4 PROBABILITY AND STATISTICS 9 Hrs.

Measures of central tendency: Mean, Median, Mode – Measures of dispersion: Standard deviation for discrete and grouped data. Definitions: Sample Space, Events – Addition Law of probability ¬– Multiplication law of probability – Conditional probability – Baye's theorem (without proof).

UNIT 5 THEORY OF SAMPLING AND TESTING OF HYPOTHESIS 9 Hrs.

Test of Hypothesis – Large samples – Z test – Single proportion – Difference of proportions – Single mean – Difference of means – Small samples – Student 's t test – Single mean – Difference of means – Test of variance – Fisher's test – Chi square test: Goodness of fit, Independence of attributes.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Solve any higher order linear differential equations
CO2 - Apply concepts of calculus on vector and scalar valued functions
CO3 - Use Laplace Transform for transformation of functions.
CO4 - Evaluate problems on conditional probability using Baye's theorem.
CO5 - Analyze the concept of testing of hypothesis in small and large samples
CO6 - Construct the Chi-Square test for goodness of fit and independence of attributes of real data.

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eigth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.
3. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi, 2011.
4. Ross L, Differential Equations, 3rd Edition, Wiley India, 2009
5. Veerarajan T, Probability, Statistics and Random Process, 4th Edition, Tata McGraw Hill, 2014.
6. Veerarajan T, Engineering Mathematics for First Year, II Edition, Tata McGraw Hill Publishers, 2008.
7. Venkataraman M.K., Engineering Mathematics – First Year, 2nd Edition, National Publishing Co., 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SPHB1101	PHYSICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the concept of crystal structures and symmetry, the physics of scattering and diffraction theory, experimental diffraction from single crystals, instrumentation and powder diffraction.
- Students will be able to understand the Identify and describe properties of matter, including: flexibility, strength and transparency.
- The objective of this course is to develop a working knowledge of the laws and methods of thermodynamics and elementary statistical mechanics and to use this knowledge to explore various applications.
- Differentiate between various acoustic terms and understand how these apply to different materials and acoustic design solutions.
- To give knowledge about semiconductor physics and discus working and applications of basic devices, including p-n junctions, BJTs and FETs

UNIT 1 QUANTUM MECHANICS 9 Hrs.

Introduction to Quantum mechanics – Energy distribution function, Wave – particle duality-de Broglie matter waves – Concept of wave function and its physical significance – Heisenberg's Uncertainty Principle – Schrodinger's wave equation – Time independent and Time dependent equations – Particle in a one - dimensional rigid box – tunnelling (Qualitative) – Scanning Tunnelling Microscope (STM).

UNIT 2 PROPERTIES OF MATTER 9 Hrs.

Introduction- Elasticity- Hooke's law - Torsional stress & deformations – Twisting couple – Torsion pendulum - theory and experiment–bending of beams - bending moment–cantilever: - Theory and experiment–uniform and non-uniform bending: theory and experiment- Magnetism - Basic definitions - Magnetic permeability, susceptibility, relation between permeability and susceptibility - Bohr magneton. Classification of magnetic materials-Hysteresis.

UNIT 3 CRYSTAL PHYSICS 9 Hrs.

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances – coordination number and packing factor for SC, BCC, FCC, HCP. – crystal imperfections: point defects, line defects –growth of single crystals: solution and melt growth techniques.

UNIT 4 SEMICONDUCTOR PHYSICS 9 Hrs.

Classification of materials-Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors - Fermi level in intrinsic and extrinsic semiconductors. Theory of p-n junctions – diode and transistor: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, V-I characteristics, junction capacitance and voltage breakdown. Zener diode and its characterization- Avalanche breakdown- JEFT- I-V characteristics- amplifying and switching.

UNIT 5 LASER AND ITS APPLICATIONS 9 Hrs.

Absorption and Emission of Radiation by atoms, ions and molecules. Laser medium Phenomenon of population inversion. Laser cavity (fiber laser, and other cavities), generation of coherent beam, Q-switching, short pulse generation, power amplification. Basic Laser Principles: Theory of Laser, Properties of Laser, Fundamental Optical properties, Modified Optical properties, Laser output – its characteristics.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Solve the time independent Schrodinger wave equation for a particle in a box to obtain the Eigen values and Eigen functions.

CO2 - Understand the dual nature of radiation and matter

CO3 - Estimate the atomic packing factor for SC, BCC & FCC structures.

CO4 - Recognize sound level descriptors and how they are used in architectural acoustics and analyse acoustic properties of typically used materials for design consideration.

CO5 - Understanding the working, design considerations and applications of various semi conducting devices including p-n junctions, BJTs and FETs

CO6 - Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.

TEXT / REFERENCE BOOKS

1. Pillai S.O., Solid state Physics, New age International Publishers, 7th Edition.
2. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill Publications.
3. M. N. Avadhanulu & P. G. Kshirasagar. A text book of Engineering Physics, S. Ch. Publishing.
4. B. B. Laud, Lasers and nonlinear optics, new age International Publishers, II-Edition.
5. R. Murugesan, Modern Physics, S. Chand Publishing, 15th Edition (2015).
6. D. S. Mathur, Elements of Properties of Matter, S. Chand Publishing (2014).
7. A. K. Bandyopadhyay, Nanomaterials, New age International Publishers,
8. K. K. Chattopadhyay, Introduction to nano science and nano technology, PHI publisher,
9. Sulabha Kulkarni, Introduction to Nanoscience and Nanotechnology 2nd Edition
10. David Griffiths, Introduction to electrodynamics, Addison-Wesley publishing 3rd Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

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	Credits	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 SN1, SN2 and SNi 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.
6. Jayakumar V., Engineering Metallurgy, ARS publications, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SMEB2201	WORKSHOP PRACTICE	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To provide the students with hands on experience on different trades of engineering like Plumbing Works, Fitting, Carpentry, Plumbing, Foundry, Welding and Sheet metal.

LIST OF EXPERIMENTS:

A. PLUMBING WORKS:

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
b) Preparation of plumbing line sketches for water supply and sewage works.
c) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

B. CARPENTRY

a) Handling of carpentry tools, A practice in marking, sawing planning and chiseling to size. Making simple joints such as half-lap, dove-tail, TEE joint and mortise and Tenon joints. (Any two joints to be practiced)
b) Use of modern materials such as plywood, chip board, Nova pan, laminated sheets (Demonstration only).

C. FITTING

Use of fitting tools-practice in marketing, fitting to size and drilling-making of simple mating and profiles such as V, Square, Dove-tail, Half-round and TEE - joints. (Any two joints to be practiced)

D. WELDING

a) Electric Arc Welding.
   i. Study on Edge preparation techniques for Arc welding.
   ii. List of Welding Exercises.

1. Lap Joint 2. Butt Joint 3. Fillet Joint 4. Tee Joint 5. V Joint 6. Corner Joint (Any two joints to be practiced)

b) Study on gas welding and gas cutting.

E. FOUNDRY

a) Sand testing - Grain fineness - Permeability test.
b) Study on Pattern Allowances.
c) Preparation of green sand moulding (Solid and Split pattern)
d) Flanges 2. Bush 3. Hexagon 4. Dumbbell
e) Metal casting technique (Demonstration only).

F. SHEET METAL

a) Tools and equipment's– practice.
b) Making rectangular tray, hopper, scoop, etc. (Anyone to be practiced)
c) Study on Fabrication of a small cabinet, dust bin, etc.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Work with various components used in fluid flow pipelines and to make connections for various applications suitably.

CO2 - Handle carpentry tools for wood working.

CO3 - Perform various fitting operations

CO4 - Make precise weld joints using arc and gas welding processes

CO5 - Make mould precisely and to place runner, riser at suitable places also they understand how to provide various allowances.

CO6 - Handle sheet metal tools for making various sheet metal components

SPHB2101	PHYSICS LAB	L	T	P	EL	Credits	Total Marks
		0	0	2	0	1	100

COURSE OBJECTIVE

- To introduce experiments in optics, semiconductors, magnetism, thermal physics and quantum mechanics in order to acquire the first-hand information and to realize the basic physics concepts.

LIST OF EXPERIMENT (Any SIX experiments & TWO demonstrations)

1. Determine the Rigidity modulus of a given wire by Torsional pendulum
2. To determine the angle of Minimum Deviation by I - D curve method.
3. Determine V-I characteristics of a photodiode
4. To determine the Numerical aperture of an optical fiber
5. To find the Energy gap of a semiconductor
6. Determination of Young's modulus- non-uniform bending
7. Determination of Young's modulus- Uniform bending
8. Determination of the wave length of the laser using grating- Laser.
9. Determination of thickness of a thin sheet/wire- Air wedge.
10. Determination of Numerical Aperture and acceptance angle- Optical fibre.
11. Photoelectric effect
12. Michelson Interferometer.
13. V-I characterization of solar cell
14. CRO- FUNCTIONS
15. DFT Theory and calculations

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Measure the rigidity modulus of a given wire by oscillations.
CO2 - Measure the angle of minimum deviation by spectrometer.
CO3 - Analyse the I-V characteristics of the given photo diode.
CO4 - Measure the band gap of the given semiconductor.
CO5 - Measure the young's modulus of bar by uniform bending method.
CO6 - Determine the wavelength of the given laser light source.

SMEB2102	ENGINEERING DRAWING AND DESIGN	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

The main learning objective of this course is

- To understand the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products and to expose them to existing national standards related to technical drawings.
- To make the student to visualize and read the drawings.
- To learn about the orthographic and pictorial projections.

LIST OF EXPERIMENTS:

CONCEPTS AND CONVENTIONS

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

PLANE CURVES

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — Drawing of tangents and normal to the above curves.

PROJECTION OF POINTS AND LINES

Projection - Types of projection - Projection of points lying in four quadrants - Projection of lines (First angle projection only) -Projection of lines parallel and inclined to one or both the planes.

PROJECTION OF SOLIDS

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.
Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

SECTION OF SOLIDS

Purpose of sectioning - Sectional views - Hatching - Section plane perpendicular to one plane and parallel to other plane -Section plane inclined to HP-True shape of the section.
Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

DEVELOPMENT OF SURFACESAND FREEHAND SKETCHING

Need for development of surfaces - Types of development of surfaces - Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids, cylinders and cones.

ORTHOGRAPHIC PROJECTION

Visualizationconcepts and Free Hand sketching: Visualization principles —Representation of Three Dimensionalobjects — Layout of views- Freehand sketching of multiple views from pictorial views of objects. Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Identify the national standards related to the Engineering drawing based on BIS and construct conic sections and polygons.

CO2 - Solve practical problems involving projection of lines.

CO3 - Draw orthographic projections of solids.
CO4 - Draw orthographic section of solids and improve the students visualization skill to develop New products .
CO5 - Draw the Development of surfaces and its applications in manufacturing industry
CO6 - Draw the orthographic view of solids and learn to convert pictorial into orthographic projection.

TEXT I REFERENCE BOOKS

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House,53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
3. Venugopal K. and Prabhu Raja V., “Engineering Graphics", New Age International (P) Limited,2018.
4. Engineering drawing practice for schools and colleges, SP 46 – 1988 (http:// web.iitd.ac.in/~achawla/ public_html/201/lectures/sp46.pdf).

PUBLICATION OF BUREAU OF INDIAN STANDARDS:

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

SMTB1301	TRANSFORM TECHNIQUES AND COMPLEX ANALYSIS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- The purpose of this course is for modeling the Engineering problems and obtaining its solutions mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 FOURIER TRANSFORMATION 9 Hrs.

The infinite Fourier transform – Sine and Cosine transform – Properties – Inversion theorem – Convolution theorem – Parseval's identity – Finite Fourier sine and cosine transform.

UNIT 2 Z TRANSFORMATION AND DIFFERENCE EQUATIONS 9 Hrs.

Z Transform – Elementary properties – Inverse Z Transform – Partial fraction method, Convolution method, Residue method – Formation of difference equations – Solution of difference equations using Z Transform.

UNIT 3 COMPLEX VARIABLES 9 Hrs.

Analytic functions – Cauchy - Riemann equations in Cartesian and polar form – Harmonic functions – Properties of analytic functions – Construction of analytic functions using Milne – Thompson method – Some Standard Transformations – Translation, Magnification and Rotation, Inversion and Reflection and simple problems based on the above - Bilinear transformation.

UNIT 4 COMPLEX INTEGRATION 9 Hrs.

Cauchy's integral theorem – Cauchy's integral formula – problems – Taylor's and Laurent's series – Singularities – Poles and Residues – Cauchy's residue theorem and problems.

UNIT 5 PARTIAL DIFFERENTIAL EQUATION 9 Hrs.

Formation of equations by elimination of arbitrary constants and arbitrary functions – Solutions of First order Linear PDE – Lagrange's linear equation – Solution of Linear Homogeneous PDE of higher order with constant coefficients.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Analyze Fourier Transform with its properties
CO2 - Apply Z Transform with its properties to solve difference equations.
CO3 - Create analytic function, bilinear transformation with its properties.
CO4 - Evaluate complex integration using Cauchy Integral theorem and Cauchy Residue theorem
CO5 - Create partial differential equation by eliminating arbitrary constant or functions
CO6 - Solve first order linear PDE and homogeneous higher order PDE's

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 7th Edition, Mc. Graw Hill, 2004.

3. Erwin Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley and Sons, Singapore, 2001.
4. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi,2011.
Kandasamy P., Thilagavathy K. & Gunavathy K., Engineering Mathematics, (4th Revised Edition), S. Chand & Co., New Delhi, 2001.
5. Veerarajan T., Higher Engineering Mathematics, Tata Mcgraw Hill Publishing Co., NewDelhi, First Edition, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SISB4301	UNIVERSAL HUMAN VALUES	L	T	P	EL	Credits	Total Marks
		2	0	0	4	3	100

COURSE OBJECTIVE

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence
- To strengthen self-reflection
- To develop commitment and courage to act

MODULE 1 COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for selfexploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking**.**

MODULE 2 UNDERSTANDING HARMONY IN THE HUMAN BEING - HARMONY IN MYSELF!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease**.**

MODULE 3 UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY- HARMONY IN HUMAN-HUMAN RELATIONSHIP

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

MODULE 4 UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS COEXISTENCE

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
4. SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY SCHOOL OF COMPUTING
5. Holistic perception of harmony at all levels of existence.
6. Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

MODULE 5 IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b.
5. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
6. Case studies of typical holistic technologies, management models and production systems
7. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
8. Sum up.

Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Total: 28 Lectures and 14 Practice Sessions

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - To become more aware of themselves, and their surroundings (family, society, nature)

CO2 - They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind

CO3 - To have better critical ability

CO4 - To become sensitive to their commitment towards what they have understood (human values, human relationship and human society)

CO5 - To apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

TEXT / REFERENCE BOOKS

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj – PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

S19BLH31	FLUID MECHANICS	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVE

- Understand the basic fluid properties, the fundamental principles and equations related to fluid mechanics
- Apply the physical and mathematical models to understand the fluid flow measurement and fluid machineries in engineering applications

UNIT 1 FLUID FLOW PHENOMENA 9 Hrs.

Nature of fluids-properties of fluids, incompressible and compressible, hydrostatic equilibrium. Manometers U-Tube and inclined. Potential flow, boundary layer, the velocity field, laminar flow, Newtonian and Non-Newtonian fluids, Newton's law of viscosity, turbulence. Reynolds number and transition from laminar to turbulent flow, Eddy viscosity, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes.

Practical : Estimation of viscosity of fluids, pressure measuring devices.

UNIT 2 KINEMATICS OF FLUID FLOW 9 Hrs.

Streamlines and stream tubes, equation of continuity, Bernoulli equation. Flow of incompressible fluids in conduits and thin layers: friction factor, relationships between skin friction parameters, average velocity for laminar flow of Newtonian fluids, Hagen-Poiseuille equation, hydraulically smooth pipe, von Karman equation, roughness parameter, friction-factor chart, equivalent diameter. Form frictional losses in Bernoulli's equation, Couette flow.

Practical : Estimation of friction factor through pipes and conduits

UNIT 3 FLOW PAST IMMERSED BODIES AND FLUIDIZATION 9 Hrs.

Drag and drag coefficients. Drag coefficients of typical shapes, Ergun equation, terminal settling velocity, free and hindered settlings, Stokes' law, Newton's law, criterion for settling regime. Fluidization, conditions for fluidization, minimum fluidization velocity.

Practical: Flow through packed bed, fluidized bed

UNIT 4 TRANSPORTATION OF FLUIDS 9 Hrs.

Introduction to pipe and tubing, joint and fittings, stuffing boxes, mechanical seals, gate valves and globe valves, plug cocks and ball valves, check valves. Classification and selection of pumps, blowers and compressors. Pumps, developed head, power requirement, suction lift and cavitation, NPSH, constructional and working principle of single-suction volute centrifugal pump, Characteristics curves of centrifugal and reciprocating pump.

Practical: Characteristics of a Reciprocating pump, Centrifugal pump, Gear pump

UNIT 5 METERING OF FLUIDS 9 Hrs.

Constructional features and working principles of Venturi meter, Orifice meter, Area meters-Rota meter, Point velocity-Pitot tube, V-element meter, Target meter-ultrasonic meters, vortex shredding meter, magnetic meters, turbine meter. Application of Bernoulli's equation to venturi and orifice meter, flow rate measurements.

Practical: Flow through Venturimeter, Flow through Orifice meter, Flow through Pitot tube, V- Notches

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Determine the fluid pressure and use various devices for measuring fluid pressure

CO2 - Calculate hydrostatic equilibrium and use of law of conservation mass to fluid flow.

CO3 - Compute the ∆P for the flow past immersed bodies
CO4 - Apply Bernoulli's equation to fluid flow problems and boundary layer theory to determine lift and drag forces on a submerged body.
CO5 - Apply the concepts of metering of fluids in the selection of flow meters
CO6 - Use of different fluid flow measuring devices

TEXT / REFERENCE BOOKS

1. McCabe, W.L, Smith J.C and Harriot. P., Unit Operations in Chemical Engineering, 7th Edition, Mc-Graw-Hill, 2009.
2. Bansal R K, Text book of Fluid Mechanics, Lakshmi Publication, 2008.
3. Coulson J.M. and Richardson J.E., Chemical Engineering, Volume 1, 3rd Edition, Pergamon Press, 2000.
4. White, F.M., Fluid Mechanics, 4th Edition, McGraw-Hill Inc., 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1301	CHEMICAL ENGINEERING THERMODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To acquire basic understanding of concepts and laws of thermodynamics, volumetric properties of fluids, thermodynamic properties of fluids and applications of law of thermodynamics

UNIT 1 INTRODUCTION 9 Hrs.

The scope of thermodynamics, Dimensions and units, Measures of amount or size, Force, temperature, pressure, work, energy, heat, etc. Internal Energy, Enthalpy, The first law of thermodynamics, Thermodynamic state, state functions, Energy balance for closed systems, Equilibrium, The Phase rule, The reversible process, Heat capacity. General Statements of First Law of Thermodynamics, First Law of Thermodynamics for Cyclic Process, First Law of Thermodynamics for Non-flow Process, First Law of Thermodynamics for Flow Process.

UNIT 2 REAL GAS 9 Hrs.

PVT behaviour of pure substances, Ideal and non-ideal gases, Equation of states, Virial, Cubic, van der Waals, Redlich/Kwong (RK) etc., Calculation of constants in terms of Pc, Tc, Vc. Generalized Correlations for gases and liquids.

UNIT 3 HEAT 9 Hrs.

Sensible heat effects, Temperature dependence of the heat capacity, Latent heats of pure substances, Approximate methods for the estimation of the latent heat of vaporization, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature Dependence of ΔH^0, Heat effects of Industrial Reactions.

UNIT 4 SECOND LAW OF THERMODYNAMICS 9 Hrs.

Statements of second law of thermodynamics, Heat engines, Thermodynamic Temperature Scales, Concept of entropy, Entropy changes of an Ideal Gas, Third law of thermodynamics. The fundamental property relations for homogeneous phases, Maxwell's equations, Residual properties, Mathematical relations among thermodynamic properties, two phase systems, Thermodynamic diagrams.

UNIT 5 THERMODYNAMIC APPLICATIONS 9 Hrs.

Fundamental equations and relationships, flow in pipes, maximum velocity in pipe flow, nozzles, Single and Multistage compressors and ejectors. Carnot refrigerator, Vapor compression cycle, Absorption refrigeration, Choice of refrigerant, Heat pump, Liquefaction processes.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Interpret the principles of thermodynamics and the properties
CO2 - Discuss second law of thermodynamics to analyze the feasibility of system
CO3 - Solve PVT behavior of fluids and the equations of state
CO4 - Compare the thermodynamic property relations
CO5 - Estimate the performance of compressors and nozzles
CO6 - Design of the ideal and actual vapor-compression refrigeration cycle and evaluate the performance

TEXT / REFERENCE BOOKS

1. Smith J.M. and Van Ness H.C., Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw Hill, 2005.
2. Narayanan K.V, A Text Book of Chemical Engineering Thermodynamics, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2013.
3. Gopinath Halder, Introduction to Chemical Engineering Thermodynamics, 2nd Edition, PHI Learning Private Limited, 2009.
4. Rao Y.V.C., Chemical Engineering Thermodynamics, 1st Edition, University Press (I) Ltd., Hyderabad, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1302	CHEMICAL PROCESS CALCULATIONS	L	T	P	EL	Credits	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 BASIC CHEMICAL CALCULATIONS 9 Hrs.

Classifications and modes of chemical processes, Units and dimensions, Conversion factors, Mole concept, Concept of normality, molarity, and molality, Density and specific gravity, Methods of expressing composition of mixtures and solutions, Ideal gas law, Dalton's law, Amagat's law.

UNIT 2 MATERIAL BALANCE WITHOUT CHEMICAL REACTION 9 Hrs.

Law of conservation of mass. Process flow sheet Material balance calculations involving drying, mixing, distillation, crystallization, evaporation, absorption and extraction.

UNIT 3 MATERIAL BALANCE WITH CHEMICAL REACTION 9 Hrs.

Stoichiometric equation, stoichiometric coefficient, limiting reactant, excess reactant percent excess, conversion, degree of completion and yield. Recycle, Purge, Bypass calculations in unit operations and unit process.

UNIT 4 COMBUSTION CALCULATIONS 9 Hrs.

Flue gas analysis, Orsat analysis, theoretical and excess air requirement for solid, liquid and gaseous fuels.

UNIT 5 ENERGY BALANCE 9 Hrs.

Standard heat of formation, Standard heat of combustion, Standard Heat of reaction, Hess's law Determination of heat of reaction, Calculation of theoretical flame temperature.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Enrich the knowledge to systems of units, conversion and measurement scales.
CO2 - Carry out material and energy balance calculations separation processes.
CO3 - Analyse the behavior of recycle processes, performing approximate material balances and setting up calculations for rigorous solution.
CO4 - Analyse the behaviors of recycle processes with reactions, performing approximate material balances, and setting up calculations for rigorous solution.
CO5 - Perform the energy balance and determine the heat of combustion, heat of formation for the unit process.
CO6 - Apply the general energy balance equation to calculate the heat requirements for the unit operation

TEXT / REFERENCE BOOKS

1. RM Felder, Ronald W. Rousseau, Lisa G. Bullard, Elementary principles of Chemical processes, 14th Ed., John Weily & Sons, Asia ,2017.
2. D.M. Himmelblau, J. B. Riggs, Principles and calculations in chemical Engineering, 8 th Ed., Prentice Hall of India, 2012
3. Narayanan K.V., Lakshmikutty B, Stoichiometry and Process calculations, Prentice Hall India Limited, New Delhi, 2006.

4. Bhatt B.I., Thakore S. B., Stoichiometry, 5th ed., Tata McGraw – Hill Book Company, New Delhi, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB2301	ORGANIC CHEMICAL PROCESS AND SYNTHESIS	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To have a thorough understanding on the estimation and analysis of chemical compounds.

LIST OF EXPERIMENT

SYNTHESIS

1. Synthesis of compounds involving the following reactions Acetylation
2. Synthesis of aspirin from salicylic acid
3. Synthesis of compounds involving the following reactions Hydrolysis
4. Esterification
5. Aldol condensation
6. Grignard reaction
7. Trans-esterification

QUALITATIVE ESTIMATION

8. Qualitative analysis of
- Cement
- Drug
- Fertilizer

QUANTITATIVE ESTIMATION

9. Quantitative analysis of organic compound – aldehydes, ketone, acid, ester, alcohol
10. Estimation of molecular weight by Rast method
11. Identification using Spectroscopic measurement

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Develop the synthesis process for the organic substance.
CO2 - Estimate the raw material requirement using material balance.
CO3 - Determine the quality of the fertilizer, drug.
CO4 - Analyze the composition of the cement.
CO5 - Determine the quantity of components present in the organic compound
CO6 - Determination of functional groups and their characteristics

SCHB2302	MECHANICAL OPERATIONS LAB	L	T	P	EL	Credits	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

SMTB1401	FOURIER SERIES AND NUMERICAL METHODS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- The purpose of this course is for modeling the Engineering problems and obtaining its solutions mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 FOURIER SERIES 9 Hrs.

Fourier series – Euler's formula – Dirichlet's conditions – Fourier series for periodic functions – Parseval's identity (without proof) – Half range cosine series and sine series – simple problems – Harmonic Analysis.

UNIT 2 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 9 Hrs.

One dimensional wave equation – Transverse vibrating of finite elastic string with fixed ends – Boundary and initial value problems – One dimensional heat equation – Steady state problems with zero boundary conditions – Two-dimensional heat equation – Steady state heat flow in two dimensions- Laplace equation in Cartesian form (No derivations required).

UNIT 3 NUMERICAL METHODS FOR SOLVING EQUATIONS 9 Hrs.

Solution of algebraic equation and transcendental equation: Regula Falsi Method, Newton Raphson Method (including solving algebraic equations in two variables f(x,y)=0 and g(x,y)=0) – Solution of simultaneous linear algebraic equations: Gauss Elimination method, Gauss Jacobi method and Gauss Seidel method.

UNIT 4 INTERPOLATION, NUMERICAL DIFFERENTATION AND INTEGRATION 9 Hrs.

Interpolation: Newton forwards and backward interpolation formula, Lagrange's formula for unequal intervals – Numerical differentiation: Newton's forward and backward differences to compute first and second order derivatives – Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8th rule.

UNIT 5 NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS 9 Hrs.

Ordinary differential equations: Taylor series method, Runge Kutta method for fourth order - Partial differential equations – Finite differences – Laplace equation and its solutions by Liebmann's process – Solution of Poisson equation – Solutions of parabolic equations by Bender Schmidt Method – Solution of hyperbolic equations.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Develop Fourier series for different types of functions
CO2 - Derive and obtain the solutions of wave and heat equations
CO3 - Formulate numerical solution of algebraic, transcendental and simultaneous linear equations
CO4 - Solve interpolation, numerical differentiation and integration problems
CO5 - Analyze various numerical methods for the solution of ordinary differential equations
CO6 - Apply numerical techniques to solve partial differential equations

TEXT / REFERENCE BOOKS

1. Kreyszig E., Advanced Engineering Mathematics, (8th Edition), John Wiley and Sons (Asia) Pte Ltd., Singapore, 2001.
2. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi,2011.
3. Kandasamy P., Thilagavathy K. & Gunavathy K., Engineering Mathematics, (4th Revised Edition), S. Chand & Co., New Delhi, 2001.
4. Veerarajan,T., Engineering Mathematics, Tata Mcgraw Hill Publishing Co., New Delhi, 2005.
5. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata Mcgraw Hill Publishing Co., New Delhi, 2003.
6. Kandasamy P., Thilagavathy K. and Gunavathy, K., Applied Numerical Methods, S. Chand & Co., New Delhi, 2003.
7. E.Balagurusamy, Numerical Methods, McGraw-Hill Education (India) Pvt Limited, 1999
8. B.S. Grewal, Numerical Methods in Engineering Science, Khanna Publisher, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1401	PHASE EQUILIBRIUM THERMODYNAMICS	L	T	P	EL	Credits	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

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

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

S19BLH41	HEAT TRANSFER	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVE

- To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipment's like evaporator and heat exchanger
- Solve various heat transfer problems encountered in practice.

UNIT 1 HEAT TRANSFER BY CONDUCTION 9 Hrs.

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, Hollow cylinder, sphere, Heat conduction through a series and parallel series of resistances: thermal conductivity measurement; temperature effect on thermal conductivity Heat transfer occurs on extended surfaces.

Practical: Determine the thermal conductivity of metal rod, Composite walls, lagged pipe

UNIT 2 HEAT TRANSFER BY CONVECTION 9 Hrs.

Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Colburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, and flow through packed beds.

Practical: Determine the temperature distribution for a cylinder due to heat transfer by natural convection.

UNIT 3 HEAT TRANSFER TO FLUIDS WITH PHASE CHANGE 9 Hrs.

Heat transfer from condensing vapors, drop wise and film wise condensation, Nusselt equation for vertical and horizontal.

tubes, condensation of superheated vapors, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling. Introduction to heat transfer in packed &fluidized beds: Calculation of heat transfer coefficients.

Practical: Heat transfer in jacketed vessels, boilers furnaces and agitated vessels

UNIT 4 HEAT TRANSFER BY RADIATION 9 Hrs.

Black body radiation, Emissivity, Stefan - Boltzmann law, Plank's law, radiation between surfaces. Basic definition pertaining to radiation, Emissive power, Radiosity, Irradiation, Absorptivity, reflectivity, and transmissivity, Black body radiation, Planck's law, Wien's law, Stefan-Boltzmann law, Special characteristics of black body radiation, Kirchhoff's law, Grey body, Radiative heat exchange between surfaces, View factor, Relation between view factors, Heat exchange between non-black bodies, Radiation shield.

Practical: Measurement of emissivity of the test plate and plot a graph between emissivity and temperature.

UNIT 5 EVAPORATOR AND HEAT EXCHANGER 9 Hrs.

Theory of evaporation: single effect and multiple effect evaporation; design calculations for single effect and multiple effect evaporation. Single pass and multi-pass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers, effectiveness; number of transfer unit - Chart for different configurations – Fouling factors

Practical: Study and compare temperature distribution heat transfer rate, overall heat transfer co-efficient in parallel flow heat exchanger and counter flow heat exchanger

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Examining the basic modes of heat transfer.
CO2 - Apply principles of heat transfer to predict transfer coefficients
CO3 - Analyze working of various heat transfer equipment
CO4 - Design heat transfer equipment.
CO5 - Evaluate radiative heat transfer including blackbody radiation and Kirchoff's law, and able to solve radiative problems
CO6 - Solving the heat transfer rate and surface area of condensers/evaporators

TEXT / REFERENCE BOOKS

1. Holman, J. P., 'Heat Transfer', 8th Ed., McGraw Hill, 1997.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
4. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Ed., McGraw-Hill, 2001.
5. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Ed., Asian Books Pvt. Ltd., India, 1998.

SCHB1402	PRINCIPLES OF MASS TRANSFER	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- Understand the principles of diffusion in gas, liquid and solid phases
- Interpret the relation between mass transfer coefficients and the theories of mass transfer for different separation operations.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to Mass transfer operation, Fick's law of diffusion, Steady state molecular diffusion in fluids under stagnant and laminar flow conditions, Diffusion coefficient measurement and prediction, Molecular diffusion in gas and Liquids, Multicomponent diffusion, Diffusion through variable cross-sectional area, Diffusivity in solids and its applications.

UNIT 2 MASS TRANSFER COEFFICIENT 9 Hrs.

Introduction to mass transfer coefficient, Correlation for convective mass transfer coefficient, Correlation of mass transfer coefficients for single cylinder, Packed column, flow over a flat plate, Penetration theory, Surface Renewal Theory, Interphase mass transfer, two film theory, Overall mass transfer coefficients.

UNIT 3 HUMIDIFICATION 9 Hrs.

Basic concepts, Principles of Humidification –Definitions Wet Bulb Temperature Adiabatic Saturation Temperatures –Air/Water System psychrometric and Psychrometric Charts – Utilization of Psychrometric Charts – Dehumidification – Cooling Towers – Mechanical Draft Towers: forced draft towers and induced draft towers; Design calculations of cooling tower.

UNIT 4 DRYING 9 Hrs.

Principles of Drying-Definitions of moisture and other terms on Drying, Classification of Drying operations. Rate of Drying -Constant and Falling Rate Drying. Moisture movement in solids -Through Circulation Drying - Rate of drying for Continuous Direct heat Driers-Types of Dryers used in practice and their operation-Batch and Continuous Dryers.

UNIT 5 CRYSTALLIZATION 9 Hrs.

Crystal Geometry - Invariant Crystals - Principles of Crystallization- Supersaturation- Nucleation-Crystal growth -Material & Energy Balance applied to Crystallizers-Types of Crystallizers used in practice

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Solve molecular diffusion in fluids and solids using correlation and theories
CO2 - Compare various mass transfer coefficients and analogies for various Chemical Engineering applications
CO3 - Interpret the theories of mass transfer for individual and overall mass transfer coefficients
CO4 - Design of humidification equipment's based on material and energy balances
CO5 - Estimate the Psychometric properties of air-water system using charts and equations
CO6 - Discuss different types of mass transfer equipment's cooling tower, drier, crystallizer used for Industrial applications

TEXT / REFERENCE BOOKS

1. B. K. Dutta, Principles of Mass Transfer and Separation Processes, 8th Printing, PHI Learning Private Limited, 2015
2. W. L. McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th Ed., McGraw Hill, 2005
3. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw Hill, 1983
4. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall India, 1993
5. Cussler, E.L, Diffusion: MassTransfer in Fluid Systems, Cambridge university press,2017
6. Anantharaman N, MS Begum K.M., Mass Transfer-Theory and practice, Prentice-Hall of India, New Delhi, 2011

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCSBDPRROJ	DESIGN THINKING AND INNOVATIONS	L	T	P	EL	Credits	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/

SCHB1501	MASS TRANSFER OPERATIONS	L	T	P	EL	Credits	Total Marks
		3	1	0	3	4	100

COURSE OBJECTIVE

- To provide students with the theoretical/analytical background to understand mass transfer operations as well as application and to tackle the sort of complex problems.

UNIT 1 DISTILLATION 9 Hrs.

Vapor-Liquid Equilibrium; Enthalpy-Concentration Diagram; Flash Vaporization; Steam Distillation; Batch Distillation; Continuous Multistage Fractionation; McCabe-Thiele Method; Ponchon - Savarit Method

UNIT 2 GAS-LIQUID CONTACTING EQUIPMENT 9 Hrs.

Gas Dispersed: Sparged vessels, mechanically agitated vessels, Gas-Liquid contact, Tray Tower, Tray tower internals, Different types of trays, Weirs, Downcomers and criteria of their selection, Flooding, Loading, Coning, Weeping & dumping in tray tower. Liquid Dispersed: Venturi scrubber, Wetted wall towers, spray towers, Packed Towers, Packed tower internals, Different types of packings and their selection criteria, Co-current flow of gas & liquid, End effects and axial mixing, Tray tower vs. Packed tower Absorption: Equilibrium in gas-Liquid Systems; Selection of Solvent; Design of Packed Tower; Correlations for Mass Transfer Coefficient; Determination of Number of Stages in Tray Tower; HETP.

UNIT 3 ADSORPTION 9 Hrs.

Adsorbents – Characteristics and Properties, Adsorption Equilibrium - Isotherms, Adsorbent Selection, Adsorption Equipment, Pressure Swing Adsorption, Ion Exchange, Chromatography.

UNIT 4 LIQUID-LIQUID EXTRACTION 9 Hrs.

Liquid-Liquid Equilibrium; Examples of Solvent Extraction; Solvent Selection; Design Calculations Ternary liquid- liquid equilibrium and tie line data, system of three liquids-one pair partially soluble, two partially soluble, two partially soluble liquids and one solid, multi-component system, stage wise contact, Single stage extraction, Co-current and cross current extraction, Continuous counter current multistage extraction. Theory & performance of continuous contact equipment's.

UNIT 5 SOLID-LIQUID EXTRACTION 9 Hrs.

Solid-Liquid Contacting – Strategy, Equilibrium, Calculations. Steady state and unsteady state leaching operations, Single stage leaching, Multistage cross current and counter current leaching, Rate of leaching, Recovery of solvent, Application of leaching, Leaching equipment's.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Solve problems on VLE and problems related to design calculation of distillation columns.
CO2 - Explain the gas-liquid contacting process and solve related problems
CO3 - Determine number of stages in distillation, absorption and extraction operations
CO4 - Determine the height of packed column in absorption, distillation and extraction
CO5 - Formulate and solve mass balances for extraction, absorption, adsorption and distillation.
CO6 - Describe the principles of leaching and estimate the number of ideal stages.

TEXT / REFERENCE BOOKS

1. B. K. Dutta, Principles of Mass Transfer and Separation Processes, 8th Printing, PHI Learning Private Limited, 2015
2. W. L. McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th Ed., McGraw Hill, 2005
3. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw Hill, 1983
4. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall India, 1993

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1502	PRINCIPLES OF CHEMICAL REACTION ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- To enable the students to gain knowledge on different types of chemical reactions and reactors
- To design chemical reactors under isothermal and non-isothermal conditions

UNIT 1 INTRODUCTION TO REACTION ENGINEERING 9 Hrs.

Rate equation, rate constant, order, molecularity, half-life period, fractional order, temperature dependent rate theories, integral and differential analysis, constant volume and variable volume reactions.

UNIT 2 DESIGN OF IDEAL REACTORS 9 Hrs.

Material balance, batch operation, continuous operation, batch reactor, plug flow reactor, mixed flow reactor, semi-batch reactor, recycle reactor.

UNIT 3 MULTIPLE REACTOR SYSTEMS 9 Hrs.

Mixed flow reactors in series and parallel connection, plug flow reactors in series and parallel connection, reactors of different types in series, size comparison of reactors using performance charts.

UNIT 4 DESIGN OF REACTORS FOR MULTIPLE REACTIONS 9 Hrs.

Series reactions, Parallel reactions and Series-Parallel reactions, factors affecting optimum yield and conversion, selectivity and fraction of impurities.

UNIT 5 NON-ISOTHERMAL REACTIONS 9 Hrs.

Equilibrium conversion, temperature effects on chemical reaction rates, optimum temperature progression, size of reactor, design procedures for adiabatic and non-adiabatic operation of reactors.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Apply basic concepts of reaction kinetics
CO2 - Design performance equations for ideal reactors
CO3 - Analyze design aspects for multiple reactors
CO4 - Evaluate product distribution of multiple reactions
CO5 - Demonstrate the effect of temperature and pressure on conversion
CO6 - Develop skills to design reactors for non-isothermal operations

TEXT / REFERENCE BOOKS

1. Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 3rd edition, 2000.
2. Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 3rd edition, 1981.
3. Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 4th edition, 2006.
4. Chemical Reactor Analysis, G. F. Froment and K. B. Bischoff, John Wiley & Sons, Singapore, 2nd edition, 1990.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 Exam Duration:3 Hrs.

PARTA : 10 Questions of 2marks each-No choice **20 MARKS**
PARTB : 2 Questions from each unit of internal choice, each carrying 16marks **80 MARKS**

SCHB1503	PROCESS INSTRUMENTATION AND CONTROL	L	T	P	EL	Credits	Total Marks
		3	0	0	1	3	100

COURSE OBJECTIVE

- This course enables the students to know about control methods and make the students knowledgeable in various types of measuring instruments used in chemical process industries.

UNIT 1 INSTRUMENTATION 9 Hrs.

Temperature measurement: Thermocouples, Resistance thermometers, Optical and Radiation pyrometers. Pressure measurement: Use of manometers, Bourdon gauge, Bellows type gauge. Flow measurement: Variable area meters. Positive displacement type meters. Liquid level measurement: Direct and differential method, measurement in open and pressure vessels.

UNIT 2 BASIC CONCEPTS OF PROCESS CONTROL 9 Hrs.

Laplace transformation and its application in process control. Response of first order systems Examples of first order systems Process Dynamics of linear open systems. Second order and first order systems in series higher order systems Transfer Function Step, Ramp, Pulse and Sinusoidal inputs and Linearization.

UNIT 3 LINEAR CLOSED LOOP SYSTEMS 9 Hrs.

Open loop and Closed loop control systems, Block Diagram representation, Controllers and Final control element, Servo and Regulator problems. Principles of Pneumatic and Electronic controllers. Transportation Lag Transient response of closed loop control systems, Control valve PI, P, PID control.

UNIT 4 STABILITY ANALYSIS 9 Hrs.

Stability, Stability criterion, Routh test for stability; Routh-Hurwitz criterion, Root-Locus analysis. Introduction to frequency
response of closed-loop systems, Frequency response - Bode plot and Bode stability criterion. Gain and Phase margins, Nyquist plot.

UNIT 5 CONTROL VALVES & INDUSTRIAL CONTROL SYSTEMS 9 Hrs.

Control valves, Valve sizing Characteristics Control valve construction, Valve positioning. Introduction to industrial control.
systems - Programmable Logic Controllers (PLCs), Distributed Control Systems (DCS), Supervisory control and Data Acquisition (SCADA). Cascade control, Feed forward control and Feedback control.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Interpret the working principles of various instruments.
CO2 - Develop transfer functions of various open loop systems and their responses.
CO3 - Determine the functioning of a control system and conventional controllers.
CO4 - Interpret the stability concepts and various techniques to check stability of the control systems.
CO5 - Describe the working and characterization of control valves.
CO6 - Discuss various industrial control systems.

TEXT / REFERENCE BOOKS

1. Coughanowr D.R and Koppel L.M., Process Systems Analysis and Control, 3rd Edition, McGraw Hill, NewYork, 2009.
2. Harriot P., Process Control, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.

3. George Stephanopoulos., Chemical Process Control, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2015.
4. Vyas.R.P., Process control and instrumentation, 8th Edition, Central Techno Publications, Nagpur 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1504	CHEMICAL PROCESS TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- Familiarize the concepts of design, operation details and schematic of industrial equipment.
- Ascertain the right separation technology for easy separation of chemical components

UNIT 1 INTRODUCTION - CHLORO ALKALI INDUSTRIES 9 Hrs.

Introduction - Basic principles of unit operations and unit process to common devices used in manufacturing processes like Reactors, Steam jet ejectors, Pumps, Thickeners, Dryers, Electrostatic precipitators, Condenser, Vacuum evaporator in block diagram - Standard symbols used for such devices, Process flow sheet. Manufacturing of soda ash, caustic soda and chlorine - manufacture of bleaching powder.

UNIT 2 SULPHUR, SULPHURIC ACID AND SILICATE INDUSTRIES 9 Hrs.

Mining and manufacture of Sulphur, recovery of Sulphur from polluting gases, Sulphur trioxide and sulfuric acid, hydrochloric acid, sodium sulphate, sodium thiosulphate. Manufacture of Portland cement, Manufacture of Glasses and Special glasses.

UNIT 3 INDUSTRIAL GASES AND PAINTS 9 Hrs.

Manufacture of Carbon dioxide, Hydrogen, Oxygen, Nitrogen, Acetylene, Water Gas, Producer Gas, Production of Natural Gas. Introduction of Paints, Pigments, Emulsions and Varnishes, Manufacture of Paints, Manufacture of White and Colored Pigments.

UNIT 4 NATURAL PRODUCTS 9 Hrs.

Edible and essential oils, soaps and detergents, glycerin, pulp and paper, starch and its derivatives, Manufacturing of sugar.

UNIT 5 SYNTHETIC ORGANIC CHEMICALS 9 Hrs.

Methane and synthesis gas, ethylene, acetylene and propylene. Aromatic chemicals - Benzene, toluene, and xylene. Production of thermo- plastic and thermo-setting resins: polyethylene, polypropylene, and Polyvinylchloride, Polymers and their engineering applications. Polyamides and polyesters and processes for the production of natural and synthetic rubber.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Demonstrate the schematic representation of various unit process and operation
CO2 - Analyze the various methods of manufacturing process pertain to chloro – alkali industry
CO3 - Explain the various techniques for sulfuric acid manufacturing
CO4 - Apply the basic fundamentals in manufacturing of industrial gases and paints
CO5 - Develop the flow sheet for the manufacturing of natural products
CO6 - Develop the flow sheet for the production of synthetic organic chemicals

TEXT / REFERENCE BOOKS

1. Gopala Rao. M. and Marshall Sittig, “Dryden's Outlines of Chemical Technology”, 3rd Ed., East West Press, New Delhi, 2008
2. George. T Austin, “Shreve's Chemical Process Industries”, 8th Ed., McGraw-Hill International Editions, Singapore, 2002.
3. Srikumar Koyikkal,” Chemical Process Technology and Simulation”,3rd Ed. PHI Learning Ltd ,2013.

4. Shukla and G.N. Pandey “Text book on Chemical Technology”, 2nd Ed., Vikas publishing company ,2001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB2501	MASS TRANSFER LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- This lab gives an overall idea of various mass transfer operations used in the industry

LIST OF EXPERIMENT

1. T-x-y diagram for water-acetone system.
2. To prove Rayleigh equation by carrying out simple distillation of methanol-water system
3. To determine rate of drying of given sample and to plot (kg moisture content/ kg of dry solid) V/S time and rate of drying V/S time
4. Gaseous diffusion coefficient apparatus.
5. Packed bed distillation column
6. Solid – liquid extraction - Conduct a batch leaching test to leach out sodium carbonate from the mixture given and hence find out the percentage of sodium carbonate leached out.
7. Batch adsorption studies - Verify Freundlich equation for the adsorption of oxalic acid onto activated carbon
8. Liquid – Liquid extraction studies
9. Determine the diffusivity coefficient for oxalic acid in water at different temperatures.
10. Determine the liquid - liquid equilibrium of the system (Benzene - Acetic acid - Water) and hence draw the ternary graph for the system.
11. Determine the mass transfer coefficient for the given system using Wetted wall column.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Determine efficiency of the operation
CO2 - Estimate the mass transfer coefficient.
CO3 - Verify Rayleigh's equation for batch distillation
CO4 - Determine HETP and HTU for given packing for distillation
CO5 - Determine the critical moisture content in drying
CO6 - Analyse the equilibrium characteristics.

SCHB1601	CONTINUUM MECHANICS & TRANSPORT PHENOMENA	L	T	P	EL	Credits	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 ANND 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 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

1. Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, 2nd Edition, Wiley, New York, 2006,
2. 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:3 Hrs.**

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	Credits	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 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB1603	REACTION ENGINEERING AND CATALYSIS	L	T	P	EL	Credits	Total Marks
		3	1	0	1	3	100

COURSE OBJECTIVE

- To enable the students to determine non-ideal behavior of ideal reactors
- To design heterogeneous reactors for solid catalyzed reactions

UNIT 1 NON - IDEAL FLOW SYSTEMS 9 Hrs.

Non ideal flow in reactors, RTD of fluid in reactors, Age distribution, F curve, C curve and E curve, Parameter models, Dispersion model, Tank in Series model, Conversion in non-ideal reactors.

UNIT 2 INTRODUCTION TO CATALYSIS 9 Hrs.

Homogenous and Heterogeneous Catalysis, Surface area determination, Pore volume distribution; Catalyst preparation, Promoters, Inhibitors and Poisons, Isotherms.

UNIT 3 FLUID-SOLID CATALYTIC REACTIONS 9 Hrs.

Diffusion within catalyst particle, Pore diffusion resistance combined with Surface Kinetics, Effectiveness factor, Thiele modulus, Experimental methods for determination of performance equations for reactors containing porous catalyst particles.

UNIT 4 CATALYST DEACTIVATION AND REGENERATION 9 Hrs.

Deactivation of catalyst, Decay reactions, Poisoning Models, Mechanism of deactivation of catalyst, Rate and performance study of deactivation, Determination of rate for independent deactivation reactions.

UNIT 5 INDUSTRIAL CATALYTIC REACTORS 9 Hrs.

Packed bed reactor, Fixed Bed, Fluidized Bed, Trickle bed, Slurry Reactors, Bio reactors, Industrial significance, trouble shooting.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Identify non-ideal behavior of reactors and their causes
CO2 - Estimate the controlling mechanism for non-catalytic heterogeneous reactions
CO3 - Analyze various preparation and characterization methods of catalysts
CO4 - Design performance equations for reactors containing porous catalyst particles
CO5 - Apply kinetic concepts to heterogeneous reactors
CO6 - Evaluate the mechanism of deactivation of catalyst

TEXT / REFERENCE BOOKS

1. Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 4th edition, 2006.
2. Chemical Reactor Analysis, G. F. Froment and K. B. Bischoff, John Wiley & Sons, Singapore, 2nd edition, 1990.
3. Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 3rd edition, 2000.
4. Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 3rd edition, 1981.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

S19BPB61	FACTORY AUTOMATION INDUSTRY 5.0	L	T	P	EL	Credits	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 & amp; 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 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. Uthayan Elangovan, Smart Automation to Smart Manufacturing: Industrial Internet of Things, Momentum, 1st Edition, 2019.

SCHB2601	CHEMICAL REACTION ENGINEERING LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	4	2	100

COURSE OBJECTIVE

- To understand the kinetics of ideal and non-ideal reactors
- To determine the rate constant and conversion in industrial reactors

LIST OF EXPERIMENT

1. Interpretation of Batch Reactor Data
2. RTD Studies in Plug Flow Reactor using pulse input
3. RTD Studies in Mixed Flow Reactor using pulse input
4. Performance study on Combined Reactors (PFR Followed by MFR)
5. Performance study on Combined Reactors (MFR Followed by PFR)
6. Performance Study on Semi Batch Reactor
7. Kinetic Studies in a Mixed Flow Reactor
8. Kinetic Studies in a Plug Flow Reactor
9. Determination of Rate of Dissociation using Solid – Liquid Non-Catalytic Reactor
10. Study on Adiabatic Reactor

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Apply the concepts of reaction kinetics to batch and continuous reactors
CO2 - Estimate the rate constant and conversion in single reactors
CO3 - Estimate the rate constant and conversion in multiple reactors
CO4 - Evaluate the dissociation constant in non-catalytic reactor
CO5 - Determine the residence time for non-ideal reactors
CO6 - Analyze the kinetics of semi-batch and adiabatic reactor

SCHB1701	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L	T	P	EL	Credits	Total Marks
		3	0	0	1	3	100

COURSE OBJECTIVE

- To enable students to learn about implementation of safety procedures and hazard identification.
- To develop the responsibility and ability for risk analysis and assessment.

UNIT 1 PROCESS PLANT SAFETY 9 Hrs.

Handling of hazardous chemicals, LFL, UFL, LEL, UEL, TLV, BLEVE, TWA, Safety in handling of gases, liquids and solids, Material safety data sheet, Plant Layout.

UNIT 2 HAZARD AND RISK ANALYSIS 9 Hrs.

Hazard identification, Types of hazard analysis, Steps involved and significance, Fault tree analysis, Event tree analysis, Failure Mode Effect Analysis and Illustrated examples, Quantitative risk assessment - rapid and comprehensive risk.

UNIT 3 HAZOP STUDIES 9 Hrs.

Hazard and Operability studies, Guide words, parameters, deviation, causes, consequences, recommendation, HAZOP case studies.

UNIT 4 SAFETY REGULATIONS 9 Hrs.

Safe working environment, OSHA Regulations and Significance, Health standards and rules, Factories act, Labor welfare act, ESI act, Workmen compensation act, Provisions and features.

UNIT 5 SAFETY APPRAISAL 9 Hrs.

Safety audit, Effective steps to implement safety procedures, periodic training and regular maintenance, personal protective equipment, types, Elements of safety Program, Fire Formation, Fire Triangle, Fire prevention and firefighting equipment.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Identify, formulate, and solve broadly defined technical or scientific problems by applying knowledge of science and/or technical topics to areas relevant to occupational safety.

CO2 - formulate or design a system, process, procedure or program to meet desired needs.

CO3 - Develop and conduct experiments or test hypotheses, analyze and interpret data to draw conclusions.

CO4 - Communicate effectively with a range of participants to create safety goals and targets

CO5 - Apply the ethical and professional responsibilities and the impact of technical and/or scientific solutions in environmental, and safety contexts.

CO6 - Establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty

TEXT / REFERENCE BOOKS

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl and Joseph F. Louvar, Prentice Hall International Series, 2nd Edition,2011
2. Safe and Efficient Plant Operation and Maintenance, Greene R., McGraw Hill Book Co., New York,1980
3. Safety Management and Practices for Hazardous Units, Dekkar Marcel, McGraw Hill Book Co., New York, 1995

4. Safety and Good House Keeping, Saxena, National Productivity Council, New Delhi (1976), 3rd Edition.
5. Safety in Process Plant Design, Wells G.L., George Godwin Ltd., (1980).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

S19BLH71	PROCESS MODELING AND SIMULATION	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVE

- The objective of this course is to give a broad coverage of the field of mathematical modeling and simulation in chemical engineering. Both steady-state and dynamic models will be examined and discussed.

UNIT 1 BASICS OF MODELLING 9 Hrs.

Introduction to Modeling, need of models and their classification, Uses of Mathematical Models, Scope of Coverage, Principles of Formulation. Fundamental Laws-Continuity Equation, Energy Equation, Equations of Motion. Regression and Correlation Analysis.

UNIT 2 MODELING OF HEAT TRANSFER AND OTHER EQUIPMENTS 9 Hrs.

Two Heated Tanks, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Evaporators, mixing process, interacting and non-interacting system and Gravity flow tank.

UNIT 3 MODELING OF REACTORS 9 Hrs.

Batch Reactor, Series of Isothermal Constant-Holdup CSTR, CSTR with Variable Holdup, Non-Isothermal CSTR, Semi batch Reactor, Plug Flow Reactor, Packed Bed Reactor and bioreactor models.

UNIT 4 MODELING OF MASS TRANSFER OPERATIONS 9 Hrs.

Absorption Columns, Ideal Binary Distillation column, Multi component Non-Ideal Distillation Column, Batch Distillation with Holdup, Single Component vaporizer multi component flash drum and extraction models.

UNIT 5 DYNAMIC SIMULATION 9 Hrs.

Dynamic Simulation of Batch Reactor, Non-Isothermal CSTR, Three CSTR in Series, PFR, Binary Distillation Column, Evaporator, Absorption column and Gravity Flow Tank.

LIST OF EXPERIMENTS:

1. Introduction to software (flow sheeting)
2. Simulation of flash drum
3. Simulation of distillation columns
4. Simulation of absorption column
5. Simulation of Reactors
6. Simulation of Heat Exchangers.
7. Simulation of pumps
8. Simulation of mixing
9. 9. Simulation of compressors.

Max.60 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Organize the important physical phenomena from the problem statement
CO2 - Demonstrate the stages involved in the development of a process model.
CO3 - Develop model equations for heat transfer and other equipment
CO4 - Analyze model equations for the given reactors
CO5 - Explain model equations for the given mass transfer operations
CO6 - Solving the chemical engineering models developed

TEXT / REFERENCE BOOKS

1. Amiya K. Jana," ChemicalProcess Modelling and Computer Simulation" 2nd Ed., PHI Learning Ltd, 2019.
2. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2nd Ed., PHI Learning Ltd ,2016.
3. Ramirez W., Computational Methods in Process Simulation, 2nd Edition, Butterworth's Publishers, New York, 2000.
4. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes ", John Wiley, 2018.

SCHB2701	MAT LAB AND VIRTUAL INSTRUMENTATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To develop the knowledge on the time and frequency response of the system using MAT LAB software
- To measure and control various process parameters using Lab view software

LIST OF EXPERIMENT

1. Step, Ramp, Impulse response of First and Second orders System using Mat lab
2. Identification of damping in Second order System using Mat lab
3. Time Domain Analysis of Second Order System using Mat lab
4. Frequency Response of Second Order System - Bode Plot using Mat lab
5. Frequency Response of Second Order System -Polar Plot using Mat lab

VIRTUAL INSTRUMENTATION LAB

1. Arithmetic operations using Lab view
2. Building VI to demonstrate conversion of Centigrade to Fahrenheit and using Lab view
3. Building VI to create a subroutine for conversion of Centigrade to Fahrenheit using Lab view
4. Building VI to demonstrate ON-OFF controller using Lab view
5. Building VI to demonstrate level controller using Lab view
6. Building VI to demonstrate waveform generator using Lab view

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, pristine 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

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

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

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

COURSE OBJECTIVE

- This course will provide an overview of a modern, integrated petroleum refinery, including its feed stocks, 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 corves, 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 Clennel Palmer , Andrew Palmer, 2020
2. Oil and Gas Engineering for Non-Engineers, by Quinta Nwanosike Warren , 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3003	PETROCHEMICAL TECHNOLOGY	L	T	P	EL	Credits	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 principled 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 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3004	UNCONVENTIONAL OIL AND GAS TECHNOLOGY	L	T	P	EL	Credits	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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3005	BIOREFINERY	L	T	P	EL	Credits	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 CO_2 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3006	EOR TECHNIQUES	L	T	P	EL	Credits	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

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

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3007	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	EL	Credits	Total Marks
		3	0	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.

The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions

UNIT 2 EIA METHODOLOGIES 9 Hrs.

Environmental attributes -Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation and Evaluation, impact communication, Methods-Adhoc methods, Checklist's methods, Matrices methods, Networks methods, and Overlays methods. EIA review-Baseline Conditions -Construction Stage Impacts, post project impacts.

UNIT 3 COMPONENTS OF EIA 9 Hrs.

Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, international agreements.

UNIT 4 ENVIRONMENTAL MANAGEMENT PLAN 9 Hrs.

EMP preparation, Monitoring, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, Monitoring Methods, Pre-Appraisal and Appraisal. Environmental Legislation and Life cycle Assessment: Environmental laws and protection acts, Constitutional provisions-powers and functions of Central and State government, The Environment (Protection) Act 1986, The Water Act 1974, The Air act 1981, Wild Life act 1972, Guidelines for control of noise, loss of biodiversity, solid and Hazardous waste management rules. Life cycle assessment: Life cycle analysis, Methodology, Management, Flow of materials-cost criteria. EIA notification September 2006 and amendments: Categorization of projects, Procedure for getting environmental clearance.

UNIT 5 CASE STUDIES 9 Hrs.

Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, nuclear fuel complex, Sewage treatment plant, Municipal Solid waste processing plant, EIA for chemical industry.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Identify the environmental attributes to be considered for the EIA study
CO2 - Formulate objectives of the EIA studies
CO3 - Identify the methodology to prepare rapid EIA
CO4 - Apply the different methodologies to predict and assess the impacts of project on various aspects of environment.
CO5 - Prepare EIA reports and environmental management plans
CO6 - Enumerate the role of public participation in environmental decision-making process

TEXT / REFERENCE BOOKS

1. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
2. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
3. Anjaneyulu. Y and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
4. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3008	GREEN TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the principles of green chemistry and ecofriendly methodologies.
- To provide basic knowledge on green technology.

UNIT 1 INTRODUCTION 9 Hrs.

Green product design definition, Product strategy, Life cycle of product, Environmental load of product, Material selection, resource use, production requirements and planning for the final disposition (recycling, reuse, or disposal) of a product.

UNIT 2 GREEN CHEMISTRY 9 Hrs.

Twelve principles of green chemistry, green technology-definition, importance, factors affecting green technology. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology.

UNIT 3 GREEN SYNTHESIS 9 Hrs.

Green methods of synthesis- microwave assisted synthesis, solvent free techniques- Reaction on solid supports. Alternative solvents Ionic liquids- general synthesis, applications; super critical fluids-extraction, process and applications.

UNIT 4 GREEN MANUFACTURING SYSTEM 9 Hrs.

Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems

UNIT 5 GREEN ENERGY 9 Hrs.

Energy efficient motors, energy efficient lighting, control and selection of luminaries; bio-fuels, fuel cells-working, selection of fuels, Ecofriendly and cost-effective materials, Energy management.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Realize the importance of green technologies in sustainable growth of Industry
CO2 - Adopt alternative methods and solvents for green synthesis
CO3 - Design and implementation of suitable energy efficient processes
CO4 - Plan and use of selective materials
CO5 - Enlist different concepts of green technologies in a project
CO6 - Recognize the benefits of green fuels with respect to sustainable development

TEXT / REFERENCE BOOKS

1. Khan B.H, Non-conventional energy resources, Tata McGraw-Hill, New Delhi 2006.
2. Rashmi Sanghi and M.M. Srivastava, Green Chemistry-Environment Friendly Alternatives, Narosa Publishing House, New Delhi 2009.
3. Paul L. Bishop, Pollution prevention –Fundamentals and Practices, McGraw-Hill- international 2000.
4. Fiksel, Joseph, ed. Design for Environment: creating eco-efficient products and processes. New York: McGraw- Hill

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3009	ENVIRONMENTAL POLLUTION AND CONTROL	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the impact of environment pollution on the community
- To enable the students to determine and control pollutants of Air, Water and Land

UNIT 1 ENVIRONMENT AND INDUSTRIAL POLLUTION 9 Hrs.

The biosphere, Hydrologic cycle, Nutrient cycles, pollution of air, water and soil. Characteristics of industrial wastes, Effects of industrial pollutants on environment – air, water and land.

UNIT 2 AIR POLLUTION AND CONTROL 9 Hrs.

Introduction-Sources of air pollution, Air pollution effect on human, plant and animal. Air pollution control methods-Source correction method, Cleaning of gaseous effluent, Particulate Emission control and equipment's used in particulate emission control, Air pollution laws and air quality standard.

UNIT 3 WATER POLLUTION AND CONTROL 9 Hrs.

Origin of waste water, Types of waste pollutants and their effects, Waste water sampling and analysis, Determination of organic and inorganic matters, Physical characteristics, Bacteriological measurements, Primary, Secondary and Tertiary treatments, Water pollution laws and air quality standard.

UNIT 4 NOISE POLLUTION AND RADIOACTIVE POLLUTION 9 Hrs.

Introduction, sources of noise pollution, Characteristics of sound, noise units, types of noise, effects and control of noise pollution. Radioactive pollution (RAP), Sources of RAP-Classification of its radiation effects on humans, plants and animals, Control.

UNIT 5 SOLID WASTE MANAGEMENT 9 Hrs.

Solid waste characteristics – Classification of hazardous waste - waste disposal methods - Composting - Landfill- Briquetting - Gasification – Incineration, Case studies.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Understand various cycles of environment and factors influencing the cycles.
CO2 - Analyzing and controlling techniques of air pollution
CO3 - Analyzing and controlling techniques of water pollution
CO4 - Analyzing and controlling techniques of noise and radioactive pollution
CO5 - Understanding the solid waste management techniques
CO6 - Ability to understand the key principles that support pollution prevention and control.

TEXT / REFERENCE BOOKS

1. McKinney, M.L., Schoch, R. and Yonavjak, R.M. 2012.Environmental Science Systems and Solutions. Fifth Edition. Jones & Bartlett Publishing Inc., Delhi
2. Environmental pollution analysis, S. M. Khopkar, New age international. 2011
3. Air Pollution Control Equipment Louis Theodore, Burley Intuscence 2008.
4. A Text Book of Engineering Chemistry,Dara S.S., 3rd Edition, S. Chan & Co Ltd, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

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	Credits	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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3011	RISK AND SAFETY MANAGEMENT IN PROCESS INDUSTRIES	L	T	P	EL	Credits	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 Exam Duration:3 Hrs.

PARTA : 10 Questions of 2marks each-No choice **20 MARKS**
PARTB : 2 Questions from each unit of internal choice, each carrying 16marks **80 MARKS**

SCHB3012	HAZARD ANALYSIS	L	T	P	EL	Credits	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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3013	DRUGS AND PHARMACEUTICAL TECHNOLOGY	L	T	P	EL	Credits	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
CO2 - Understanding knowledge of various drugs on different disease
CO3 - Demonstrate statistical quality control procedure
CO4 - Analyze the quality assurance programmes in various stages of pharmaceutical process
CO5 - Apply the principles on choosing active ingredients for finished product
CO6 - Develop new process and product formulations.

TEXT / REFERENCE BOOKS

1. Rawlnes, E.A., Bentley's Text Book of Pharmaceuticals, 7th Edition, Bailliere Tindalls, London, 2009.
2. Remingston, Pharmaceutical Sciences, 20th Edition, Mach Publishing Co., 2001.
3. Nita panditK, Introduction to pharmaceutical sciences, 4th Edition, Lippincott Williams &wilkins, 2013.
4. James swarbrick, Encyclopedia of pharmaceutical technology, 3rd Edition, informa healthcare distribution, 2006.
5. 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3014	INDUSTRIAL BIOTECHNOLOGY	L	T	P	EL	Credits	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 method of cell's bioprocessing under various conditions, strain improvement methods

CO2 - Demonstrate the experimental techniques related with aseptic processes, media preparation and upstream techniques

CO3 - Design and develop medium for statistical quality control procedure

CO4 - Analyze the quality assurance program in various stages of pharmaceutical process

CO5 - Apply the principles on choosing active ingredients for finished product

CO6 - Develop new process and product formulations.

TEXT / REFERENCE BOOKS

1. Rawlnes, E.A., Bentley's Text Book of Pharmaceuticals, 7th Edition, Bailliere Tindalls, London, 2009.
2. Remingston, Pharmaceutical Sciences, 20th Edition, Mach Publishing Co., 2001.
3. Nita panditK, Introduction to pharmaceutical sciences, 4th Edition, lipincott Williams &wilkins, 2013.
4. James swarbrick, Encyclopedia of pharmaceutical technology, 3rd Edition, informa healthcare distribution, 2006.
5. 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3015	FERTILIZER TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- This course helps the students to understand the various processes involved in chemical industries for the production of nitrogenous fertilizers and also to know the technological advancements in agriculture and fertilizer industry.

UNIT 1 INTRODUCTION TO FERTILIZERS & NITROGENOUS FERTILIZERS 9 Hrs.

Plant nutrients and its types, Fertilizer and its types, Production of Ammonia and Nitric acid, Methods of production, Specification, storage and handling of nitrogenous fertilizers, Ammonium sulphate, Ammonium nitrate, Urea, Calcium ammonium nitrate, Ammonium chloride.

UNIT 2 POTASSIUM FERTILIZERS 9 Hrs.

Sources of potassium, Location, Methods of production, Specification, storage and handling of potassic fertilizers, potassium chloride, Potassium choenites. Function of potassium in plants.

UNIT 3 PHOSPHATIC FERTILIZERS 9 Hrs.

Raw materials, Phosphate rock, Sulfur, pyrites etc., processes for the production of sulphuric and phosphoric acids; Phosphatic fertilizers, ground rock phosphate, Bone meal, Single super phosphate, Triple super phosphate, Thermal phosphate and their methods of production, storage and handling and specifications.

UNIT 4 COMPLEX AND NPK FERTILIZERS 9 Hrs.

Types of complex fertilizers, composition, Production of ammonium phosphate fertilizers, Ammonium sulfate, Diammonium phosphate, Nitro phosphate, Mono Ammonium Phosphate and various grade of NPK fertilizers.

UNIT 5 MISCELLANEOUS FERTILIZERS 9 Hrs.

Mixed fertilizers and granulated mixtures, Biofertilizers and nutrients. Secondary and micronutrients; fluid fertilizers, controlled release fertilizers.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Elaborate the production of nitrogenous fertilizers
CO2 - Explain the production of potassium fertilizers
CO3 - Analyze the application of phosphate fertilizer & their production
CO4 - Develop the production process for NPK Fertilizers/Biofertilizers
CO5 - Analyze the application of mixed fertilizers
CO6 - Evaluate the environmental impacts and their mitigation measures pertain to fertilizer industry

TEXT / REFERENCE BOOKS

1. Handbook of Fertilizer Technology, Fertilizer Association of India, New Delhi, 2000.
2. Gopala Rao M. and Marshall S, Dryden's Outlines of Chemical Technology, 3rd Edition., East-West Press, New Delhi, 2010.
3. Fertilizer technology and management, Brahma Mishra, I.K International Publishing House PVT lts, 2011
4. Fertilizer Manual, Kluwer Academic Publishers, Netherlands, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3016	FOOD TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To enable students to understand various properties of raw materials and technologies used in food processing
- To emphasize the fundamental concepts of unit operations & unit processes with an application to food technology.

UNIT 1 INTRODUCTION TO FOOD PROCESSING 9 Hrs.

Fundamentals of Food Process Engineering, Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control.

UNIT 2 UNIT OPERATIONS IN FOOD INDUSTRIES 9 Hrs.

Material & Energy Balances in Food Engineering Practices, Material handling, heat transfer, mixing, size reduction, mechanical separations.

UNIT 3 FOOD PRESERVATION 9 Hrs.

Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling.

UNIT 4 FOOD PACKAGING 9 Hrs.

Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – Metal, Glass and Flexible packaging, Cleaning/sanitation In Process (CIP and SIP).

UNIT 5 PRODUCTION OF FOOD PRODUCTS 9 Hrs.

Cereals, Vegetables, Fruits, Oils, Bread, Chocolates, Beverages, Dairy Products, Meat Products.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - To understand the Quality and Nutritive aspects of various food constituents
CO2 - Evaluate the various deteriorative factors of food and maintain quality
CO3 - Demonstrate the unit operations involved in food industries
CO4 - Classify packaging technologies for appropriate food products
CO5 - Compare the various food preservation technologies
CO6 - Demonstrate the principles of unit operation, preservation and packaging technologies for various food preparations

TEXT / REFERENCE BOOKS

1. Fundamentals of Food Processing Operation Heid J.L. Joslyn M.A., 6th Edition, The AVI publishing Co., West port 2018.
2. Food Science, Potter N.N., 6th Edition, The AVI publishing Co., Westport, 2007
3. Food Process Engineering, Heldman D.R., 4th Edition, The AVI publishing.2005
4. Food Chemistry, Owen. R. Fennema., 4th Edition, Marcel Dekker Inc New York, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 Exam Duration:3 Hrs.

PARTA : 10 Questions of 2marks each-No choice **20 MARKS**
PARTB : 2 Questions from each unit of internal choice, each carrying 16marks **80 MARKS**

SCHB3017	BIOCHEMICAL ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To introduce the key aspects of biochemical processes and to enable the implementation of these principles in related industries.

UNIT 1 INTRODUCTION 9 Hrs.

Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics.

UNIT 2 ENZYME AND ENZYME KINETICS 9 Hrs.

Nomenclature and classification and properties of Enzyme, Mechanism and Kinetics of enzymatic Reactions, Evaluation of Kinetic Parameters, Enzyme activity and factors affecting Enzyme activity, Types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance.

UNIT 3 KINETICS OF MICROBIAL GROWTH 9 Hrs.

Microbial Growth, Phases of cell growth in batch cultures, Microbial Growth Kinetics, The Stoichiometry of Microbial Reactions, Medium Formulation and Yield Factors, Material Balance of Cell Growth, Degree of Reduction, Fed Batch Culture, Fed-Batch Model Formulation. Kinetics of Substrate Utilization, Product Formation and Biomass Production in Cell Cultures, The kinetics of substrate consumption in cellular growth, Unstructured Batch Growth Models, Structured Kinetic Models, Compartmental models, Metabolic models, Product Formation Kinetics, Sterilization, Introduction, Applications, Heat Sterilization. Design and analysis of biological reactors.

UNIT 4 MIXING AND MASS TRANSFER 9 Hrs.

Mixing and Mass Transfer, Macro-mixing, Micro-mixing, Methods for Characterizing Mixing, Oxygen Transfer, Gas-Liquid Mass Transfer, Oxygen Transfer Rate, Oxygen Consumption in Cell Growth, Factors Affecting Cellular Oxygen Demand, Measurement of kla in Continuous-Stirred-Tank Bioreactor and Airlift Bioreactor, Continuous-Stirred-Tank Bioreactor, Airlift Bioreactor, Liquid Mixing, Types of Mixing and Stirrers Types of Flows in Agitated Tanks, The Mechanism of Mixing Power Requirement for Mixing, Un-gassed Newtonian Fluids, Un-gassed non-Newtonian Fluids, Gassed Fluids.

UNIT 5 DOWN STREAM PROCESSING 9 Hrs.

Downstream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra-filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Understand basics of microbiology to engineer them.
CO2 - Apply the basic concepts of mass and energy balances, reaction kinetics and for biochemical processes
CO3 - Apply mass transfer correlations to bioreactor design
CO4 - Estimation of the biomass growth and product formation rate, used for bioreactor design.
CO5 - Design of bioreactors and develop downstream processing
CO6 - Application of chemical concepts in bio-based industries

TEXT / REFERENCE BOOKS

1. Rao D. G., Introduction to Biochemical Engineering, Tata McGraw- Hill, 2008.
2. Michael S and Fikret K, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
3. Syed Tanveer A I, Biochemical Engineering Principle and Concepts, 2nd Edition, PHI Learning Private Limited,2009.
4. Wagemann, Kurt, Advances in Biochemical Engineering/Biotechnology, Springer, 2019

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3018	FERMENTATION TECHNOLOGY	L	T	P	EL	Credits	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 2 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 3 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

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

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3019	NANOTECHNOLOGY AND NANO BIOTECHNOLOGY	L	T	P	EL	Credits	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 2 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 3 NANO IN BIOPERSPECTIVE 9 Hrs.

Overview of nanostructures in protein and nucleic acids-cellular nano structures-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 4 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 5 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

1. CM Niemeyer & CA Mirkin, Nanobiotechnology-concepts, applications and perspectives, WILEY-VCH Verlag GmbH & Co. KGaA, 2004.
2. Nanobiotechnology Molecular Diagnostics: Current Techniques and Applications (Horizon Bioscience) by K.K. Jain Publisher, Taylor and Francis, 2006
3. Suresh S. and Amit Keshav, Text book of Separation Processes, Studium Press India Ltd., 2012

4. 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3020	ADVANCE SEPARATION PROCESS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To identify about the kind of separation processes in general and novel separations as an integral part of process chemical industries.

UNIT 1 THERMAL SEPARATION 9 Hrs.

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipment's design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications, Zone Refining and Zone levelling.

UNIT 2 SORPTION TECHNIQUES 9 Hrs.

Types and choice of adsorbents, Normal Adsorption techniques, Chromatographic techniques, Equipment and Commercial processes, Recent advances and Economics, Molecular Sieves. Affinity chromatography and immune chromatography recent advancements in separation techniques **-** Latest developments in separation techniques: Cryogenic, Supercritical fluid extraction, Bio-separation, and Azeotropic separation.

UNIT 3 PRINCIPLE OF MEMBRANE SEPARATIONS PROCESS 9 Hrs.

Classification: Reverse osmosis, Ultrafiltration, Micro-filtration, Nano-filtration and Dialysis; Analysis and modelling of membrane separation processes; Membrane modules and application; Ion selective membranes and their application in electro-dialysis; Pervaporation and gas separation using membranes; Electrophoresis; Liquid membranes and its industrial applications.

UNIT 4 IONIC SEPARATION 9 Hrs.

Controlling factors, Applications, Equipment's for Electrophoresis, Dielectrophoretic, Electro Dialysis and Ion – Exchange. Adductive Crystallization Applications, Economics and Commercial processes.

UNIT 5 MULTICOMPONENT DISTILLATION 9 Hrs.

Introduction to multi component separation system. Introduction to Multi component distillation-Key components, Estimation of minimum theoretical stages using Fenske's equation.Foam separation **-** Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Surface Adsorption, Nature of foams, Apparatus, Applications, and controlling factor.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Understand the thermal Separation principle and the equipment.
CO2 - Understand the various sorbents, adsorption techniques and chromatographic techniques
CO3 - Concepts of selecting the membranes for application in industries
CO4 - Ability to understand the Ionic Separation
CO5 - Apply other industrial separation like multicomponent distillation and foam separation techniques
CO6 - Knows the current scenario of advanced separation process.

TEXT / REFERENCE BOOKS

1. Seader J.D. and Henley E.J., Separation Process Principles, 3rd Edition, John Wiley & Sons, Inc., 2011.
2. Perry R.H. and Green D.W., Perry's Chemical Engineers Hand book, 8th Edition, McGraw Hill, New York, 2006.

3. Sinaiski E. G. and Lapiga E.J., Separation of Multiphase, Multicomponent Systems, 1st Edition, Wiley-VCH Verlag GmbH & Co., 2003.
4. Suresh S. and Amit Keshav, Text book of Separation Processes, Studium Press India Ltd., 2012.
5. 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3021	SMART MATERIALS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand various smart material and its importance in engineering application.
- To know various processing technics of smart materials and get knowledge of use of smart material as sensors and actuators.

UNIT 1 INTRODUCTION 9 Hrs.

Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics.Shape memory alloys **-** Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations.

UNIT 2 ELECTRO RHEOLOGICAL AND MAGNETO RHEOLOGICAL FLUIDS 9 Hrs.

Mechanisms and Properties, Characteristics, Fluid composition and behavior, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).Fiber optics **-** Introduction, Physical Phenomenon, Characteristics, Fiber optic strain sensors, Twisted and Braided Fiber Optic sensors, Optical fibers as load bearing elements, Crack detection applications, Integration of Fiber optic sensors and shape memory elements.

UNIT 3 VIBRATION ABSORBERS 9 Hrs.

Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.Biomimetics **-** Characteristics of Natural structures. Fiber reinforced: organic matrix natural composites, Natural creamers, Biomimetic sensing, Challenges and opportunities.

UNIT 4 MEMS 9 Hrs.

History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Micro fabrication: Photolithography, Thermal oxidation, thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design.Piezoelectricsensing and actuation **-** Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies, Comparison of major sensing and actuation methods.

UNIT 5 POLYMER MEMS & MICROFLUIDICS 9 Hrs.

Introduction, Polymers in MEMS (Polyimide, SU-8, LCP, PDMS, PMMA, Perylene, Others) Applications (Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Describe the methods of controlling vibration using smart systems.
CO2 - Study the fabrication methods of MEMS.
CO3 - Explain the principal concepts of smart materials, structures, fiber optics, ER
CO4 - Understand working of MR Fluids, Biomimetics and MEMS with principles.

CO5 - Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.

CO6 - Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, fiber optics, piezoelectric sensing and actuation.

TEXT / REFERENCE BOOKS

1. Srinivasan A.V. “Smart Structures –Analysis and Design”, Cambridge University Press, New York, 2001.
2. Gandhi M. V. and Thompson B.S. “Smart Materials and Structures”, Chapmen & Hall, London, 1992.
3. Chang Liu. “Foundation of MEMS, Pearson Education.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3022	MULTICOMPONENT SEPARATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- Understand the basic principles of staged and continuous contact separation equipment involved in equilibrium staged operations such as distillation, absorption, liquid-liquid extraction, leaching, adsorption and other modern separation operations.
- Perform basic design calculations for staged and continuous contact equilibrium staged separation operations.
- Describe various types of equipment's and modern separation methods for high purity products widely used in separation operation.

UNIT 1 DISTILLATION COLUMN 9 Hrs.

Types of contact – Tray Vs Packed Column; Derivation of operating line equation for different section and parts of distillation column - rectification section – stripping section - feed tray location - condenser - reboiler - efficiency of distillation column; Determination of theoretical trays – McCabe - Thiele method – Ponchon - Savarit method; Case study of Industrial distillation column for multicomponent separation using Aspen Plus.

UNIT 2 ABSORPTION 9 Hrs.

Introduction to absorption - Continuous contact counter-current multi-stage absorption (Tray absorber); Design of packed tower based on overall mass transfer coefficient; Absorber column operation using Aspen Plus.

UNIT 3 EXTRACTION 9 Hrs.

Extraction of multi component system-Choice of solvent, single stage extraction-'Multistage extraction-co currentand counter current-batch, simulation of continuous counter current cascade extraction, Stage Efficiency, Types ofextractors.

UNIT 4 LEACHING AND ADSORPTION 9 Hrs.

General principles of leaching - Factors influencing the leaching rate – Equipment for leaching – Advanced industrial leaching processes. Adsorption theory- Structure of adsorbents - Adsorption isotherms – Langmuir and Freundlich isotherms - Adsorption equipment

UNIT 5 MODERN SEPARATION TECHNIQUES 9 Hrs.

Membrane separation - microfiltration - ultrafiltration - nanofiltration - reverse osmosis; Chromatography – liquid chromatography - Advanced separation techniques - Divided wall column, melt crystallization, zone melting; Develop membrane separators using Aspen and solving for optimum purification.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Describe basic principles of various equilibrium staged operations involving material and energy balances

CO2 - Determine the number of equilibrium stages required for distillation and absorption units

CO3 - Determine number of transfer units and height requirements required for extraction, leaching and adsorption units

CO4 - Explain different column/equipment used for various separation applications

CO5 - Recognize modern separation techniques applied in industries for high purity products

CO6 - Develop experiments for various equilibrium staged operations using experimental setup and simulation software such as Aspen Plus, MAT LAB Simulink and Pro Simulator.

TEXT / REFERENCE BOOKS

1. Sinaiski E.G., and Lapiga E.J., Separation of Multiphase, Multicomponent Systems, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2013
2. Treybal R.E., Mass Transfer operation, 3rd Edition, McGraw Hill, 2017
3. Sinnott R.K., Chemical Engineering Design, 3rd Edition, Vol-6, Asian Book Printers Ltd., 2018
4. Jana A.K., Chemical Process Modelling and Computer Simulation, 2nd ed., Prentice Hall of India, India, 2017.
5. Dutta B.K., Principles of Mass transfer and Separation Processes, 1st ed., Prentice Hall of India, India, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3023	PROCESS PLANT UTILITIES	L	T	P	EL	Credits	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., Nirali Prakashan 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3024	FLUIDIZATION ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To provides an overview about the fluidization phenomena and technology.
- To give a vast knowledge about flow regimes, hydrodynamics of bubbling, turbulent, fast fluidized beds and pneumatic conveying.

UNIT 1 APPLICATIONS OF FLUIDIZED BEDS 9 Hrs.

Introduction, Industrial application of fluidized beds, physical operations and reactions.

UNIT 2 MAPPING OF REGIMES AND DENSE BED 9 Hrs.

Fixed beds of particles, types of fluidizations without carryover and with carryover of particles, mapping of fluidization regimes, distributor types, Davidson model for gas flow at bubbles.

UNIT 3 HEAT AND MASS TRANSFER IN FLUIDIZED BED SYSTEMS 9 Hrs.

Mass and heat transfer between fluid and solid. Gas conversion in bubbling beds. Heat transfer between fluidized bed and surfaces.

UNIT 4 ELUTRIATION AND ENTRAINMENT 9 Hrs.

RTD and distribution of solid in a fluidized bed, Circulation systems- circuits for the circulation of solids, flow of gas- solid mixtures in downcomers, flow in pneumatic transport lines.

UNIT 5 DESIGN OF FLUIDIZED BED SYSTEMS 9 Hrs.

Three –phase fluidization, design of fluidization columns for physical operations, catalytic and non-catalytic reactions.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Survey various applications of fluidized beds in industries.
CO2 - Explain the types of fluidizations, fluidizing regimes and develop model for gas flow.
CO3 - Describe the concept of heat and mass transfer between fluid and solid and determine the design parameters.
CO4 - Analyze the solid flow distribution in circulation systems.
CO5 - Analyze the working of a three-phase fluidized bed system.
CO6 - Design fluidization columns for physical operations and reactions.

TEXT / REFERENCE BOOKS

1. Kunii Diazo and Levenspiel O., “Fluidization Engineering”, Second Edition, Butterworth Heinemann, 1991
2. Davidson, J.F and Harrison, “Fluidization”, Academic Press, London, 1990
3. D. Kunii and O. Levenspiel, Fluidization Engineering, Butterworth, 1991.
4. D. Gidaspow, Multiphase flow and fluidization: continuum and kinetic theory description, Elsevier Science & Technology Books, 1993
5. L.G. Gibilaro, Fluidization-dynamics, Butterworth-Heinemann, 2001
6. S. K. Majumder, Hydrodynamics and Transport Processes of Inverse Bubbly Flow, 1st ed. Elsevier, Amsterdam (2016)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3025	OPTIMIZATION OF CHEMICAL PROCESS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- Provide an overview of state-of-the-art optimization algorithms.
- Impart the theoretical knowledge of chemical engineering principles that underpin optimization techniques.
- Enhance the modelling skills to describe and formulate optimization problems and their use for solving several types of practically relevant optimization problems in Chemical engineering.

UNIT 1 FORMULATION OF OPTIMIZATION PROBLEMS 9 Hrs.

Nature and Organization of Optimization problem; Mathematical concepts of optimization; Developing model for optimization; Taylor expansion; Gradient and Hessian matrix; Convex functions and sets; Gaussian elimination method.

UNIT 2 LINEAR AND NONLINEAR LEAST SQUARE PROBLEMS 9 Hrs.

One-dimensional search - Methods requiring derivatives (Newton, Quasi Newton, Secant method); Region elimination methods (Interval halving, Fibonacci search, Golden section);Polynomial approximations (Lagrange's, quadratic & Cubic).

UNIT 3 MULTIVARIABLE OPTIMIZATION 9 Hrs.

Unconstrained multivariable optimization - Graphical visualization (contour plots, 3D plots);Gradient based methods – Steepest descent, conjugate direction, and Newton methods. Test for optimality – Barrier methods - Sensitivity analysis; Concept of duality; Introduction to interior-point.

UNIT 4 NONLINEAR PROGRAMMING 9 Hrs.

Nonlinear programming (NLP) with constraints; Lagrange multipliers - Graphical illustration of NLP problems - KKT necessary and sufficient conditions; Quadratic programming – Successive linear and quadratic programming; Penalty function method; Integer and mixed integer programming. (IP and MIP) - Graphical solution - Branch and bound methods.

UNIT 5 DYNAMIC PROGRAMMING 9 Hrs.

Dynamic programming - Minimum cost routing problems - Solution of separable nonlinear programming problems; Global optimization problems; Introduction to multi objective optimization problems- Pareto optimal solutions (graphical illustration).

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Demonstrate the basic principles of Chemical Engineering Systems
CO2 - Recognize the different types of optimization problems for process engineering
CO3 - Evaluate single and multivariable optimization chemical engineering problems
CO4 - Execute the complex chemical engineering processes using software tools
CO5 - Identify the different types of hypotheses for the model equations chemical system
CO6 - Solve the Optimal Control and Dynamic optimization problems

TEXT / REFERENCE BOOKS

1. Edger T.F., Himmelblau D.M., Lasdon L.S., Optimization of Chemical Processes, 2nd ed., McGraw-Hill, USA, 2015.
2. Hillier F.S., Lieberman G. J., Introduction to Operations Research, 7th ed., McGraw-Hill, USA, 2001.

3. Rao S.S., Engineering Optimization: Theory and Practice, 4th ed., John Wiley & Sons Ltd., USA, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3026	COMPUTATIONAL FLUID DYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the flow, temperature field in engineering problems and diffusion in mass transfer operations.
- Students can develop a Computational Fluid Dynamics code to solve chemical engineering problems.

UNIT 1 INTRODUCTION 9 Hrs.

Concepts of Fluid Flow, Pressure distribution in fluids, Reynold's transport theorem, Integral form of conservation equations, Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations, Properties of supersonic and subsonic flows, Flow characteristics over various bodies. Role of CFD, Problem solving in CFD, Components of CFD Software, Governing Equations of Fluid flow and Heat Transfer, Mass conservation, Momentum and Energy equation, Differential and Integral forms, Conservation and non-conservation form.

UNIT 2 GRID GENERATION 9 Hrs.

Basic theory of structured grid generation, Surface grid generation, Mono block, multi block, hierarchical multi block, Moving and sliding multiblock, Grid clustering and grid enhancement. Basic theory of unstructured grid generation, advancing front, Delaunay triangulation and various point insertion methods, Unstructured quad and hex generation, grid-based methods, various elements in unstructured grids, Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination.

UNIT 3 NUMERICAL METHODS IN CFD 9 Hrs.

Finite Difference, Finite Volume, and Finite Element, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Study and transient solutionsIntroduction to turbulence modelling -Algebraic models, One equation model, Two equation models, Near wall treatment, Reynold's stress models, Eddy viscosity models, Nonlinear eddy viscosity models, LES, RANS, hybrids, Direct numerical simulation

UNIT 4 INTRODUCTION TO MULTIPHASE MODELLING 9 Hrs.

Fundamentals of multiphase flows, Eulerian-Lagrangian approach, Eulerian-Eulerian approach, Volume of Fraction approach, Solving Numerical

UNIT 5 CHEMICAL FLUID MIXING SIMULATION 9 Hrs.

Stirred tank modelling using the actual impeller geometry, Rotating frame model, The MRF Model Sliding mesh model, Snapshot model, Evaluating Mixing from Flow Field Results, Industrial Examplespost-processing of CFD results **-** Contour plots, vector plots, and scatter plots, Shaded and transparent surfaces, Particle trajectories and path line trajectories, Animations and movies, Exploration and analysis of data.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Understand the basic concept of CFD and conservation laws in chemical engineering.
CO2 - Ability to develop model for a given fluid flow system.
CO3 - Experiment with finite volume techniques for fluid flow and heat transfer models.

CO4 - Analyze finite difference method for mass transfer problems.
CO5 - Evaluate computational fluid flow problems using finite volume techniques.
CO6 - Solve and get familiarized to develop grid generation and analysis of complex fluid-flow systems.

TEXT / REFERENCE BOOKS

1. Anderson John D., "Computational Fluid Dynamics: The Basics with Applications", Mc Graw Hill, 1995
2. Ranade V.V., "Computational Flow Modelling for Chemical Reactor Engineering", Process Engineering Science, Volume 5, 2001
3. Knupp P. and Steinberg S., "Fundamentals of Grid Generation", CRC Press, 1994
4. Wilcox D.C., "Turbulence Modelling for CFD", 1993
5. Wesseling P., "An Introduction to Multigrid Methods", John Wiley & Sons, 1992.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3027	PROCESS FLOW SHEETING, DESIGN AND SYNTHESIS	L	T	P	EL	Credits	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. Douglus, “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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3028	MATHEMATICAL MODELING FOR CHEMICAL ENGINEERS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To make the students knowledgeable in different aspects of modeling chemical process systems & familiarizes with the numerical simulation of models in fluid flow operations, separation processes and reactors.
- To acquire knowledge on the fundamental concepts of recent techniques in process simulation

UNIT 1 INTRODUCTION TO FUNDAMENTALS OF PROCESS MODELING 9 Hrs.

Introduction, Physical modeling, mathematical modeling and its classification, chemical systems modeling, Principles of formulation, Representation of a model, Model building, Boundary conditions, Black box principles, Fundamental laws used in modeling: Continuity equations, Energy equation, Equation of Motion, Transport equations, Equations of state, Equilibrium relations, Chemical kinetics.

UNIT 2 MODELS IN FLUID FLOW OPERATIONS 9 Hrs.

The process and the model aspects of mixed vessel, laminar flow in pipe, Gravity flow tank, Cone shaped tank, Mixing tank, Stirred tank heater, Two stirred tank heaters, Interacting stirred tank heaters, Interacting and Non-interacting tanks, Agitated tank for solid dissolution.

UNIT 3 MATHEMATICAL MODELING OF REACTORS 9 Hrs.

The Process and the model aspects of Batch reactor, Tubular reactor, Jacketed tubular reactor, CSTR, CSTR with cooling jacket, Two CSTRs, Series of CSTR – three CSTRs, constant and variable holdup, CSTR – isothermal and non-isothermal, Continuous stirred tank bioreactor.

UNIT 4 MODELS IN SEPARATION PROCESSES 9 Hrs.

Mathematical model aspects of Multi component flash drum, Single component vaporizer, Refinery debutanizer column, Ideal binary distillation column, Binary continuous distillation column, Gas liquid bubble reactor, Solvent extraction – steady state single stage and two stage, Absorption column, Triple effect evaporator – Forward and backward feed, Double pipe heat exchanger.

UNIT 5 PROCESS SIMULATION 9 Hrs.

Process Simulation – Scope, Formulation of a problem, Steps in Steady state simulation, Simulation approach for steady state process, Process Simulator- Organization and structure. HYSYS: Integrated simulation environment, products, intuitive and interactive process modeling, open and extensible HYSYS architecture; ASPEN PLUS: Unit operation models, selection of EOS; Artificial Neural Network – training, modes & applications.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - Apply the concepts of various mathematical models and fundamentals laws
CO2 - Develop mathematical models for various fluid flow systems
CO3 - Develop mathematical models for various types of reactors
CO4 - Build up mathematical models for distillation and separation columns
CO5 - Apply the concepts of simulations techniques to simulate chemical process systems
CO6 - Apply ANN concept in chemical engineering.

TEXT / REFERENCE BOOKS

1. Babu B.V., “Process Plant Simulation”, Oxford University Press, New Delhi, 2004.
2. Luyben W.L., “Process Modeling, Simulation and Control for Chemical Engineers”, 2nd Edition, McGraw Hill Book Company, New York, 1990.
3. Amiya K. Jana, “Chemical Process Modeling and Computer Simulation”, Prentice Hall of India, 2017.
4. Gaikwad R.W. and Dhirendra, “Process Modeling and Simulation”, 2nd Edition, Denett and Company, Nagpur, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3029	AI AND ML FOR CHEMICAL ENGINEERS	L	T	P	EL	Credits	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.Graphtheoreticalgorithms **-** 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 – Krushkal'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”, Word Scientific, Singapore 1997.
4. Chidambaram, M. “Computer Control of Processes”, Narosa Publications, New Delhi,2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3030	PIPING ENGINEERING	L	T	P	EL	Credits	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, utilitypiping 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 Exam Duration:3 Hrs.

PARTA : 10 Questions of 2marks each-No choice **20 MARKS**
PARTB : 2 Questions from each unit of internal choice, each carrying 16marks **80 MARKS**

SBAB4001	PRINCIPLES AND PRACTICES OF MANAGEMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To analyse how the field of Management has evolved and its significant contributions
- To analyse and apply the critical role of managers in modern organizational settings.
- To illustrate and evaluate the importance of planning, organizing, directing and controlling in decision making.

UNIT 1 INTRODUCTION 9 Hrs.

Definition, Functions, Process, Scope and Significance of Management. Nature of Management, Managerial Roles, Managerial Skills and Activities, Difference between Management and Administration. Significance of Values and Ethics in Management.

UNIT 2 SCHOOLS OF MANAGEMENT 9 Hrs.

Evolution of Management Thought - Contributions of F.W. Taylor, Henry Fayol, Elton Mayo, Approaches of Management Thought (including MBO & MBE) Functions of Management. Concept of Leadership- Theories and Styles.

UNIT 3 PLANNING AND ORGANIZING 9 Hrs.

Nature, Scope, Objective and Significance of Planning, Elements and Steps of Planning, Decision Making Organizing Principles, Span of Control, Line and Staff Relationship, Authority, Delegation and Decentralization. Effective Organizing, Organizational Structures, Formal and Informal Organizations, Staffing.

UNIT 4 DIRECTING 9 Hrs.

Effective Directing, Supervision, Motivation: Different Theories of Motivation - Maslow, Herzberg, Mc Clelland, Vroom, Porter and Lawler, Job Satisfaction. Communication Process, Channels and Barriers, Effective Communication.

UNIT 5 CONTROLLING AND COORDINATING 9 Hrs.

Elements of Managerial Control, Control Systems, Management Control Techniques, Effective Control Systems. Coordination Concept, Importance, Principles and Techniques of Coordination, Concept of Managerial Effectiveness.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will able to

CO1 - To provide an understanding of basic management concepts, principles, and practices.
CO2 - To develop planning and decision-making strategies in an organization.
CO3 - To summarize the concept and complete the process of organizing.
CO4 - To develop an understanding of staffing, leadership, directing and motivation in an organization.
CO5 - To predict the dynamics of controlling and its emerging issues in management.
CO6 - Assess managerial practices and choices relative to ethical principles and standards.

TEXT / REFERENCE BOOKS

1. Stephen P. Robbins, David A. Decenzo, Fundamentals of Management, Pearson Education, 9th Edition.
2. Harold Koontz, O'Donnell and Heinz Weihrich, Essentials of Management. New Delhi, 9th edition, Tata McGraw Hill.

3. Management Fundamentals: Concepts, Applications, & Skill Development, 6th edition, Sage.
4. Richard L. Daft, Principles Of Management, Cengage Learning.
5. Prasad, L.M. Principles and Practice of Management, Sultan Chand
6. Jhunjhunwala J Mohanty, Management Principles and Applications, Himalaya Publishing House.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max.Marks:100 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SBAB4002	VENTURE CREATION	L	T	P	EL	Credits	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 strategiesand 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 stakeholdersTo 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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**

SCHB3031	INDUSTRIAL ECONOMICS AND PROFESSIONAL ETHICS	L	T	P	EL	Credits	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 **Exam Duration:3 Hrs.**

PARTA :	10 Questions of 2marks each-No choice	**20 MARKS**
PARTB :	2 Questions from each unit of internal choice, each carrying 16marks	**80 MARKS**