**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**

**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

**Course Structure**

**&**

**Syllabus**

**For**

**B. Tech (Regular- Full Time Program) - R19**

**DEPARTMENT OF CHEMICAL ENGINEERING**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**
**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**
**B.Tech (Chemical Engineering) 2019-20**
**COURSE STRUCTURE**

**I YEAR I Semester**

| SEMESTER - 1 | | | | | |
|---|---|---|---|---|---|
| **S.No** | **Course No** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1 | 19A15101 | Linear Algebra And Calculus | BS | 3-1-0 | 4 |
| 2 | 19A15301 | Engineering Chemistry | BS | 3-0-0 | 3 |
| 3 | 19A10501 | Problem Solving & Programming | ES | 3-1-0 | 4 |
| 4 | 19A10302 | Engineering Workshop | LC | 0-0-2 | 1 |
| 5 | 19A10301 | Engineering Graphics | ES | 1-0-4 | 3 |
| 6 | 19A15302 | Engineering Chemistry Lab | BS | 0-0-3 | 1.5 |
| 7 | 19A10506 | Problem Solving & Programming Lab | ES | 0-0-3 | 1.5 |
| | | | | **Total** | **18** |

**I YEAR II Semester**

| SEMESTER - 2 | | | | | |
|---|---|---|---|---|---|
| **S.No** | **Course No** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| **1** | 19A10801 | Introduction to Chemical Engineering | PC | 2-0-0 | 3 |
| 2 | 19A15501 | Communicative English 1 | HS | 2-0-0 | 2 |
| 3 | 19A15102 | Differential Equations and Vector Calculus | BS | 3-1-0 | 4 |
| 4 | 19A15203 | Engineering Physics | BS | 3-0-0 | 3 |
| 5 | 19A10105 | Strength of Materials | ES | 2-0-0 | 2 |
| 6 | 19A10106 | Engineering Mechanic (Chemical Engineering) | ES | 3-0-0 | 3 |
| 7 | 19A10802 | Material Science for Chemical Engineers | ES | 2-0-0 | 2 |
| 8 | 19A10803 | Chemical Engineering Workshop | LC | 0-0-2 | 1 |
| 9 | 19A15502 | Communicative English Lab-1 | HS | 0-0-2 | 1 |
| 10 | 19A15204 | Engineering Physics Lab | BS | 0-0-3 | 1.5 |
| | | | | **Total** | **21.5** |

**II YEAR I Semester**

| Semester – 3 (Theory - 7, Lab – 3) | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No.** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | 19A20601 | Complex Variables, Transforms and Partial Differential Equations | BSC | 2-1-0 | 3 |
| 2. | 19A20701 | Organic Chemistry | BSC | 3-0-0 | 3 |
| 3. | 19A20801 | Chemical Process Calculations | PCC | 2-1-0 | 3 |
| 4. | 19A20802 | Chemical Engineering Thermodynamics –I | PCC | 2-1-0 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| 5. | 19A25501 | Fundamentals of Python Programming | ESC | 2-0-0 | 2 |
| 6. | 19A20803 | Momentum Transfer | PCC | 2-1-0 | 3 |
| 7. | 19A25502 | Fundamentals of Python Programming Lab | BSC | 0-0-3 | 1.5 |
| 8. | 19A20702 | Organic Chemistry lab | BSC | 0-0-3 | 1.5 |
| 9. | 19A20804 | Momentum Transfer lab | PCC | 0-0-3 | 1.5 |
| 10. | 19A10804 | Environmental Science | MC | 3-0-0 | 0 |
| | | | | **Total** | **21.5** |

**II YEAR II Semester**

| **Semester – 4 (Theory - 8, Lab – 2)** | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No.** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | 19A20805 | Chemical Engineering Thermodynamics –II | PCC | 2-1-0 | 3 |
| 2. | 19A20806 | Process Heat Transfer | PCC | 2-1-0 | 3 |
| 3. | 19A20807 | Mechanical Operations | PCC | 2-1-0 | 3 |
| 4. | 19A20808 | Mass Transfer operations -I | PCC | 2-1-0 | 3 |
| 5. | 19A20703 | Analytical Chemistry | BSC | 2-1-0 | 3 |
| 6. | 19A20603 | Numerical Methods, Probability and Statistics | BSC | 2-1-0 | 3 |
| 7. | 19A20901 | Universal Human Values | HE | 2-0-0 | 2 |
| 8. | 19A20809 | Process Heat Transfer lab | PCC | 0-0-3 | 1.5 |
| 9. | 19A20810 | Mechanical Operations lab | PCC | 0-0-3 | 1.5 |
| 10. | 19A28801 | Biology for Engineers | MC | 3-0-0 | 0 |
| | | | | **Total** | **23** |

**III YEAR I Semester**

| semester – 5 | | | | | |
|---|---|---|---|---|---|
| S. No. | Course No. | Course Name | Category | L-T-P | Credits |
| 1. | 19A50801 | Chemical Technology | PCC | 3-0-0 | 3 |
| 2. | 19A50802 | Mass Transfer operations –II | PCC | 2-1-0 | 3 |
| 3. | 19A50803 | Chemical Reaction Engineering –I | PCC | 2-1-0 | 3 |
| 4. | (Professional Elective-I) | | PEC-1 | 3-0-0 | 3 |
| | 19A50804 | Petroleum Refining and Petrochemicals | | | |
| | 19A50805 | Process Modelling and Simulation | | | |
| | 19A50806 | Numerical Methods in Chemical Engineering | | | |
| 5. | (Open Elective-I) | | | | |
| | 19A50807 | Membrane Technology | | | |

| | | | | | |
|---|---|---|---|---|---|
| | 19A50808 | Water Conservation and Management | OEC-1 | 3-0-0 | 3 |
| | 19A50513T | Introduction to Java Programming /Lab19A50513L | | | |
| | 19A50809 | Energy Engineering | | | |
| 6. | 19A50810 | Instrumentation and Process Control | PCC | 2-1-0 | 3 |
| 7 | 19A55401 | Research Methodology | MC | 3-0-0 | 0 |
| 8 | 19A50811 | Mass Transfer operations lab | PCC | 0-0-3 | 1.5 |
| 9 | 19A50812 | Instrumentation and Process Control lab | PCC | 0-0-3 | 1.5 |
| 10 | 19A50813 | Socially Relevant Project | PR | 0-0-1 | 0.5 |
| | | | | Total | 21.5 |

**III YEAR II Semester**

| Semester – 6 | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No.** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | 19A60801 | Chemical Reaction Engineering -II | PCC | 2-1-0 | 3 |
| 2. | 19A60802 | Chemical Process Equipment Design | PCC | 2-1-0 | 3 |
| 3. | 19A65501 | English Language Skills | HSMC | 3-0-0 | 3 |
| 4. | (Professional Elective-II) | | PEC-2 | 3-0-0 | 3 |
| | 19A60803 | Chemical Plant Design & Economics | | | |
| | 19A60804 | Polymer Science & Engineering | | | |
| | 19A60805 | Food Processing Technology | | | |
| 5. | (Open Elective-II)/MOOCs | | OEC-2 | 3-0-0 | 3 |
| | 19A60806 | Industrial safety and Hazardous management | | | |
| | 19A60807 | Green Technology | | | |
| | 19A60808 | Nuclear Engineering | | | |
| 6. | (Humanities Elective-I) | | HSMC | 3-0-0 | 3 |
| | 19A65401 | Managerial Economics and Financial Analysis | | | |
| | 19A65402 | Business Ethics and Corporate Governance | | | |
| | 19A65403 | Entrepreneurship & Incubation | | | |
| 7. | 19A65406 | Constitution of India | MC | 3-0-0 | 0 |
| 8. | 19A60809 | Chemical Reaction Engineering lab | PCC | 0-0-3 | 1.5 |
| 9. | 19A65502 | English Language Skills lab | HSMC | 0-0-3 | 1.5 |
| 10. | 19A60810 | Socially Relevant Project | PR | 0-0-1 | 0.5 |
| | | | | Total | 21.5 |

**IV YEAR I Semester**

| Semester – 7 | | | | | |
|---|---|---|---|---|---|
| S. No. | Course No | Course Name | Category | L-T-P | Credits |
| 1. | 19A70801 | Transport Phenomena | PCC | 2-1-0 | 3 |
| 2. | 19A70802 | Optimization of Chemical Processes | PCC | 2-1-0 | 3 |
| 3. | (Professional Elective-III) | | PEC-3 | 3-0-0 | 3 |
| | 19A70803 | Industrial Pollution Control Engineering | | | |
| | 19A70804 | Interfacial and Colloidal Science | | | |
| | 19A70805 | Technology of Pharmaceuticals & Fine Chemicals | | | |
| 4. | (Open Elective-III) | | OEC-3 | 3-0-0 | 3 |
| | 19A70806 | Basics of Nanotechnology | | | |
| | 19A70807 | Solid Waste Management | | | |
| | 19A70808 | Process Intensification | | | |
| 5. | (Humanities Elective-II) | | HSMC | 3-0-0 | 3 |
| | 19A75401 | Management Science | | | |
| | 19A75402 | Organizational Behaviour | | | |
| | 19A75403 | Business Environment | | | |
| 6. | 19A70809 | Process Simulation lab | PCC | 0-0-3 | 1.5 |
| 7. | 19A70810 | Process Equipment Design & Drawing lab | PCC | 0-0-3 | 1.5 |
| 8 | 19A70811 | Seminar | PR | 0-0-1 | 0.5 |
| 9. | 19A70812 | Project I | PR | 0-0-3 | 1.5 |
| 10. | 19A70813 | Industrial Training/Skill Development/Research Project | PR | ------ | 2 |
| | | | | Total | 22 |

**IV YEAR II Semester**

| Semester – 8 | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | (Professional Elective-IV) | | PEC-4 | 3-0-0 | 3 |
| | 19A80801 | Biochemical Engineering | | | |
| | 19A80802 | Computational Fluid Dynamics | | | |
| | 19A80803 | Fuel Cell Technology | | | |
| 2. | (Open Elective-IV) | | OEC-4 | 3-0-0 | 3 |
| | 19A80804 | Design and Analysis of Experiments | | | |
| | 19A80805 | Corrosion Engineering | | | |
| | 19A80806 | Renewable Energy | | | |
| 3. | 19A80807 | **Project II** | **PR** | **0-0-7** | **7** |
| | | | | **Total** | **13** |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. I-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **3** | **1** | **0** | **4** |

**Linear Algebra & Calculus**

| **Course Objectives:** | |
|---|---|
| **1** | This course will illuminate the students in the concepts of calculus and linear algebra. |
| **2** | To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications |

**Bridge Course:** Limits, continuity, Types of matrices

**Unit 1: Matrices**

Rank of a matrix by echelon form, solving system of homogeneous and non-homogeneous equations linear equations. Eigen values and Eigen vectors and their properties, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, diagonalisation of a matrix, quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical forms by orthogonal transformation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Solving systems of linear equations, using technology to facilitate row reduction determine the rank, eigen values and eigenvectors, diagonal form and different factorizations of a matrix;
- Identify special properties of a matrix, such as positive definite, etc., and use this information to facilitate the calculation of matrix characteristics.

**Unit 2: Mean Value Theorems**

Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof)

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Translate the given function as series of Taylor's and Maclaurin's with remainders
- Analyze the behaviour of functions by using mean value theorems

**Unit 3: Multivariable calculus**

Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Find partial derivatives numerically and symbolically and use them to analyze and interpret the way a function varies.
- Acquire the Knowledge maxima and minima of functions of several variable
- Utilize Jacobian of a coordinate transformation to deal with the problems in change of Variables.

**Unit 4: Multiple Integrals**

Double integrals, change of order of integration, double integration in polar coordinates, areas enclosed by plane curves. Evaluation of triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates.

**Learning Outcomes:**

- At the end of this unit, the student will be able to
- Evaluate double integrals of functions of several variables in two dimensions using Cartesian and polar coordinates
- Apply double integration techniques in evaluating areas bounded by region
- Evaluate multiple integrals in Cartesian, cylindrical and spherical geometries

**Unit 5: Special Functions**

Beta and Gamma functions and their properties, relation between beta and gamma functions, evaluation of definite integrals using beta and gamma functions.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand beta and gamma functions and its relations
- Conclude the use of special function in evaluating definite integrals

**Text Books:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Engineering Chemistry**

| COURSE OBJECTIVES | |
|---|---|
| 1 | To familiarize engineering chemistry and its applications |

| | |
|---|---|
| 2 | To impart the concept of soft and hard waters, softening methods of hard water |
| 3 | To train the students on the principles and applications of electrochemistry, polymers, surface chemistry, and cement |

**Unit1:WaterTechnology**
**(8 hrs)**

Introduction –Soft Water and hardness of water, Estimation of hardness of water by EDTA Method - Boiler troubles **-** scale and sludge, Industrial water treatment – specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, zeolite and ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

**Unit 2: Electrochemistry and Applications:** (10 hrs)

Electrodes – concepts, electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zn-$MnO_2$ (Leclanche cell), Li Battery
Secondary cells – lead acid and lithium ion batteries- working of the batteries including cell reactions.

Fuel cells- Basic Principles and Working Principles of hydrogen-oxygen, methanol fuel cells

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

**Unit 3: Polymers and Fuel Chemistry**:(12 hrs)

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth and coordination polymerization,
Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of PVC and Bakelite
Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol
Fuels – Types of fuels, calorific value, numerical problems based on calorific value; Analysis of coal, Liquid Fuels refining of petroleum, fuels for IC engines, knocking and anti-knock agents, Octane and Cetane values, cracking of oils; alternative fuels- propane, methanol and ethanol, bio fuels.

**UNIT-4 Advanced Engineering Materials** **(8 hrs)**

(i)Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications
(ii)Refractories- Classification, Properties, Factors affecting the refractory materials and Applications
(iii)Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils and Applications
(iv)Building materials- Portland Cement, constituents, phases and reactivity of clinker, Setting and Hardening of cement.

**Unit 5: Surface Chemistry and Applications:** (10 hrs)

Introduction to surface chemistry, colloids, micelle formation, synthesis of colloids (any two methods with examples), chemical and electrochemical methods (not more than two methods) of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, solid-gas interface, solid-liquid interface, adsorption isotherm, applications of colloids and nanomaterials – catalysis, medicine, sensors.

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | **List** the differences between temporary and permanent hardness of water, **explain**the principles of reverse osmosis and electrodialysis. **compare**quality ofdrinking water with BIS and WHO standards. **illustrate**problems associated with hard water - scale and sludge**. explain** the working principles of different Industrial water treatment processes |
| CO2 | **Apply** Nernst equation for calculating electrode and cell potentials, **apply** Pilling Bedworth rule for corrosion and corrosion prevention, **demonstrate** the corrosion prevention methods and factors affecting corrosion, **compare** different batteries and their applications |
| CO3 | **Explain** different types of polymers and their applications, **Solve the numerical problems based on Calorific value, select** suitable fuels for IC engines, **explain** calorific values, octane number, refining of petroleum and cracking of oils |
| CO4 | Explain the constituents of Composites and its classification Identify the factors affecting the refractory material, Illustrate the functions and properties of lubricants, demonstrate the phases and reactivity of concrete formation, identify the constituents of Portland cement, enumerate the reactions at setting and hardening of the cement |
| CO5 | **Summarize** the applications of SEM, TEM and X-ray diffraction in surface characterization, **explain** the synthesis of colloids with examples, **outline** the preparation of nanomaterials and metal oxides **identify** the application of colloids and nanomaterials in medicine, sensors and catalysis |

Text Books:


1. Engineering Chemistry by KNJayaveera, GVSubba Reddy and C. Ramachandraiah, McGraw Hill Higher Education, Foruth Edition, New Delhi
2. A Text Book of Enigneering Chemistry, Jain and Jain, Dhanapathi Rai Publications, New Delhi


References:


1.A Text book of Engineering Chemistry by SS Dhara, S. Chand Publications, New Delhi

2. Engineering Chemistry by K.B.Chandra Sekhar, UN.Das and Sujatha Mishra, SCITECH Pubblications India Pvt Limited.
3. Concepts of Engineering Chemistry- Ashima Srivastavaf and N.N. Janhavi
4. Text Book of Engineering Chemistry – C. Parameswara Murthy, C.V.Agarwal and Andra Naidu
5. Chemistry of Engineering Materials, C.V.Agarwal, C.Parameswaramurthy and Andranaidu
6. Text Book of Engineering Chemistry, Shashichawla, Dhanapathirai Publications.


**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Problem Solving & Programming**

| COURSE OBJECTIVES | |
|---|---|
| 1 | Introduce the internal parts of a computer, and peripherals. |
| 2 | Introduce the Concept of Algorithm and use it to solve computational problems |
| 3 | Identify the computational and non-computational problems |
| 4 | Teach the syntax and semantics of a C Programming language |
| 5 | Demonstrate the use of Control structures of C Programming language |
| 6 | Illustrate the methodology for solving Computational problems |

**Unit 1:**

**Computer Fundamentals: What is a Computer, Evolution of Computers, Generations of Computers, Classification of Computers, Anatomy of a Computer, Memory revisited, Introduction to Operating systems, Operational overview of a CPU.**

**Introduction to Programming, Algorithms and Flowcharts**: Programs and Programming, Programming languages, Compiler, Interpreter, Loader, Linker, Program execution, Fourth generation languages, Fifth generation languages, Classification of Programming languages, Structured programming concept, Algorithms, Pseudo-code, Flowcharts, Strategy for designing algorithms, Tracing an algorithm to depict logic, Specification for converting algorithms into programs.

**Introduction to computer problem solving:** Introduction, the problem-solving aspect, top-down design, implementation of algorithms, the efficiency of algorithms, the analysis of algorithms.

Unit Outcomes:

Student should be able to

1. Identify the different peripherals, ports and connecting cables in a PC (L2)
2. Illustrate the working of a Computer (L3)
3. Select the components of a Computer in the market and assemble a computer (L4)
4. Solve complex problems using language independent notations (L3)

**Unit 2:**

**Types, Operators, and Expressions:** Variable names, data types and sizes, constants, declarations, arithmetic operators, relational and logical operators, type conversions, increment and decrement operators, bitwise operators, assignment operators and expressions, conditional expressions precedence and order of evaluation.

**Input and output:** standard input and output, formatted output-Printf, formatted input-Scanf.

**Control Flow:** Statements and blocks, if-else, else-if, switch, Loops-while and for, Loops-Do-while, break and continue, Goto and labels.

**Learning Outcomes**: Student should be able to

1. Solve Computational problems (L3)
2. Apply Algorithmic approach to solving problems (L3)
3. Analyze the algorithms (L4)

**Unit 3:**

**Fundamental algorithms:** Exchanging the values of two variables, counting, summation of a set of numbers, factorial computation, sine function computation, generation of the Fibonacci sequence, reversing the digits of an integer.

**Functions and Program Structure:** Basics of functions, functions returning non-integers, external variables, scope variables, header variables, register variables, block structure, initialization, recursion, the C processor.

**Learning Outcomes**: Student should be able to

1. Recognize the programming elements of C Programming language (L1)
2. Select the control structure for solving the problem (L4)
3. Apply modular approach for solving the problem (L3)

**Unit 4:**

**Factoring methods:** Finding the square root of a number, the smallest divisor of a number, the greatest common divisor of two integers, generating prime numbers.

**Pointers and arrays:** Pointers and addresses, pointers and function arguments, pointers and arrays, address arithmetic, character pointers and functions, pointer array; pointers to pointers, Multi-dimensional arrays, initialization of arrays, pointer vs. multi-dimensional arrays, command line arguments, pointers to functions, complicated declarations.

**Array Techniques:** Array order reversal, finding the maximum number in a set, removal of duplicates from an order array, finding the $k^{th}$ smallest element

**Learning Outcomes**: Student should be able to

1. Solve mathematical problems using C Programming language (L3)
2. Structure the individual data elements to simplify the solutions (L6)
3. Facilitate efficient memory utilization (L6)

**Unit 5:**

**Sorting and Searching:** Sorting by selection, sorting by exchange, sorting by insertion, sorting by partitioning, binary search.

**Structures:** Basics of structures, structures and functions, arrays of structures, pointers to structures, self-referential structures, table lookup, typedef, unions, bit-fields.

**Some other Features**: Variable-length argument lists, formatted input-Scanf, file access, Error handling-stderr and exit, Line Input and Output, Miscellaneous Functions.

**Learning Outcomes**: Student should be able to

1. Select sorting algorithm based on the type of the data (L4)
2. Organize heterogeneous data (L6)
3. Design a sorting algorithm (L6)

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Construct his own computer using parts (L6). |
| CO2 | Recognize the importance of programming language independent constructs (L2) |

| | |
|---|---|
| CO3 | Solve computational problems (L3) |
| CO4 | Select the features of C language appropriate for solving a problem (L4) |
| CO5 | Design computer programs for real world problems (L6) |
| CO6 | Organize the data which is more appropriated for solving a problem (L6) |

**Text Books**:


1. Pradip Dey, and Manas Ghosh, "Programming in C", 2018, Oxford University Press.
2. R.G. Dromey, "How to Solve it by Computer". 2014, Pearson.
3. Brian W. Kernighan, and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Pearson.


**Reference Books:**


1. P.Chenna Reddy, " Computer Fundamentals and C Programming" 2018, BS Publications
2. RS Bichkar " Programming with C", 2012, Universities Press.
3. Pelin Aksoy, and Laura Denardis, "Information Technology in Theory", 2017, Cengage Learning.


**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

# Engineering Workshop

**(COMMON TO CIVIL, CHEMICAL, CHEMICAL)**

| **Course Objective**: | |
|---|---|
| 1 | To familiarize students with wood working, sheet metal operations, fitting and electrical house wiring skills. |

**Wood Working:**

Familiarity with different types of woods and tools used in wood working and make following joints

a) Half – Lap joint *
b) Mortise and Tenon joint *
c) Corner Dovetail joint or Bridle joint

**Sheet Metal Working:**

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets

a) Tapered tray *
b) Conical funnel *
c) Elbow pipe *
d) Brazing

**Fitting:**

Familiarity with different types of tools used in fitting and do the following fitting exercises

a) V-fit *
b) Dovetail fit *
c) Semi-circular fit
d) Wheel Balancing, tubeless tyre puncture and change of two wheeler tyre.

**Electrical Wiring:**

Familiarities with different types of basic electrical circuits and make the following connections

a) Parallel and series *
b) Two way switch *
c) Godown lighting
d) Tube light *
e) Three phase motor
f) Soldering of wires

Note:* Students exercise. Remaining all for demonstration.

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Apply wood working skills in real world applications. (L3) |
| CO2 | Build different objects with metal sheets in real world applications. (L3) |
| CO3 | Apply fitting operations in various applications. (L3) |
| CO4 | Apply different types of basic electric circuit connections. (L3) |
| CO5 | Understanding the soldering, brazing and principle of automobile wheel balancing, alignment and operation of power tools. (L2) |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 4 | 3 |

# ENGINEERING GRAPHICS
## (COMMON TO CIVIL, CHEMICAL, CHEMICAL)

| Course Objectives | |
|---|---|
| 1 | Bring awareness that Engineering Drawing is the Language of Engineers. |
| 2 | To know how to represent letters and numbers in drawing sheets.. |
| 3 | To know about the different types of the projections, projection of points, straight lines, planes and regular solids |
| 4 | To know sectional views and development of different types of surfaces. |
| 5 | To know about the projection of orthographic views, isometric views and isometric projections. |

**UNIT-I**

Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance

Curves used in practice:

a) Conic sections – Ellipse, Parabola, Hyperbola & Rectangular Hyperbola (general method)
b) Cycloid, Epicycloid and Hypocycloid – Normal and Tangent
c) Involutes – Normal and Tangent

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the Printing of Letters and dimensioning.(L1)
2. Draw the geometric constructions; drawing parallel and perpendicular lines, and to construct circles, arcs, tangencies, and irregular curves (L6)
3. Construct the Conic sections and cycloidal curves.(L6)

**UNIT –II**

Principles of orthographic projections – First and Third angle projections Projection of points., Projections of lines inclined to one plane and inclined to both planes – True length, true angles of projected lines – Projection of regular planes inclined to one plane and both planes by rotational method.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the Orthographic Projection in four quadrants (L2)
2. Project the points, lines and planes (L6)

**UNIT –III**

Projection of solids inclined to one plane and inclined to both planes by rotational/auxiliary method – Prism, Cylinder, Pyramid, Cone.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Project the solids inclined to one or both planes. (L6)
2. draw the solids by auxiliary method. (L6)

**UNIT –IV**

Sections of solids: Sections and Sectional views of regular solids – Prism, Cylinder, Pyramid, Cone – True shapes

Development of solids- Prism, Cylinder, Pyramid, Cone
Interpenetration of Solids – Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs cone, square prism Vs square prism.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Project the sectional view of regular solids.(L6)
2. Draw the true shapes of the sections.(L2)
3. Draw the development of surfaces of the solids.(L6)
4. Develop the sectional parts of the solids.(L2)

**UNIT –V**

Orthographic projections: Conversion of Pictorial views to orthographic views – Conventions.
Isometric projection: Isometric views of lines, plane figures, simple and truncated solids – orthographic views into isometric views.

**Learning Outcomes:**

At the end of this unit the student will be able to

1.Draw the orthographic views with dimensions.
2.Draw the Isometric views and isometric projections.

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Draw various curves applied in engineering. (L2) |
| CO2 | Plot the projection of points, Lines and planes.(L2) |
| CO3 | Draw the projections of solids inclined to one or both planes. (L2) |
| CO4 | Draw the sectional views and development of surfaces.(L2) |
| CO5 | Draw the orthographic views, Isometric views and isometric projections. (L3) |

**TEXT BOOKS:**

1. Engineering Drawing, N.D. Bhatt, Charotar Publishers
2. Engineering Drawing, K.L. Narayana & P. Kannaih, Scitech Publishers, Chennai.

**REFERENCES:**

1. Engineering Drawing, Johle, Tata McGraw-Hill Publishers.
2. Engineering Drawing, Shah and Rana,2/e, Pearson Education
3. Engineering Drawing and Graphics, Venugopal/New age Publishers
4. Engineering Graphics, John & John.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

## Engineering Chemistry Lab

| COURSE OBJECTIVES | |
|---|---|
| 1 | Verify the fundamental concepts with experiments |

### LIST OF EXPERIMENTS

1. Determination of Hardness of a groundwater sample.
2. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. Determination of Strength of an acid in Pb-Acid battery
6. Preparation of a polymer
7. Determination of percentage of Iron in Cement sample by colorimetry
8. Estimation of Calcium in port land Cement
9. Adsorption of acetic acid by charcoal
10. Determination of percentage Moisture content in a coal sample
11. Determination of Viscosity of lubricating oil by Red Viscometer 1
12. Determination of Flash and Fire points of fuels
13. Determination of Calorific value of gases by Junker's gas Calorimeter

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | **Determine** the cell constant and conductance of solutions (L3) |
| CO2 | **Prepare** advanced polymer materials (L2) |
| CO3 | **Determine** the physical properties like surface tension, adsorption and viscosity (L3) |
| CO4 | **Estimate** the Iron and Calcium in cement (L3) |
| CO5 | **Calculate** the hardness of water (L4) |

**TEXT BOOKS:**


1. Vogel's Text book of Quantitative Chemical Analysis, Sixth Edition – J. Mendham et al, Pearson Education.
2. Chemistry Practical – Lab Manual by Chandra Sekhar, GV Subba Reddy and Jayaveera


**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**

**DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. I-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **0** | **0** | **3** | **1.5** |

**Problem Solving & Programming Lab**

**Laboratory Experiments#**

1. Basic DOS Commands/Unix Commands
2. Familiarize with windows/Linux Environment.
3. Familiarize with development environment of C Language
4. Design a C program which reverses the number
5. Design a C program which finds the second maximum number among the given list of numbers.
6. Construct a program which finds the kth smallest number among the given list of numbers.
7. Design an algorithm and implement using C language the following exchanges

   a ← b ← c ← d

5. Develop a C Program which counts the number of positive and negative numbers separately and also compute the sum of them.
7. Implement the C program which computes the sum of the first n terms of the series Sum = 1 – 3 + 5 -7 + 9
8. Design a C program which determines the numbers whose factorial values are between 5000 and 32565.
9. Design an algorithm and implement using a C program which finds the sum of the infinite series $1 - x^2/2! + x^4/4! - x^6/6! + ....$
10. Design a C program to print the sequence of numbers in which each number is the sum of the three most recent predecessors. Assume first three numbers as 0, 1, and 1.
11. Implement a C program which converts a hexadecimal, octal and binary number to decimal number and vice versa.
12. Develop an algorithm which computes the all the factors between 1 to 100 for a given number and implement it using C.
13. Construct an algorithm which computes the sum of the factorials of numbers between m and n.
14. Design a C program which reverses the elements of the array.
15. Given a list of n numbers, Design an algorithm which prints the number of stars equivalent to the value of the number. The starts for each number should be printed horizontally.
16. Implement the sorting algorithms a. Insertion sort b. Exchange sort c. Selection sort d. Partitioning sort.
17. Illustrate the use of auto, static, register and external variables.
18. Design algorithm and implement the operations creation, insertion, deletion, traversing on a singly linked list.
19. Develop a C program which takes two numbers as command line arguments and finds all the common factors of those two numbers.
20. Design a C program which sorts the strings using array of pointers.

# The above list is not exhaustive. Instructors may add some experiments to the above list. Moreover, 50% of the experiments are to be changed every academic year. Instructors can choose the experiments, provided those experiments are not repetitions.

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Construct a Computer given its parts (L6) |
| CO2 | Select the right control structure for solving the problem (L6) |
| CO3 | Analyze different sorting algorithms (L4) |
| CO4 | Design solutions for computational problems (L6) |
| CO5 | Develop C programs which utilize the memory efficiently using programming constructs like pointers. |

**References**:

1. B. Govindarajulu, "IBM PC and Clones Hardware Trouble shooting and Maintenance", Tata McGraw-Hill, 2nd edition, 2002.

2. R.G. Dromey, "How to Solve it by Computer". 2014, Pearson.
3. P.Chenna Reddy, "Computer Fundamentals and C Programming" 2018, BS Publications.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem** **L T P C**
**2 0 0 3**

## Introduction to Chemical Engineering

**Pre-requisites:** None
**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the role of Chemical Engineers in everyday life and the importance of Chemical Engineering subject. |
| CO2 | Learn about material & energy balance calculations. |
| CO3 | Understand the concept of fluid flow. |
| CO4 | Understand the principles of heat transfer, mass transfer and mechanical operations |
| CO5 | Learn the importance of safety in process industries |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | 2 | 3 | 3 | - | - | - | 3 |
| CO2 | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| CO3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| CO4 | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| CO5 | 3 | - | - | - | - | 2 | 3 | 3 | - | - | - | 3 |

**Objectives:**

1. To impart the role of Chemical Engineers in everyday life and the importance of Chemical Engineering.
2. To learn the role of various Unit Operations and Unit Processes in Chemical industries.
3. To learn the role of Chemical Engineers in environmental and safety aspects in process industries

**Detailed Syllabus:**

**Unit-I**

Introduction, Chemical Engineering in everyday life, Scaling up or down, Engineering applications of portable devices, challenges in petroleum sector, versatility of a Chemical Engineer, role of Chemical Engineers in Biomedical Engineering, similarities in dissimilar applications.

Batch Processing, paint manufacture, transition from batch to continuous processing, Case study: Manufacture of Sulphuric acid, role of basic sciences in Chemical Engineering (Introduction) (Text Book 1)

**Unit-II**

Introduction, Unit operations, basic laws, units and dimensions, partial pressure, vapor pressure.

Solutions, concentration measurements, humidity and saturation. Material and Energy balances.

Flow of fluids: Introduction, nature of fluid, viscosity, velocity profile, flow field, types of fluid motion, laminar and turbulent flow, flow of a fluid past a solid surface, Reciprocating, rotary, and centrifugal pumps(Text Book 2)

**Unit-III**

Heat transfer: Conduction, convection (omit correlations for calculation of heat transfer coefficients, heat transfer with change in phase) and radiation. Flow arrangement in heat exchangers, variation of fluid temperatures in heat exchangers, heat transfer equipment (double pipe & Shell and tube heat exchanger),evaporation, long tube vertical type and forced circulation type evaporators, multiple effect evaporation, methods of feeding(Text Book 2)

**Unit-IV**

Mass transfer: Introduction - Diffusion, mass transfer operation, equipment for gas-liquid operations, contact patterns, classification of separation processes and applications, basic definitions of separation processes, VLE, LLE, boiling point diagram.(Text Book 2)

**Unit-V:**

Introduction to mechanical operations: Size reduction, filtration, basic differences between agitation and mixing.

Types of reactions and reactors.

Introduction to environmental pollution: types and their effect.

Safety in chemical process industries (case study on DDT, environmental hazards of a green project)(Text Book 1&2)

**TEXT BOOK:**

1. Introduction to chemical engineering by S. Pushpavanam, PHI, 2012.
2. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill5th ed. 1993.

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

## Communicative English 1

**Introduction**

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

| COURSE OBJECTIVES | |
|---|---|
| The students will be able to | |
| 1 | Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers |
| 2 | Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials |
| 3 | Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations |
| 4 | Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information |
| 5 | Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing |

**Unit 1**

**Lesson: On the Conduct of Life: William Hazlitt**

**Listening:** Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions. **Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others. **Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information. **Reading for Writing :**Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph. **Grammar and Vocabulary:** Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.

**Learning Outcomes**

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information

- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

**Unit 2**

**Lesson: The Brook: Alfred Tennyson**

**Listening:** Answering a series of questions about main idea and supporting ideas after listening to audio texts. **Speaking:** Discussion in pairs/small groups on specific topics followed by short structured talks. **Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together. **Writing:** Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters. **Grammar and Vocabulary:** Cohesive devices - linkers, sign posts and transition signals; use of articles and zero article; prepositions.

**Learning Outcomes**

At the end of the module, the learners will be able to

- comprehend short talks on general topics
- participate in informal discussions and speak clearly on a specific topic using suitable discourse markers
- understand the use of cohesive devices for better reading comprehension
- write well structured paragraphs on specific topics
- identify basic errors of grammar/ usage and make necessary corrections in short texts

**Unit 3**

**Lesson: The Death Trap: Saki**

**Listening:** Listening for global comprehension and summarizing what is listened to. **Speaking:** Discussing specific topics in pairs or small groups and reporting what is discussed **Reading:** Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension. **Writing:** Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. **Grammar and Vocabulary:** Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

**Learning Outcomes**

At the end of the module, the learners will be able to

- comprehend short talks and summarize the content with clarity and precision
- participate in informal discussions and report what is discussed
- infer meanings of unfamiliar words using contextual clues
- write summaries based on global comprehension of reading/listening texts
- use correct tense forms, appropriate structures and a range of reporting verbs in speech and writing

**Unit4**

**Lesson: Innovation: Muhammad Yunus**

**Listening:** Making predictions while listening to conversations/ transactional dialogues without video; listening with video. **Speaking:** Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. **Reading:** Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data. **Writing:** Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. **Grammar and Vocabulary:** Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

**Learning Outcomes**

At the end of the module, the learners will be able to

- infer and predict about content of spoken discourse
- understand verbal and non-verbal features of communication and hold formal/informal conversations
- interpret graphic elements used in academic texts
- produce a coherent paragraph interpreting a figure/graph/chart/table
- use language appropriate for description and interpretation of graphical elements

**Unit 5**

**Lesson: Politics and the English Language: George Orwell**

**Listening:** Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension. **Speaking:** Formal oral presentations on topics from academic contexts - without the use of PPT slides. **Reading:** Reading for comprehension. **Writing:** Writing structured essays on specific topics using suitable claims and evidences. **Grammar and Vocabulary:** Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

**Learning Outcomes**

At the end of the module, the learners will be able to

- take notes while listening to a talk/lecture and make use of them to answer questions
- make formal oral presentations using effective strategies
- comprehend, discuss and respond to academic texts orally and in writing
- produce a well-organized essay with adequate support and detail
- edit short texts by correcting common errors

**Prescribed Text:**

**Language and Life: A Skills Approach- I Edition 2019, Orient Black Swan**

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Understand the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English |
| CO2 | Apply grammatical structures to formulate sentences and correct word forms |
| CO3 | Analyze discourse markers to speak clearly on a specific topic in informal discussions |
| CO4 | Evaluate reading/listening texts and to write summaries based on global comprehension of these texts. |
| CO5 | Create a coherent paragraph interpreting a figure/graph/chart/table |

**Reference Books**


- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
- Oxford Learners Dictionary, 12th Edition, 2011


**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

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**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**Differential Equations and Vector Calculus**

| COURSE OBJECTIVES | |
|---|---|
| 1 | To enlighten the learners in the concept of differential equations and multivariable calculus |
| 2 | To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications |

**UNIT 1: Linear differential equations of higher order**
Definitions, complete solution, operator D, rules for finding complimentary function, inverse operator, rules for finding particular integral, method of variation of parameters.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- Identify the essential characteristics of linear differential equations with constant Coefficients
- Solve the linear differential equations with constant coefficients by appropriate method

**UNIT 2: Equations reducible to Linear Differential Equations**
Cauchy's and Legendre's linear equations, simultaneous linear equations with constant coefficients, Applications to L-C-R Circuit problems and Mass spring system.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- Classify and interpret the solutions of linear differential equations
- Formulate and solve the higher order differential equation by analyzing physical situations

**UNIT 3: Partial Differential Equations** First order partial differential equations, solutions of first order linear and non-linear PDEs.
Solutions to homogenous and non-homogenous higher order linear partial differential equations.
**Learning Outcomes:**
At the end of this unit, the student will be able to

- apply a range of techniques to find solutions of standard PDEs
- outline the basic properties of standard PDEs

**UNIT4: Vector differentiation**
Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- apply del to Scalar and vector point functions
- illustrate the physical interpretation of Gradient, Divergence and Curl

**UNIT 5: Vector integration**
Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- find the work done in moving a particle along the path over a force field
- evaluate the rates of fluid flow along and across curves
- apply Green's, Stokes and Divergence theorem in evaluation of double and triple integrals.

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| .CO1 | Solve the differential equations related to various engineering fields |
| CO2 | Identify solution methods for partial differential equations that model physical processes |
| CO3 | Interpret the physical meaning of different operators such as gradient, curl and divergence |
| CO4 | Estimate the work done against a field, circulation and flux using vector calculus |

**Text Books:**
1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

**Reference Books:**
1. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2011.
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B.Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 13/e, Pearson Publishers, 2013.
4. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
5. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson publishers, 2011.
6. Micheael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
7. Dean G. Duffy, Advanced engineering mathematics with MATLAB, CRC Press
8. Peter O'neil, Advanced Engineering Mathematics, Cengage Learning.
9. R.L. Garg Nishu Gupta, Engineering Mathematics Volumes-I &II, Pearson Education
10. B. V. Ramana, Higher Engineering Mathematics, Mc Graw Hill Education.
11. H. k Das, Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand.
12. N. Bali, M. Goyal, C. Watkins, Advanced Engineering Mathematics, Infinity Science Press.

## Mapping between Course Outcomes and Programme Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

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| **I- Year B.Tech. II-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **3** | **0** | **0** | **3** |

**Engineering Physics**

| | **COURSE OBJECTIVES** |
|---|---|
| 1 | To make a bridge between the physics in school and engineering courses. |
| 2 | To understand the concepts of mechanics and employ the applications of oscillations to engineering fields. |
| 3 | To familiarize the basic ideas of acoustics and ultrasonic's with their Engineering applications. |
| 4 | The mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications. |
| 5 | To evoke interest on applications of superposition effects like interference, diffraction and polarization in engineering. |
| 6. | To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications. Considering the significance of micro miniaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano materials, their properties and applications in modern emerging technologies are elicited. |

**Unit-1: Introduction to Mechanics and Oscillations**

**Introduction to Mechanics and Oscillations**-Basic laws of vectors and scalars-Rotational frames-Conservative forces – F = - grad V, torque and angular momentum – Simple harmonic oscillators-Damped harmonic oscillator-Heavy, critical and under damping- Energy decay in damped harmonic oscillator- Forced oscillations – Resonance.

**Unit-II: Acoustics and Ultrasonics**

**Acoustics**: Introduction to acoustics – Reverberation – Reverberation time– Sabine's formula- Derivation using growth and decay method – Absorption coefficient and its determination –Factors affecting acoustics of buildings and their remedies.

**Ultrasonics:** Introduction, Properties and Production by magnetostriction & piezoelectric methods - acoustic grating -Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications

**Unit-III: Lasers and Fiber optics**

**Lasers:** Introduction – Characteristics of laser – Spontaneous and stimulated emission of radiation – Einstein's coefficients – Population inversion – Pumping mechanisms – Nd:YAG laser – He-Ne laser – Applications of lasers.

**Fiber optics-** Introduction to Optical Fibers-Total Internal Reflection-Critical angle of propagation-Acceptance Angle-Numerical Aperture-Classification of fibers based on refractive index profile –Propagation of electromagnetic wave through optical fibers – Modes -Importance of V-number-Fiber optic sensors (Pressure/temperature/chemical change)

**Unit-IV: Wave Optics**

**Interference**-Principle of superposition –Interference of light – Conditions for sustained interference-interference in thin films-Colors in thin films-Newton's Rings-Determination of wavelength and refractive index.

**Diffraction**-Introduction-Fresnel and Fraunhofer diffraction-Fraunhofer diffraction due to single slit and double slit – Diffraction grating- Grating spectra.

**Polarization**-Polarization by double refraction-Nicol's Prism--Half wave and Quarter wave plates- Engineering applications of Polarization.

**UNIT V: Engineering Materials**

**Dielectric Materials:** Introduction-Dielectric polarization- Dielectric constant- Types of polarizations: Electronic and Ionic, Orientation Polarizations (Qualitative) - Lorentz (Internal) field- Clausius- Mossotti equation-Applications of Dielectrics: Ferroelectricity and Piezoelectricity.

**Magnetic Materials:** Introduction-Magnetic dipole moment-Magnetization-Magnetic susceptibility and permeability-Origin of permanent magnetic moment -Classification of Magnetic materials- Hysteresis - Soft and hard magnetic materials-Applications.

**Nanomaterials**: Introduction – Surface area and quantum confinement –Physical properties: electrical and magnetic properties- Synthesis of nanomaterials: Top-down: Ball Milling, Bottom-up: Chemical Vapour Deposition – Applications of nanomaterials.

| **COURSE OUTCOMES** | |
|---|---|
| After studying this course, the student will be able to: | |
| CO1 | Understand the basics of mechanics and types of oscillations. |
| CO2 | Explain sound propagation in buildings, acoustic properties of typically used materials in buildings and the use of ultrasonics. |
| CO3 | Apply the different realms of physics in both scientific and technological systems through the study of lasers and fiber optics. |
| CO4 | Analyze different physical phenomena of optics like interference, diffraction and polarization. |

| | |
|---|---|
| CO5 | Compare the properties of dielectric, magnetic and nano materials along with their engineering applications. |

**Prescribed Text books:**

1. Engineering Physics – Dr. M.N. Avadhanulu & Dr. P.G. Kshirsagar, S. Chand and Company

2. Engineering physics – D.K. Battacharya and Poonam Tandon, Oxford University press.

**Reference Books:**


1. Introduction to modern optics – Grant R Fowles
2. A text book on Optics – Brijlal & Subramanyam
3. Laser Fundamentals – William T. Silfvast, Cambridge University Press
4. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons
5. Introduction to Nanotechnology – C P Poole and F J Owens, Wiley
6. Hand Book of Non-destructive evaluation, C.J.Hellier, McGraw-Hill
7. Engineering Physics – K.Thyagarajan, MacGraw Hill Publishers
8. Engineering Physics – M.R.Srinivasan, New Age Publications
9. Engineering Physics – D K Pandey, S. Chaturvedi, Cengage Learning
10. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, University Press
11. Engineering Physics – M. Arumugam, Anuradha Publications


Method of Evaluation:
**Please mention if it is apart from the regular practice**

Data Books Required: Nil

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. II-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **2** | **0** | **0** | **2** |

**Strength of Materials**

Unit I

Concept of mechanics of deformable bodies- behavior of mild steel under tension-stress and strain - elastic constants and their relationships, equivalent modulus-factor of safety-principal planes and principal stresses (two dimensional), Mohr's circle representation.

Unit II

Bending moment and shear force diagrams for contilever, simply supported and over hanging beams- bending of beams: theory of simple bending-meutral axis stress distribution across section due to bending moment and shear force-thin cylindrical shells

Unit III

Deflection of beams: equation of deflection curve-slope and deflection by double integration method-moment area method-Macaulay method

Unit IV

Torsion: torsion of solid and hollow circular shafts-combined bending and torsion-springs: leaf springs-closed and open coiled helical springs

Unit V

Columns: theory of columns-combined bending and direct stresses-concept of structural stability-long columns: Euler's theory of buckling, load-Rankine-Gardon formula-Johnson's formula

**Text Books:**

B.K Bansal, strength of Materials, Lakshmi Publications House Pvt.Ltd

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**DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. II-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **3** | **0** | **0** | **3** |

**Engineering Mechanics**

***OBJECTIVE:*** *This course will serve as a basic course by introducing the concepts of basic mechanics which will help as a foundation to various courses.*

**UNIT – I**

**INTRODUCTION OF ENGINEERING MECHANICS –** Basic concepts - System of Forces – Moment of Forces and its Application – Couples and Resultant of Force System – Equilibrium of System of Forces - Degrees of Freedom – Free body diagrams –Types of Supports – Support reactions for beams with different types of loading – concentrated, uniformly distributed and uniformly varying loading.

**UNIT – II**

**FRICTION :** Types of friction– laws of Friction – Limiting friction- Cone of limiting friction– static and Dynamic Frictions – Motion of bodies – Wedge, Screw jack and differential Screw jack.

**UNIT – III**

**CENTROID AND CENTER OF GRAVITY:** Centroids of simple figures – Centroids of Composite figures – Centre of Gravity of bodies – Area moment of Inertia - Parallel axis and perpendicular axis theorems - Moments of Inertia of Composite Figures.

**MASS MOMENT OF INERTIA:** Moment of Inertia of Simple solids – Moment of Inertia of composite masses.( Simple problems only)

**UNIT – IV**

**KINEMATICS:** Rectilinear and Curvilinear motion – Velocity and Acceleration – Motion of A Rigid Body – Types and their Analysis in Planar Motion.

**KINETICS :** Analysis as a particle and Analysis as a Rigid Body in Translation – Central Forces of motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies – Work Energy Method – Equation for Translation – Work Energy application to Particle Motion, Connection System – Fixed axis Rotation and Plane Motion.

**UNIT – V**

**ANALYSIS OF PERFECT FRAMES:** Types of frames – cantilever frames and simply supported frames – Analysis of frames using method of joints, method of sections and tension coefficient method for vertical loads, horizontal loads and inclined loads.

**MECHANICAL VIBRATIONS:** Definitions, Concepts-Simple Harmonic motion-Free vibrations-Simple Compound and Torsional pendulum- Numerical problems

**TEXT BOOKS**:


(1) Engineering Mechanics by Dr.R.K.Bansal, Lakshmi Publications.
(2) Engineering Mechanics by Shames & Rao – Pearson Education.
(3) Engineering Mechanics by Bhavakatti, New age pubilishers


**REFERENCES:**


(1) Engineering Mechanics by Seshigiri Rao, Universities Press, Hyderabad.
(2) Engineering Mechanics – B. Bhattacharyya, Oxford University Publications.


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**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Material Science for Chemical Engineers**

**Pre-requisites:** None

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

| | |
|---|---|
| CO1 | Identify various crystal systems. |
| CO2 | Calculate parameters for simple crystal structures predict the behavior of crystal systems due to imperfections. |
| CO3 | Predict the properties of simple alloys and steels based on their phase diagrams, phase transitions and heat treatment. |

| | |
|---|---|
| CO4 | Describe the mechanical behavior, failure and strengthening mechanisms of various metals, alloys and plastics. |
| CO5 | Identify various types of corrosion, illustrate methods to mitigate corrosion and select suitable material for various chemical processes. |
| CO6 | Proper selection of materials for designing various equipments in a chemical industry |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | 2 | - | - | - | 3 | - | - | 3 |
| CO2 | 3 | - | 3 | - | 2 | - | - | - | 3 | - | - | 3 |
| CO3 | 3 | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | 3 |
| CO4 | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Objective:** This course will help students to learn about the relationship between structure and properties of materials, application of various classes of materials including metals, ceramics, polymers.

**Detailed Syllabus:**

**UNIT- I**

**Introduction**: Engineering Materials – Classification – levels of structure.

**Crystal Geometry and Structure Determination**: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

**UNIT -II**

**Crystal Imperfection**: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

**UNIT -III**

**Basic thermodynamic functions**: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-$Fe_3$-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-$Fe_3$-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

**UNIT -IV**

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

**Magnetic materials**: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

**UNIT- V**

**Fracture in ductile and brittle materials, creep**: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

**Oxidation and Corrosion**: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

**TEXT BOOK:**

1. Materials Science and Engineering, 5th ed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

**REFERENCES:**

1. Elements of Materials Science, L.R. Van Vlack,
2. Science of Engineering Materials, vols. 1&2, Manas Chanda, McMillan Company of India Ltd.

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. II-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **0** | **0** | **2** | **1** |

**CHEMICAL ENGINEERING WORKSHOP**

Objective: To get primary understanding on chemical process equipment and instrumentation for the measurement of various process parameters

1. Flow meters: rota meter, venturi meter, orifice meter
2. Thermocouple
3. pH, conductivity and dissolved oxygen
4. gas Chromatography
5. spectrophotometer (UV-VIS)
6. X-Ray Diffractometer
7. Heat exchanger
8. Dryer
9. Distillation
10. PID Controller (Level/Flow control)

**TEXT BOOK:**

1. Introduction to chemical engineering by S. Pushpavanam, PHI, 2012.
2. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill5th ed. 1993.

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**COMMUNICATIVE ENGLISH LABORATORY-1**

| COURSE OBJECTIVES | |
|---|---|
| 1 | Students will be exposed to a variety of self-instructional, learner friendly modes of language learning |
| 2 | Students will cultivate the habit of reading passages from the computer monitor. Thus providing them with the required facility to face computer based competitive exams like GRE, TOEFL, and GMAT etc. |
| 3 | Students will learn better pronunciation through stress, intonation and rhythm |
| 4 | Students will be trained to use language effectively to face interviews, group discussions, public speaking |
| 5 | Students will be initiated into greater use of the computer in resume preparation, report writing, format making etc |

**Unit 1**

1. Phonetics for listening comprehension of various accents
2. Reading comprehension
3. Describing objects/places/persons

**Learning Outcomes**

At the end of the module, the learners will be able to

- understand different accents spoken by native speakers of English
- employ suitable strategies for skimming and scanning on monitor to get the general idea of a text and locate specific information
- learn different professional registers and specific vocabulary to describe different persons, places and objects

**Unit 2**

1. JAM
2. Small talks on general topics
3. Debates

**Learning Outcomes**

At the end of the module, the learners will be able to

- produce a structured talk extemporarily
- comprehend and produce short talks on general topics
- participate in debates and speak clearly on a specific topic using suitable discourse markers

**Unit 3**

1. Situational dialogues – Greeting and Introduction
2. Summarizing and Note making
3. Vocabulary Building

**Learning Outcomes**

At the end of the module, the learners will be able to

- Learn different ways of greeting and introducing oneself/others
- summarize the content with clarity and precision and take notes while listening to a talk/lecture and make use of them to answer questions
- replenish vocabulary with one word substitutes, homonyms, homophones, homographs to reduce errors in speech and writing

**Unit4**

1. Asking for Information and Giving Directions
2. Information Transfer
3. Non-verbal Communication – Dumb Charade

**Learning Outcomes**

At the end of the module, the learners will be able to

- Learn different ways of asking information and giving directions
- Able to transfer information effectively
- understand non-verbal features of communication

**Unit 5**

1. Oral Presentations
2. Précis Writing and Paraphrasing
3. Reading Comprehension and spotting errors

**Learning Outcomes**

At the end of the module, the learners will be able to

- make formal oral presentations using effective strategies
- learn different techniques of précis writing and paraphrasing strategies

- comprehend while reading different texts and edit short texts by correcting common errors

**Suggested Software**

- Young India Films
- Walden Infotech
- Orell

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Remember and understand the different aspects of the English language proficiency with emphasis on LSRW skills |
| CO2 | Apply communication skills through various language learning activities |
| CO3 | Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension |
| CO4 | Evaluate and exhibit acceptable etiquette essential in social and professional settings |
| CO5 | Create awareness on mother tongue influence and neutralize it in order to improve fluency in spoken English |

**Reference Books**


- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- A Textbook of English Phonetics for Indian Students by T.Balasubramanyam


**Mapping of Course outcomes with Program outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**

**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

## ENGINEERING PHYSICS LAB

| COURSE OBJECTIVES | |
|---|---|
| 1 | The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. |
| 2 | To develop practical applications of engineering materials and use of principle in the right way to implement the modern technology. |

| | |
|---|---|
| 3 | To train engineering students on basis of measurements and the instruments |
| 4 | To equip the students with practical knowledge in electronic and optics experiments |

**LIST OF EXPERIMENTS**

**Any TEN of the following experiments has to be performed during the SEMESTER**

1. Laser: Determination of wavelength using diffraction grating.
2. Laser: Determination of Particle size.
3. Determination of spring constant of springs using Coupled Oscillator
4. Determination of ultrasonic velocity in liquid (Acoustic grating)
5. Determination of dielectric constant and Curie temperature of a ferroelectric material.
6. B-H curve
7. Stewart-Gee's Method
8. Rigidity modulus of material of a wire-dynamic method (Torsional pendulum)
9. Determination of numerical aperture of an optical fiber.
10. Determination of thickness of thin object by wedge method.
11. Determination of radius of curvature of lens by Newton's rings.
12. Determination of wavelengths of various colours of mercury spectrum using diffraction grating in normal incidence method.
13. Determination of dispersive power of the prism
14. Sonometer: Verification of the three laws of stretched strings
15. Meldes experiment: Determination of the frequency of tuning fork

Note: Out of 10 experiments, two experiments will be performed using virtual laboratory.

Data Books Required: Nil

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | On Completion of this course, students are able to –<br>Develop skills to impart practical knowledge in real time solution. |
| CO2 | Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations. |
| CO3 | Understand measurement technology, usage of new instruments and real time applications in engineering studies. |
| CO4 | The student will be able to analyze the physical principle involved in the various instruments, also relate the principle to new application. |
| CO5 | The various experiments in the areas of optics, mechanics and thermal physics will nurture the students in all branches of Engineering. |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**II year –1st Semester**

| | | | | |
|---|---|---|---|---|
| **19A20601** | **1. COMPLEX VARIABLES, TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS** | **BSC** | **2-1-0** | **3 Credits** |

**Course Objective:**

This course aims at providing the student to acquire the knowledge on the calculus of functions of complex variables. The aim is to analyze the solutions of partial differential equations.

**Unit-I: Complex Variable – Differentiation**:

Introduction to functions of complex variable-concept of Limit & continuity- Differentiation, Cauchy-Riemann equations, analytic functions (exponential, trigonometric, logarithm), harmonic functions, finding harmonic conjugate-construction of analytic function by Milne Thomson method-Conformal mappings-standard and special transformations (sin z, $e^z$, cos z, $z^2$) Mobius transformations (bilinear) and their properties.

**Learning Outcomes:**

Students will be able to

1. understand functions of Complex variable and its properties.
2. find derivatives of complex functions.
3. understand the analyticity of complex functions .
4. understand the conformal mappings of complex functions.

**Unit-II: Complex Variable – Integration**:

Line integral-Contour integration, Cauchy's integral theorem, Cauchy Integral formula, Liouville's theorem (without proof) and Maximum-Modulus theorem (without proof);power series expansions: Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (around unit circle, semi circle with f(z) not having poles on real axis).

**Learning Outcomes:**

Students will be able to

1. understand the integration of complex functions.
2. apply Cauchy's integral theorem and Cauchy's integral formula.
3. understand singularities of complex functions.
4. evaluate improper integrals of complex functions using Residue theorem.

**Unit-III: Laplace Transforms**

Definition-Laplace transform of standard functions-existence of Laplace Transform – Inverse transform – First shifting Theorem, transforms of derivatives and integrals – Unit step function – Second shifting theorem – Dirac's delta function – Convolution theorem – Laplace transform of Periodic function. Differentiation and integration of transform – solving Initial value problems to ordinary differential equations with constant coefficients using Laplace transforms.

**Learning Outcomes:**

Students will be able to

1. understand the concept of Laplace transforms and find the Laplace transforms of elementary functions.
2. find the Laplace transforms of general functions using its properties.
3. understand Laplace transforms of special functions (Unit step function, Unit Impulse & Periodic).
4. apply Laplace transforms to solve Differential Equations.

**Unit-IV: Fourier series**

Determination of Fourier coefficients (Euler's) – Dirichlet conditions for the existence of Fourier series – functions having discontinuity-Fourier series of Even and odd functions – Fourier series in an arbitrary interval – Half-range Fourier sine and cosine expansions- typical wave forms - Parseval's formula- Complex form of Fourier series.

**Learning Outcomes:**

Students will be able to

1. understand finding Fourier series expression of the given function.
2. determine Fourier coefficients (Euler's) and identify existence of fourier series of the given function.
3. expand the given function in Fourier series given in Half range interval.
4. apply Fourier series to establish Identities among Euler coefficients.
5. find Fourier series of wave forms.

**Unit-V: Partial Differential Equations & Applications**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of first order PDEs by Lagrange's method- Solution of nonlinear PDEs (Standard forms)-Solution of second order PDEs by Method of separation of variables – Solutions of one-dimensional wave equation, one dimensional heat equation under initial and boundary conditions.

**Learning Outcomes:**

At the end of this unit, the students will be able to

1. form Partial Differential Equations.
2. solve Partial Differential Equations of first order.
3. understand the method of separation of variables.
4. solve applications of Partial Differential Equations.

Text Books:

1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
2. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India

Reference Books:

1. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
2. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.

**Course Outcomes:**

After the completion of course, students will be able to

1. understand the analyticity of complex functions and conformal mappings.
2. apply Cauchy's integral formula and Cauchy's integral theorem to evaluate improper integrals along contours.
3. understand the usage of Laplace Transforms.

4. evaluate the Fourier series expansion of periodic functions.
5. formulate/solve/classify the solutions of Partial differential equations and also find the solution of one-dimensional wave equation and heat equation.

**II year –1st Semester**

| | | | | |
|---|---|---|---|---|
| **19A20701** | **2. ORGANIC CHEMISTRY** | **BSC** | **3-0-0** | **3 Credits** |

**COURSE OBJECTIVES:**

This course aims to provide the student to

- Understand the Mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- Carry out industrial processes for the manufacture of drugs and pharmaceuticals, Comprehension on basic reactions, reagents and their applications.
- Explain the electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
- Conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**COURSE OUTCOMES:**

**After completion of the course student shall be able to**

- Analyze the mechanism of organic chemical reaction which are essential to synthesis new organic compounds in drug and pharmaceutical industries

- Acquire the knowledge on chemical processes industrially for the manufacture of drugs, pharmaceuticals and understand the basic reactions, reagents and their applications.
- Illustrate the electronic behaviour of organic molecules, their special and geometrical arrangement of functional groups.
- Explain the reaction mechanisms for different types of reactions.
- Identify the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**UNIT I:** Polar effects – Inductive effect, electromeric effect, resonance, hyper conjugation, steric hindrance, and aromaticity – examples. (9h)

**UNIT II:** Electrophilic reactions: a) Friedel-Craft reaction b) Riemer- Teimenn Reaction c) Backmann rearrangement. Nucleophillic reactions : a) Aldol condensation b) Perkin Reaction c) Benzoin condensation.(10h)

**UNIT – III:** Stereo isomerism; Optical isomerism; Symmetry and chirality; Optical isomerism in lactic acid and tartaric acid; Sequence rules; Enantiomers, diastereomers; Geometrical Isomerism; E-Z system of nomenclature, conformational analysis of ethane and Cyclohexane. (12h)

**UNIT.IV:** Some Reagents of Synthetic importance: Preparation and applications of Aluminum Chloride, N-Bromosuccinamide (NBS), Diazomethane, Dicyclohexylcarbodiimide(DCC), Potassiumtertiarybutoxide and Grignard reagent. (12h)

**UNIT.V:** Some Useful Reactions in Organic Synthesis:

i). Protection of functional groups: Hydroxyl, Carbonyl and amino groups

ii). Oxidation: Oxidation of alcohols and carbonyl compounds with suitable examples

iii). Reduction: Reduction of double and triple bonds and carbonyl compounds with suitable

Examples. (12h)

**Text Books:**

1. Text book of Organic Chemistry – Morrsion and Boyd.

2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

3. Vogel's Text Book of Qualitative Organic Analysis.

**References:**

1. Reaction mechanism – Peter Skyes.

2. Text book of Organic Chemistry – P.L. Soni.

3. Organic Chemistry Vol- I-IL. Finar.

4. Reactions and Reagents – O.P. Agrawal.

5. A Text Books of Organic Chemistry- Bahl and ArunBahl, S. Chand company, New Delhi

6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**II year –1st Semester**

| | | | | |
|---|---|---|---|---|
| **19A20801** | **3. Chemical Process Calculations** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce chemical process calculations, different unit systems and conversion from one-unit system to another.
- To introduce the use of Log-Log, Semi-Log and triangular graphs and graph plotting software such as MS-Excel, Polymath, Minitab, Origin etc.
- To impart concepts of vapour pressure and calculation of percent saturation of a given vapor-gas mixture.
- To emphasize the importance of basis of calculation and develop a systematic methodology to carry out material balances on chemical processes/equipment without and with reactions including recycle, purge and bypass.
- To convey different thermal effects associated with processes involving chemical reactions and phase changes
- To present how to calculate mass and energy balances involving combustion of fuels.

**UNIT- I**

**Stoichiometric & Composition relations**: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.

(For Assignments only: Use of Log-Log and Semi-Log graphs; Graph plotting using plotters like MS-Excel, Polymath, Minitab, Origin, etc..)

**Behavior of Ideal gases**: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

**UNIT -II**

**Vapor pressure**: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non-volatile solutes.

**Humidity and Saturation**: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization.

**UNIT- III**

**Material balances**: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with the help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

**UNIT -IV**

**Thermo physics**: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids enthalpy and its evaluation.

**Thermo chemistry**: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change,

**UNIT- V**

**Flame Temperature Calculations:** Calculation of theoretical and actual flame temperatures.

**Combustion Calculations**: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

**TEXTBOOKS:**

**1.** Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. 2nd Edition,John Wiley and Sons, New York, 1963.

**REFERENCES:**

1. Basic principles and calculations in chemical engineering by D.H. Himmelblau, 7th Ed. PHI, 2013
2. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

**Data Tables:** Use of steam tables, humidity chart under data tables permitted in the Examination hall

**Course outcomes:**

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

- Identify process calculations relevant to chemical engineering processes including conversion of physical quantities into different unit systems. (L3)
- Predict the behaviour of gases and vapours using ideal gas law.(L6)
- Estimate the composition of the given vapour-gas mixture using the principles of vapour pressure. (L6)
- Solve material balances on chemical processes/equipment without and with reactions including recycle, purge and bypass. (L6)
- Evaluate thermal effects associated with chemical reactions. (L5)
  Calculate mass and energy balances involving combustion of fuels. (L5)

**II year –1st Semester**

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|---|---|---|---|---|
| **19A20802** | **4. CHEMICAL ENGINEERING THERMODYNAMICS - I** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce the laws of thermodynamics and their scope along with properties of different types.
- To explain how to calculate the heat and work requirements for industrial processes
- To teach the importance of PVT behaviour and its prediction using different equations of state and generalized correlations.
- To expose second law of thermodynamics and its application to find entropy changes.

- To transmit knowledge regarding the conversion of heat into work by power cycles such as Carnot, Rankine, Otto and Diesel cycles.
- To inform different refrigeration cycles and liquefaction processes

**UNIT -I**

**Introduction**: The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiments.

**The first law and other basic concepts:** The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant-P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

**UNIT -II**

**Volumetric properties of pure fluids:** The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, second virial coefficients from potential functions.

**UNIT- III**

Cubic equations of state, generalized correlations for gases.

**The second law of thermodynamics:** Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale

**UNIT -IV**

Entropy, Entropy changes of an ideal gas, mathematical statement of the second law

The third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

**Power cycles:** Carnot cycle, Rankine cycle, Otto cycle, Diesel cycle.

**UNIT –V**

**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

**TEXT BOOKS**

1. J.M.Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, 8th ed, Tata McGraw Hill,2017.

**REFERENCE BOOKS**

1. Y.V. C. Rao, Chemical Engineering Thermodynamics, University publications.
2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001.

**Course outcomes:**

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

- Apply the first and second laws of thermodynamics to chemical processes. (L3)
- Compute the properties of ideal and real mixtures using equations of state and generalized correlations. (L5)
- Analyse the behaviour of flow and non-flow processes using mass and energy balances. (L4)
- Estimate heat and work requirements for industrial processes. (L5)
- Determine the efficiency of processes involving heat into work, refrigeration and liquefaction. (L5)

**II year –1st Semester**

| | 5. FUNDAMENTALS OF PYTHON PROGRAMMING | ESC | 2-0-0 | 2 Credits |
|---|---|---|---|---|

**Course Objectives:**

- To teach the fundamentals of Python
- To elucidate problem-solving using a Python programming language
- To introduce a function-oriented programming paradigm through python
- To train in the development of solutions using modular concepts
- To introduce the programming constructs of python

**Course Outcomes:** After completion of the course a successful student is able to

- List the basic constructs of Python
- Design programs for data structure list and manipulating strings
- Apply object orientation concepts, use data structure dictionaries
- Organize data in the form of files

**Unit – I**

**Introduction:** What is a program, Running python, Arithmetic operators, Value and Types.

Variables, Assignments and Statements: Assignment statements, Script mode, Order of operations, string operations, comments.

**Functions**: Function calls, Math functions, Composition, Adding new Functions, Definitions and Uses, Flow of Execution, Parameters and Arguments, Variables and Parameters are local, Stack diagrams, Fruitful Functions and Void Functions, Why Functions.

**Learning Outcomes**: Student should be able to

- List the basic constructs of Python (L1)
- Solve the problems by applying modularity principle (L3)

**Unit – II**

**Conditionals and Recursion**: floor division and modulus, Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, Recursion, Infinite Recursion, Keyboard input.
**Fruitful Functions**: Return values, Incremental development, Composition, Boolean functions, More recursion, Leap of Faith, Checking types,

**Learning Outcomes**: Student should be able to

- Apply the conditional execution of the program (L3)
- Apply the principle of recursion to solve the problems (L3)

**Unit - III**

**Iteration**: Reassignment, Updating variables, The while statement, Break, Square roots, Algorithms.
**Strings**: A string is a sequence, len, Traversal with a for loop, String slices, Strings are immutable, Searching, Looping and Counting, String methods, The in operator, String comparison.

**Learning Outcomes**: Student should be able to

- Design programs for manipulating strings (L6)

**Unit – IV**
**Lists**: List is a sequence, Lists are mutable, Traversing a list, List operations, List slices, List methods, Map filter and reduce, Deleting elements, Lists and Strings, Objects and values, Aliasing, List arguments.
**Tuples:** Tuples are immutable, Tuple Assignment, Tuple as Return values, Variable-length argument tuples, Lists and tuples, Dictionaries and tuples, Sequences of sequences.

**Learning Outcomes**: Student should be able to
- Apply object orientation concepts (L3)
- Use data structure lists and tuples (L3)

**Unit – V**

**Files:** Persistence, Reading and writing, Format operator, Filename and paths, Catching exceptions, Databases, Pickling, Pipes, Writing modules.
**Classes and Objects**: Programmer-defined types, Attributes, Instances as Return values, Objects are mutable, Copying.
**Classes and Functions**: Time, Pure functions, Modifiers, Prototyping versus planning.

**Learning Outcomes**: Student should be able to
- Organize data in the form of files (L6)
- Plan programs using object orientation approach (L6)

**Text books:**

- Allen B. Downey, "Think Python", 2nd edition, SPD/O'Reilly, 2016.

**Reference Books:**


- Martin C.Brown, "The Complete Reference: Python", McGraw-Hill, 2018.
- Kenneth A. Lambert, B.L. Juneja, "Fundamentals of Python", CENGAGE, 2015.
- R. NageswaraRao, "Core Python Programming", 2nd edition, Dreamtech Press, 2019


**Course Outcomes**: Student should be able to

- Explain the features of Python language (L2)
- Select appropriate data structure for solving a problem (L4)
- Design object-oriented programs for solving real-world problems (L6)

**II year –1st Semester**

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| **19A20803** | **6. MOMENTUM TRANSFER** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce the basic concepts of static and dynamic behaviour of fluids
- To disseminate different flow regimes and identification of types of fluids along with necessary equations to represent their behaviour
- To derive Bernouli's theorem and explain its application to fluid flow problems
- To introduce the concept of friction factor and its estimation for different types of flow through pipes and fittings.
- To explain dimensional analysis using Rayleighs and Buchinghm π Methods.
- To expose flow measuring devices such as head and area meters.
- To explain fluid moving machinery and its selection for a given flow problem.

**UNIT- I**

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

**UNIT- II**

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation.

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

**UNIT- III**

Dimensional analysis: Buckingham π Theorem and Rayleigh's method.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow.

**UNIT -IV**

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny-Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

Fluidization: Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidization, Continuous fluidization: Slurry and pneumatic transport.

**UNIT- V**

Transportation and Metering of fluids: Pipes, fittings and valves, Fluid- moving machinery, Fans, blowers, and compressors.

Measurement of flowing fluids: Variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meter- Rota meter.

**TEXT BOOKS:**

1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith& Peter Harriot, McGraw-Hill, 7th ed, 2007

**REFERENCE BOOKS:**

1. Transport processes and unit operations by Christie J. Geankoplis, PHI
2. Unit operations, Vol-1 –Chattopadhya, Khanna publishers
3. Principles of Unit Operations, Foust *et al*, 2nd ed., John Wiley, 1999

4. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press.
5. Unit operations- Brown etal.,Asian Publishing House.

## II year –1st Semester

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|---|---|---|---|---|
| 19A25502 | **7. FUNDAMENTALS OF PYTHON PROGRAMMING LAB** | **BSC** | **0-0-3** | **1.5 Credits** |

**Course Objectives:**

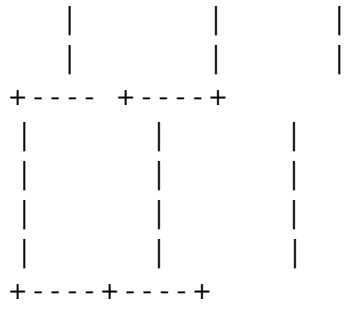
1. To train solving computational problems
2. To elucidate solving mathematical problems using Python programming language
3. To illustrate the features of Python language

**Laboratory Experiments**

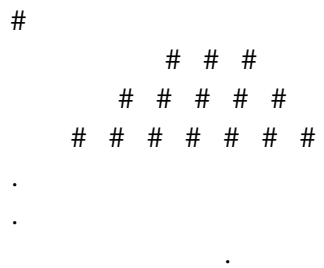
1. Install Python Interpreter and use it to perform different Mathematical Computations. Try to do all the operations present in a Scientific Calculator

2. Write a function that draws a grid like the following:

```
+ - - - -  + - - - -+
|          |         |
    |          |         |
```



3. Write a function that draws a Pyramid with # symbols



Up to 15 hashes at the bottom

4. The letters of the alphabet can be constructed from a moderate number of basic elemlents, like vertical and horizontal lines and a few curves. Design an alphabet that can be drawn with a minimal number of basic elements and then write functions that draw the letters. The alphabet can belong to any Natural language excluding English. You should consider at least Ten letters of the alphabet.

5. The time module provides a function, also named time that returns the current Greenwich Mean Time in "the epoch", which is an arbitrary time used as a reference point. On UNIX systems, the epoch is 1 January 1970.

```
>>> import time
>>>time.time()
1437746094.5735958
```

Write a script that reads the current time and converts it to a time of day in hours, minutes, and seconds, plus the number of days since the epoch.

6. Given $n+r+1 <= 2^r$ .n is the input and r is to be determined. Write a program which computes minimum value of r that satisfies the above.

7. Write a program that evaluates Ackermann function

8. The mathematician SrinivasaRamanujan found an infinite series that can be used to generate a numerical approximation of $1/\pi$ :

9. Write a function called estimate_pi that uses this formula to compute and return an estimate of $\pi$.

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{k=0}^{\infty} \frac{(4k)!(1103 + 26390k)}{(k!)^4 396^{4k}}$$

It should use a while loop to compute terms of the summation until the last term is smaller than 1e-15 (which is Python notation for $10^{-15}$). You can check the result by comparing it to math.pi.

10. Choose any five built-in string functions of C language. Implement them on your own in Python. You should not use string related Python built-in functions.
11. Given a text of characters. Write a program which counts number of vowels, consonants and special characters.
12. Given a word which is a string of characters. Given an integer say 'n'. Rotate each character by 'n' positions and print it. Note that 'n' can be positive or negative.
13. Write program which performs the following operations on list's. Don't use built-in functions
    a) Updating elements of a list
    b) Concatenation of list's
    c) Check for member in the list
    d) Insert into the list
    e) Sum the elements of the list
    f) Push and pop element of list
    g) Sorting of list
    h) Finding biggest and smallest elements in the list
    i) Finding common elements in the list

14. Write a program that reads a file, breaks each line into words, strips whitespace and punctuation from the words, and converts them to lowercase.
15. Write a program that takes a string and prints the letters in decreasing order of frequency.
16. Write a program that reads a word list from a file (see Section 9.1) and prints all the sets of words that are anagrams.
    Here is an example of what the output might look like:
    ['deltas', 'desalt', 'lasted', 'salted', 'slated', 'staled']
    ['retainers', 'ternaries'] ['generating', 'greatening']
    ['resmelts', 'smelters', 'termless']
17. Consider all the files on your PC. Write a program which checks for duplicate files in your PC and displays their location. Hint: If two files have the same checksum, they probably have the same contents.
18. Write a program illustrating the object oriented features supported by Python.
19. Design a Python script to determine the difference in date for given two dates in YYYY:MM:DD format(0 <= YYYY <= 9999, 1 <= MM <= 12, 1 <= DD <= 31) following the leap year rules.
20. Design a Python Script to determine the time difference between two given times in HH:MM:SS format.( 0 <= HH <= 23, 0 <= MM <= 59, 0 <= SS <= 59)

**Course outcomes:** Student should be able to

1. Design solutions to mathematical problems (L6)
2. Organize the data for solving the problem (L6)
3. Develop Python programs for numerical and text based problems (L3)
4. Select appropriate programming construct for solving the problem (L5)
5. Illustrate object oriented concepts (L3)

**Reference Books:**


1. Peter Wentworth, Jeffrey Elkner, Allen B. Downey and Chris Meyers, "How to Think Like a Computer Scientist: Learning with Python 3", 3rd edition, Available at http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf
2. Paul Barry, "Head First Python a Brain Friendly Guide" 2nd Edition, O'Reilly, 2016
3. Dainel Y.Chen "Pandas for Everyone Python Data Analysis" Pearson Education, 2019


**II year –1st Semester**

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| **19A20702** | **8. ORGANIC CHEMISTRY LAB** | **BSC** | **0-0-3** | **1.5 Credits** |

**COURSE OBJECTIVES:** This course aims to provide the student about the

- Detailed organic structure analysis

- Planning and implementation of advanced organic reactions
- Major concepts, theoretical and experimental principles.

**COURSE OUTCOME:**

**After completion of the course, student shall be able to**

- Explain the mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- Carry out a chemical process industrially for the manufacture of drugs and pharmaceuticals, understand the basic reactions, reagents and their applications.

**ORGANIC CHEMISTRY LAB:**

1. Criteria of Purity of Solid and Liquid, Determination of Melting Point & Boiling Point.

   Detecting Nitrogen, Sulphur, and Halogens in Organic Compounds.

2. Identification of an Unknown Substance from the following classes of Organic

   Compounds, Alcohols, Phenols, Aldehydes, Ketenes, Carbohydrates and Carboxylic acids.

3. Preparation of Aspririn

4. Preparation of Paracetamol

5. Preparation of Acetanilide

6. Preparation of Sulphonic acid

7. Preparation of derivatives for Aldehydes and Amines.

8. Beckman Rearrangement (Preparation of Benzanilide from Benzophenoneoxime).

9. Determination of strength of a Glycine Solution.

10. Estimation of an Aldehyde.

**TEXT BOOKS:**

1. Text book of Organic Chemistry – Morrsion and Boyd.

2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

3. Vogels Text Book of Qualitative Organic Analysis.

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.

2. Text book of Organic Chemistry – P.L. Soni.

3. Organic Chemistry Vol- I-IL. Finar.

4. Reactions and Reagents – O.P. Agrawal.

5. A Text Books of Organic Chemistry- Bahl and ArunBahl, S. Chand company, New Delhi

6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**II year –1st Semester**

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| **19A20804** | **9. MOMENTUM TRANSFER LAB** | **PCC** | **0-0-3** | **1.5 Credits** |

**Objective:** The lab provides knowledge on various flow patterns, flow measuring devices and pumps.

1. Identification of laminar and turbulent flows - Major equipment - Reynolds apparatus
2. Measurement of point velocities - Major equipment - Pitot tube setup
3. Verification of Bernoulli's equation - Major equipment – Bernoulli's Apparatus
4. Calibration of Rotameter - Major equipment – Rotameter Assembly
5. Variation of Orifice coefficient with Reynolds Number - Major equipment - Orifice meter Assembly
6. Determination of Venturi coefficient - Major equipment – Venturi meter Assembly
7. Friction losses in Fluid flow in pipes - Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities - Major equipment - Packed bed with Pressure drop measurement
9. Pressure drop and void fraction in a fluidized bed - Major equipment - Fluidized bed with Pressure drop measurement
10. Studying the coefficient of contraction for a given open orifice - Major equipment - Open Orifice Assembly

11. Studying the coefficient of discharge in a V-notch - Major equipment - V-notch Assembly

12. Studying the Characteristics of a centrifugal pump - Major equipment - Centrifugal Pump

13. Drag studies using two different fluids

**II year –1st Semester**

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|---|---|---|---|---|
| **19A10804** | **10. ENVIRONMENTAL SCIENCE** | **MC** | **3-0-0** | **0 Credits** |

**OBJECTIVE:** To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I:**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: –** Definition, Scope and Importance – Need for Public Awareness.

**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II:**

**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of

biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III:**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

**SOLID WASTE MANAGEMENT :** Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV:**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

**UNIT – V:**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

**TEXT BOOKS** :


(1) Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
(2) Environmental Studies by Palani Swamy – Pearson education
(3) Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company


**REFERENCES :**


(1) Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Pubilications.
(2) Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
(3) Comprehensive Environmental studies byJ.P.Sharma, Laxmi publications.
(4) Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Printice hall of India Private limited.
(5) A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Pubilishing House
(6) Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

**II Year – 2nd Semester**

| 19A20805 | 1. Chemical Engineering Thermodynamics | PCC | 2-1-0 | 3 Credits |
|---|---|---|---|---|

**Course Objectives:**

- To introduce Maxwell's relations and their application to generate property relations for homogeneous phases.
- To impart the concept of phase equilibria.
- To present the calculation of property changes of mixing.
- To explain LLE, VLLE, SLE and SVE.
- To educate the calculation of fugacity coefficient using generalized correlations and vapour-liquid equilibrium (VLE) composition for ideal and non-ideal systems
- To teach equilibrium constant and composition for a given reaction at specified temperature and pressure.

**UNIT I**

**Thermodynamic properties of fluids:** Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlation for gases.

**Solution Thermodynamics:** Theory, Fundamental property relation, chemical potential as a criterion for phase equilibrium, partial properties, ideal gas mixtures.

**UNIT II**

Fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

**Solution Thermodynamics:** Applications: The liquid phase properties from VLE data, models for the excess Gibbs energy, property changes of mixing

**UNIT III**

**VLE at low to moderate pressures:** The nature of equilibrium, the phase rule, Duhems theorem, VLE: Qualitative behavior, the gamma /Phi formulation of VLE, Dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems

**Thermodynamic Properties and VLE:** properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type.

**UNIT IV**

**Topics in phase equilibria:** Equilibrium and stability, liquid/liquid equilibrium(LLE), vapor/liquid/liquid equilibrium(VLLE), solid/liquid equilibrium (SLE), solid/vapor equilibrium (SVE).

**Thermodynamic analysis of processes:** Calculation of ideal work, lost work, thermodynamic analysis of steady-state flow processes.

**UNIT V**

**Chemical Reaction Equilibria:** The reaction coordinate, application of equilibrium criterion to chemical reactions, The standard Gibb's energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems.

**TEXT BOOK:**

1. Introduction to Chemical Engineering Thermodynamics, 6th ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2003.

**REFERENCE:**

1. Chemical Engineering Thermodynamics- Y V C Rao , University Publications.

2. Chemical Engineering Thermodynamics, Pradeep Ahuja, PHI Learning Pvt. Ltd., New Delhi, 2009
2. A Text Book of Chemical Engineering Thermodynamics, K.V. Narayanan, PHI Learning Pvt.Ltd., New Delhi, 2001.

**Course outcomes:**

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

- Apply Maxwell's relations to generate property relations for homogeneous phases. (L3)
- Define the criteria for phase equilibrium. (L1)
- Estimate the property changes of mixing (L5).
- Explain LLE, VLLE, SLE and SVE.(L2)
- Calculate fugacity coefficient using generalized correlations and vapour-liquid equilibrium (VLE) composition for ideal and non-ideal systems (L5)
- Determine equilibrium constant and composition for a given reaction at specified temperature and pressure (L5)

**II Year – 2nd Semester**

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| **19A20806** | **2. PROCESS HEAT TRANSFER** | **PCC** | **2-1-0** | **3 Credits** |

**COURSE OBJECTIVES:**

- To demonstrate different modes of heat transfer
- To describe formulae for steady/ unsteady rate of heat transfer by conduction for rectangular, cylindrical and spherical geometries
- To teach how to estimate the heat transfer coefficients for different flow geometries
- To explain the working and design of double pipe, shell and tube heat exchangers and evaporators
- To impart knowledge on the phenomenon of radiation, radiation shields and estimation of emissivity.

**UNIT -I**

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, radiation.
**Heat transfer by conduction in Solids:** Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.
**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid.

**UNIT- II**

**Principles of heat flow in fluids:** Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

**UNIT- III**

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

**UNIT -IV**

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.

**Radiation:** Introduction, properties and definitions, black body radiation, real surfaces and the Gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation Shielding, radiation to semi-transparent materials, combined heat transfer by conduction, convection and radiation.

**UNIT- V**

**Heat exchange equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method)

**Evaporators:** Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, methods of feeding, vapor recompression

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4th ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**COURSE OUCOMES:**

At the end of the course the student will be able to

- Determine individual and overall heat transfer coefficients in laminar and turbulent flow conditions. (L5)
- Design of heat exchange equipment such as double pipe heat exchanger, shell and tube heat exchanger used in chemical industry. (L6)
- Estimate the performance (capacity, economy) of a given single/multiple effect evaporator. (L5)
- Calculate heat transfer coefficient in forced convection and natural convection. (L5)
- Analyze radiation heat transfer between different surfaces. (L4)

**II Year – 2nd Semester**

| 19A20807 | 3. MECHANICAL OPERATIONS | PCC | 2-1-0 | 3 Credits |
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**COURSE OBJECTIVES:**

- To introduce to the concepts of characterization of solids
- To discuss different types of mixers for mixing of solids
- To impart knowledge on screening, size reduction and equipment for size reduction
- To give exposure to Laws of crushing
- To explain the phenomenon of particle settling in fluids and transportation of solids
- To disseminate knowledge on different techniques of particle separation from fluid
- To estimate the power consumption in agitation and mixing of liquids

**UNIT- I**

**Properties, handling and mixing of particulate solids**: Characterization of solid particles, properties of particulate masses, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids.

**UNIT- II**

**Size reduction**: Principles of computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra-fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law
Screening, Industrial screening equipment, Effectiveness of the screen, differential & cumulative analysis.

**UNIT -III**

Filtration, cake filters, centrifugal filters, cyclone separators, electro-static precipitators.
Principles of cake filtration, Clarifying filters, vacuum filtration, liquid clarification, gas cleaning, principles of clarification. Introduction to cross flow filtration.

**UNIT- IV**

**Separations based on motion of particles through fluids**: gravity settling processes and centrifugal settling processes, float and sink method, differential settling, coagulation, Flotation-separation of ores, flotation agents
**Crystallization**: crystal geometry, principles of crystallization, equilibria and yields, nucleation, crystal growth

**UNIT- V**

**Agitation and mixing of liquids**: Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

**Introduction to transportation of solid particulate mass**: Belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7th ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill
2. Introduction to Chemical Engineering by J.T.Banchero& W.L. Badger., TMH, 1997.

**COURSE OUTCOMES:**

**At the end of the course the student will be able to**

- Estimate average particle diameter using differential and cumulative analysis. (L5)
- Demonstrate the working of different equipment for size reduction, liquid clarification, gas cleaning, blenders and mixers.(L2)
- Evaluate cake and filter medium resistances.(L5)
- Evaluate power consumption in agitated vessels. (L5)
- Explain the principles of crystallization. (L2)
- Describe the working of equipment for transportation of solid particles. (L2)

**II Year – 2nd Semester**

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| **19A20808** | **4. MASS TRANSFER OPERATIONS-I** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes.
- To discuss the fundamental concepts of mass transfer principles and their applications to real engineering problems.
- To introduce the mass transfer rates and Fick's Law of diffusion.
- To describe convective mass transfer rates and mass transfer coefficients.
- To appraise different types of equipment and their operation for gas-liquid separations.
- To explain the design of mass transfer equipment for absorption, stripping, drying and humidification.

**UNIT- I**

**The Mass Transfer Operations**: Classification of the Mass-Transfer Operations, Choice of Separation Method, Methods of Conducting the Mass-Transfer Operations, Design Principles, Unit Systems

**Molecular Diffusion In Fluids**: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids, Momentum and Heat Transfer in Laminar flow

Diffusion:Diffusion in Solids, Fick's Diffusion, Unsteady State Diffusion, Types of Solid Diffusion, diffusion through polymers, diffusion through crystalline solids, Diffusion through porous solids & hydrodynamic flow of gases.

**UNIT- II**

**Mass Transfer Coefficients**: Mass Transfer Coefficients, Mass Transfer Coefficients in Laminar Flow (Explanation of equations only and no derivation), Mass Transfer Coefficients in Turbulent Flow, eddy diffusion, Film Theory, Penetration theory, Surface-renewal Theory, Combination Film-Surface-renewal theory, Surface-Stretch Theory, Mass, Heat and Momentum Transfer Analogies, Turbulent Flow in Circular Pipes. Mass transfer data for simple situations.

Inter Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equation.

**UNIT-III**

**Equipment For Gas-Liquid Operations**: Gas Dispersed, Sparged vessels (Bubble Columns), Mechanical agitated equipments(Brief description),Tray towers, General characteristics, Sieve design for absorption and distillation (Qualitative Treatment), Different types of Tray Efficiencies, Liquid Dispersed venturi Scrubbers, Wetted-Wall Towers, Packed Towers, Counter current flow of Liquid & Gas through packing, Mass transfer coefficients for packed towers, End effects and Axial Mixing Tray tower vs Packed towers.

**UNIT-IV**

**Absorption And Stripping**: Absorption equilibrium, ideal and non-ideal solutions selection of a solvent for absorption, one component transferred: material balances. Determination of number of Plates (Graphical), Absorption Factor, estimation of number of plates by Kremser Brown equation, Continuous contact equipment; HETP, Absorption of one component,

Determination of number of Transfer Units and Height of the Continuous Absorber, overall coefficients and transfer units, dilute solutions, overall height of tranasfer units.

**UNIT-V**

**Humidification Operations**: Vapor-Pressure Curve, Definitions, Psychometric Charts, Enthalpy of gas-vapor Mixtures, Humidification and Dehumidification, Operating lines and Design of Packed Humidifiers.

**Drying:** Equilibrium, Definitions, Drying Conditions- Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, Drying time Through Circulation Drying.

Classification of Drying Operations: Batch and Continuous Drying Equipment.

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

2. Separation process C.J King, Tata Mc Graw Hill
3. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi

**REFERENCE:**

1. Diffusion mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---Nil---**

***Codes/Tables:*** *Psychrometric Charts may be provided*

**Course outcomes:**

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

- Determine mass transfer rates using Fick's Law.(L5)
- Estimate convective mass transfer rates and mass transfer coefficients using analogies.(L5)
- Explain the concept of inter-phase mass transfer. (L2)
- Design absorber, stripper and humidifier.(L6)
- Estimate drying time.(L5)
- Explain the workingofBatch and Continuous Drying Equipment. (L2)

**II Year – 2nd Semester**

| 19A20703 | 5. ANALYTICAL CHEMISTRY | BSC | 2-1-0 | 3 Credits |
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**Pre-requisites:** None

**COURSE OBJECTIVES:**

**This course aims to provide the student to**

- Acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- Gain basic knowledge of limitations of analytical methods.
- Characterize the Materials synthesized by chemical industry.
- Understand the chromatographic techniques for the separation of impurities in the industrially synthesized compounds.

**COURSE OUTCOMES:**

**After completion of the course student shall be able to**

1. Analyse the statistical data for the analysis in analytical chemistry.
2. Acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.
3. Analyse the compounds by using the TGA, DTA and DSC techniques for the analysis of metals and alloys
4. Gain the knowledge on cyclic voltameter and amperometric titration techniques
5. Learn the basic principles of spectrophotometry like UV-Vis and IR

**UNIT-I: Basic Principles of Quantitative Analysis:** Limitations of analytical methods, Classification of errors, Accuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples, Paired T-test, Correlation and regression, Standard deviations. (8h)

**UNIT-II: Chromatographic Methods:** Column chromatography-general principles, terminology: retention time, rotation volume, separation factor, resolution of peaks. Principles of gas chromatography block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC.Ion Exchange chromatography-seperation of anions and cations.Suppressed & non-suppressed ion chromatography.Numerical calculations. (14h)

**Unit-III: Thermal methods of Analysis:** Introduction to Thermal methods, Thermo gravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)DSC:Differential scanning calorimetry, principles & applications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature). (12h)

**Unit-IV: Electro-Analytical Techniques:** i).Brief introduction about polarography, Basic principle, instrumentation and applications of cyclic voltametry. ii), Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations. (9h)

**Unit-V: Spectrophotometric Methods:** Introduction to Analysis: Qualitative & Quantitative Analysis;Conventional & Instrumental methods of analysis.

Molecular spectrophotormetry-Beer's law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Infrared spectrophotormetry-principle, instrumentation and Functional group analysis of organic compounds using infrared spectra. Quantitative analysis of organic molecules. Atomic absorption spectrophotormetry(AAS) and flame photometry: principle, instrumentation and applications (Determination of Sodium, Potassium and Calcium.) (12h)

**BOOKS:**

1. Quantitative analysis, R.A.Day& A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.

2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.

3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012

2. Instrumental lMethods of Chemical Analysis, GurdeepR.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.

3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000

4. Essentials of Physical Chemistry- ArunBahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers,

New Delhi.

**II Year – 2nd Semester**

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| **19A20603** | **6. NUMERICAL METHODS, PROBABILITY AND STATISTICS** | **BSC** | **2-1-0** | **3 Credits** |

## Course Objective:

This course aims at providing the student with the knowledge on

1. various numerical methods for solving equations, interpolating the polynomials, evaluation of integral equations and solution of differential equations.
2. the theory of Probability and random variables.

**Unit-I: Solution of Algebraic & Transcendental Equations:**

Introduction-Bisection method-Iterative method-Regula falsi method-Newton Raphson method

System of Algebraic equations: Gauss Jordan method-Gauss Siedal method.

**Learning Outcomes:**

Students will be able to

1. calculate the roots of equation using Bisection method and Iterative method.
2. calculate the roots of equation using Regula falsi method and Newton Raphson method.
3. solve the system of algebraic equations using Gauss Jordan method and Gauss Siedal method.

**Unit-II: Interpolation**

Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula.

**Learning Outcomes:**

Students will be able to

1. understand the concept of interpolation.
2. derive interpolating polynomial using Newton's forward and backward formulae.
3. derive interpolating polynomial using Lagrange's formulae.
4. derive interpolating polynomial using Gauss forward and backward formulae.

**Unit-III: Numerical Integration & Solution of Initial value problems to Ordinary differential equations**

Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Modified Euler's Method-Runge-Kutta Methods.

**Learning Outcomes:**

Students will be able to

1. solve integral equations using Simson's 1/3 and Simson's 3/8 rule.
2. solve integral equations using Trapezoidal rule.
3. solve initial value problems to ordinary differential equations using Taylor's method.
4. solve initial value problems to ordinary differential equations using Euler's method and Runge Kutta methods.

**Unit-IV: Probability theory:**

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

**Learning Outcomes:**

Students will be able to

1. understand the concept of Probability.
2. solve problems on probability using addition law and multiplication law.
3. understand Random variables and probability mass and density functions.
4. understand stastical constants of random variables.

**Unit-V: Random variables & Distributions:**

Probability distribution - Binomial, Poisson approximation to the binomial distribution and normal distribution-their properties-Uniform distribution-exponential distribution

**Learning Outcomes:**

Students will be able to

1. understand Probability distribution function.
2. solve problems on Binomial distribution.
3. solve problems on Poisson distribution.
4. solve problems on Normal distribution.

**Text Books:**


3. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
4. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole,PNIE.
5. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India


**Reference Books:**


3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.

**Course Outcomes:**

After the completion of course, students will be able to

1. apply numerical methods to solve algebraic and transcendental equations
2. derive interpolating polynomials using interpolation formulae
3. Solve differential and integral equations numerically
4. apply Probability theory to find the chances of happening of events.
5. understand various probability distributions and calculate their statistical constants.

**II Year – 2nd Semester**

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| **19A20901** | **7. UNIVERSAL HUMAN VALUES** | **HE** | **2-0-0** | **2 Credits** |

**Objectives:**

• To create an awareness on Engineering Ethics and Human Values.
• To instil Moral and Social Values and Loyalty
• To appreciate the rights of Others

**Students will be able to:**

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible

- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

**UNIT I: HUMAN VALUES:** Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

**UNIT II: ENGINEERING ETHICS:** Senses of 'Engineering Ethics- Variety of moral issued – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg's theory- Gilligan's theory- Consensus and controversy – Models of professional roles- Theories about right action- Self-interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

**UNIT III**: **ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

**UNIT IV: ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK:** Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing risk- Safety and the Engineer- Designing for the safety- Intellectual Property rights (IPR).

**UINIT V: GLOBAL ISSUES:** Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics and Research – Analyzing Ethical Problems in research – Intellectual property Rights( IPR).

**TEXT BOOKS:**


1. Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajananad, V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009
2. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill– 2003.
4. "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana-Maruthi Publications.
5. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran- LaxmiPublications.
6. "Professional Ethics and Human Values" by Prof.D.R.Kiran
7. Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

**II Year – 2nd Semester**

| 19A20809 | 8. PROCESS HEAT TRANSFER LAB | PCC | 0-0-3 | 1.5 Credits |
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**Objective:** This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.

**List of Experiments:**

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly
2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
   Major equipment - Double pipe heat exchanger apparatus
7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
   Major equipment – Helical coil in a agitated vessel.
8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
   Major equipment - Pin fin apparatus
9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
   Major equipment - Heat transfer coefficient determination apparatus
10. Determination of Stefan – Boltzmann constant.
    Major equipment - Stefan Boltzmann apparatus
11. Determination of emissivity of a given plate at various temperatures.
    Major equipment - Emissivity determination apparatus

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4th ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**II Year – 2nd Semester**

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| **19A20810** | **9.MECHANICAL OPERATIONS LAB** | **PCC** | **3-0-0** | **1.5 Credits** |

**Objective:** The course will equip students with the practical knowledge of different mechanical unit operations & operational conditions of different equipment.

**List of Experiments:**

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment like crushing rolls or vibrating mills and to find out the working index of the material.
Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, Weighing Balance, Energy meter.
3. To find the effectiveness of hand screening and vibrating screen of a given sample.
Major equipment - Vibrating Sieve shaker, Different sizes of sieves, Weighing Balance.
4. To achieve beneficiation of a ore using froth flotation technique.
Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
Major equipment - Plate and frame filter press.
7. To separate a mixture of particles by Jigging.
Major equipment - Jigging apparatus
8. To calculate separation efficiency of particles in a mixture using cyclone separator.
Major equipment - Cyclone separator
9. To determine reduction ratio of a given sample in a pulverizer.
Major equipment - Pulverizer
1. Filtration Studies using
    a. Plate and Frame Filter Press
    b. Rotary Drum Filter
    c. Batch Centrifuge

11. To Perform mixing studies using Ribbon Mixer.

12. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7th ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill
2. Introduction to Chemical Engineering by J.T.Banchero& W.L. Badger., TMH, 1997.

**II Year – 2nd Semester**

| 19A28801 | BIOLOGY FOR ENGINEERS | MC | 3-0-0 | 0 Credits |
|---|---|---|---|---|

**Course Objectives:**

- To provide basic understanding about life and life Process. Animal and plant systems.
- To understand what bio molecules are, their structures are functions. Application of certain Bio molecules in Industry.
- Brief introduction about human physiology and bioengineering.
- To understand hereditary units, i.e. DNA (genes) and RNA and their synthesis in living organism.
- How biology Principles can be applied in our daily life using different technologies.
- Brief introduction to the production of transgenic microbes, Plants and animals.

**Unit I:**

**Introduction to Basic Biology**

Cell as Basic unit of life, cell theory, Cell shapes, Cell structure, Cell cycle. Chromosomes. Prokaryotic and eukaryotic Cell. Plant Cell, Animal Cell, Plant tissues and Animal tissues, Brief introduction to five kingdoms of classification.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Summarize the basis of life.
- Understand the difference between lower organisms (prokaryotes) from higher organisms (eukaryotes).
- Understand how organisms are classified.

**Unit II:**

**Introduction to Biomolecules**

Carbohydrates, lipids, proteins, Vitamins and minerals, Nucleic acids (DNA and RNA) and their types. Enzymes, Enzyme application in Industry. Large scale production of enzymes by Fermentation.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Understand what are bio molecules? Their role in living cells, their structure, function and how they are produced.
- Interpret the relationship between the structure and function of nucleic acids.
- Summarize the applications of enzymes in industry.
- Understand what is fermentation and its applications of fermentation in industry.

**Unit III:**

**Human Physiology**

Nutrition: Nutrients or food substances. Digestive system, Respiratory system, (aerobic and anaerobic Respiration). Respiratory organs, respiratory cycle. Excretory system.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Understand what nutrients are
- Understand the mechanism and process of important human functions

**Unit IV:**

**Introduction to Molecular Biology and recombinant DNA Technology**

Prokaryotic gene and Eukaryotic gene structure. DNA replication, Transcription and Translation. DNA technology. Introduction to gene cloning.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Understand and explain about gene structure and replication in prokaryotes and Eukaryotes
- How genetic material is replicated and also understands how RNA and proteins are synthesized.
- Understand about recombinant DNA technology and its application in different fields.

- Explain what is cloning.

**Unit V:**

**Application of Biology**

Brief introduction to industrial Production of Enzymes, Pharmaceutical and therapeutic Proteins, Vaccines and antibodies. Basics of biosensors, biochips, Bio fuels, and Bio Engineering. Basics of Production of Transgenic plants and animals.

**Unit Outcomes:**

After completing this unit, the student will be able to Understand.

- How biology is applied for production of useful products for mankind.
- What are biosensors, biochips etc.
- Understand transgenic plants and animals and their production

**Course Outcomes:**

After studying the course, the student will be able to:

- Explain about cells and their structure and function. Different types of cells and basics for classification of living Organisms.
- Explain about biomolecules, their structure and function and their role in the living organisms. How biomolecules are useful in Industry.
- Briefly about human physiology.
- Explain about genetic material, DNA, genes and RNA how they replicate, pass and preserve vital information in living Organisms.
- Know about application of biological Principles in different technologies for the production of medicines and Pharmaceutical molecules through transgenic microbes, plants and animals.

**TEXT BOOKS:**

1. P.K.Gupta, Cell and Molecular Biology, 5th Edition, Rastogi Publications -
2. U. Satyanarayana. Biotechnology, Books & Allied Ltd 2017

**REFERENCES:**

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A Global Approach", Pearson Education Ltd, 2018.
2. T Johnson, Biology for Engineers, CRC press, 2011
3. J.M. Walker and E.B. Gingold, Molecular Biology and Biotechnology 2nd ed.. Panima Publications. PP 434.
4. David Hames, Instant Notes in Biochemistry –2016
5. Phil Tunner, A. Mctennan, A. Bates & M. White, Instant Notes – Molecular Biology –- 2014.

**3rd Year, 1st Semester**

## 1. CHEMICAL TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
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**Pre-requisites:** None

**Course Objectives:**

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing for Chemical Process Industries.
- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

***UNIT – I***

Water and Air: Importance of water, sources, plant location factors related to water, water shortage problems, methods of treating fresh water, methods of obtaining fresh water from saline waters, waste water treatment and disposal, air as a chemical raw material.

Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

**UNIT – II**

Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Sulphur and sulphuric acid, manufacture of sulphuric acid, hydrochloric acid and some other
chemicals –Aluminium sulphate and alum.

**UNIT – III**

Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol- formaldehyde resin and polyvinyl chloride polymer, SBR

**UNIT – IV**

Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

**UNIT – V**

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Pharmaceutical Industries: Classification, Alkylation, Carboxylation and Acetylation, Condensation and Cyclization, Dehydration, Halogenation, Oxidation, Sulfonation, Amination, Radio isotopes in Medicine, Fermentation and Life processing for Antibiotics, Hormones, and Vitamins, Biologicals, Steroid hormones, isolates and Animals.

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

- Make a neat and easy to understand the plant process flow sheet.
- Keeps up the productivity while maintaining all safety norms stipulated, during their job
- Solve Engineering problems that are likely to come across during the operation of plants.
- Suggest alternative manufacturing process in terms of Economic viability of the product.

**Text books:**

1. Shreve's Chemical Process Industries edited by Austin, Mc. graw-Hill.5th ed.1985.
2. Dryden's Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, 2nd ed. 1973.

**References:**

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Davis& F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

**3rd Year, 1st Semester**

## 2. MASS TRANSFER OPERATIONS-II

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

To introduce stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction and leaching and drying

- To appraise design aspects of the equipment for utilized for distillation, extraction and leaching and drying.
- To coach the importance of VLE for ideal non-ideal systems (miscible and immiscible liquids) in mass transfer operations.
- To enlighten on different types of distillation such as: batch & continuous, flash vaporization, steam distillation and differential distillation.
- To impart distillation column design using McCabe Thiele and Ponchon-Savarit methods.

**UNIT-I**

Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures, Batch distillation with Reflux.

**UNIT-II**

Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, use of open steam, types of condensers, partial condensers, effect of cold reflux, multiple feeds, tray efficiencies, continuous-contact equipment (packed towers)

Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, types of reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

**UNIT- III**

Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux

Multi stage counter current with reflux, Differential (continuous contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

**UNIT-IV**

Leaching: Fields of applications, preparation of solid for leaching, types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

**UNIT-V**

Adsorption: Adsorption, types of adsorptions, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).

Fluidized and teeter beds, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, pressure swing and vacuum swing adsorption (qualitative treatment), ion-exchange: principles of ion exchange, techniques and applications.

**Text Book:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**Reference Books:**

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc, New York

**3rd Year, 1st Semester**

## 3. CHEMICAL REACTION ENGINEERING – I

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

- To explain the temperature dependency of rate of reaction as per Arrhenius law, Collision theory and Transition State theory.
- To teach how to determine kinetics of a chemical reaction both at constant and variable volume from the experimental data using integral, differential and method of fractional lives.
- To inform how to obtain the rate law for a non-elementary chemical reaction from a given mechanism
- To describe the designing of reactors for conducting homogenous reactions under isothermal conditions.

**UNIT I**

Overview of chemical reaction engineering-classification of reactions, variables affecting the rate of reaction definition of reaction rate, kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

**Interpretation of batch reactor data- constant volume batch reactor**:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

**UNIT II**

**Constant volume batch reactor**– first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions of shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

**UNIT III**

**Introduction to reactor design**- general discussion, symbols and relationship between $C_A$ and $X_A$. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

**Design for single reactions**- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

**UNIT IV**

**Design for parallel reactions**- introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

**Multiple reactions**-Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

**UNIT V**

**Temperature and Pressure effects**- single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

**Course outcomes:**

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

- Derive the rate law for non-elementary chemical reactions based on the specified mechanism.
- Determine kinetics of a chemical reaction from the experimental data using integral, differential and fractional life methods.
- Design reactors for conducting homogenous reactions under isothermal conditions.
- Select suitable contacting patterns or operating conditions for maximizing the selectivity for parallel and series reactions.
- Show conversion as a function of temperature under adiabatic/non-adiabatic conditions.

**TEXT BOOK:**

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely & Sons, 1999.

**REFERENCES:**

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.

**3rd Year, 1st Semester**

## Professional Elective-I

## PE1. PETROLEUM REFINING AND PETROCHEMICALS

| L | T | P | C |
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| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.

- Identify important testing methods for important petroleum products.
- Have idea on Indian standards for major petroleum products

**UNIT-I**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

**UNIT-II**

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

**UNIT-III**

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

**UNIT-IV**

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

**UNIT-V**

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

**Course Outcomes:**

At the end of the course, student will be able to

- Describe the formation of crude oil, its refining techniques.
- Explain about the crude oil distillation and its products.
- Acquire knowledge about catalytic cracking / reforming processes.
- Evaluate the petrochemical feedstock for manufacture of various value-added chemicals.
- Explain the technologies of low carbon alkane and alkynes based high value chemicals.

**TEXT BOOKS:**

1. Nelson. W.L. “Petroleum refining Engineering”, 4 Edition, Mc Graw Hill, New York, 1969.

2. Rao, B.K.B. “Modern Petroleum Refining Processes”, 4 Edition, Oxford and IBH Publishing, 2002.

**REFERENCES:**

1. Goldstine. R.F. “The Petroleum Chemicals Industry”, Taylor and Francis, London, 1967.

2. Gruese. W.S.and Stevens, D.R. “Chemical Technology of Petroleum”, McGraw Hill, 1980.

3 Chauvel. A. and Lefevrev, “Petro Chemicals”, Volume 1 and 2, Gulf Publishing company 1989.

**3rd Year, 1st Semester**

**Professional Elective-I**
**PE2. PROCESS MODELING AND SIMULATION**

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

- Learn to develop mathematical model for problems.
- To impart knowledge on modelling of various equipment and their simulation using different numerical techniques.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

**UNIT I**

**Mathematical models for chemical engineering systems**: classification of mathematical models- steady state vs dynamic models, lumped vs distributed parameter models, deterministic vs stochastic models. **Examples of mathematical models**- Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

**UNIT II**

**Empirical model building**- method of least squares, linear, polynomial and multiple regression, non-Linear regression. **Solution of Non- Linear Algebraic equations**- bisection, false position, Quasi Newton and Newton- Raphson methods.

**UNIT III**

**Numerical integration**- Trapezoidal rule, Simpson's rule and Newton– Cotes formula. **Numerical solution of differential equations**- Euler's method, Runge- Kutta methods, predictor corrector methods.

**UNIT IV**

**Numerical solution of partial differential equations**- elliptic, parabolic and hyperbolic equations. finite difference methods, Leibman's method, Crank Nicholson method. Applications to steady state and Unsteady state heat conduction and temperature distribution problems.

**UNIT V**

**Process Simulation examples**: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.
**Process simulation using modular and equation based solving approaches**: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

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

1. Understand the stages involved in the development of a process model.
2. Formulate a chemical engineering problem as a mathematical model from basic engineering principles.
3. Identify the appropriate numerical solutions used in solving the models
4. Apply various simulation tools for solving the chemical engineering models developed.
5. Understand the solution techniques for solving ODEs.

**Text Books:**

1. Process modelling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

**Reference Books:**

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
1. Process Modeling and Simulation, Amiya K. Jana, 2012.

**3rd Year, 1st Semester**

**Professional Elective-I**

**PE3. NUMERICAL METHODS IN CHEMICAL ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration and numerical differentiation.
- To introduce curve fitting using method of least squares
- To teach different methods to solve ordinary differential equations.
- To explain the importance of numerical methods to solve chemical engineering problems.

**UNIT I**

Elementary row transformations - Rank, Eigen Values, Solution of system of linear equations by Gauss elimination and Gauss Jordan, Gauss Siedel and LU decomposition methods.

**UNIT II**

**Solution of Nonlinear Algebraic Equations**: Introduction, Bisection method, Newton-Raphson, Regula Falsi and Secant method. Chemical engineering problems involving solution of linear and Non-linear algebraic equations.

**UNIT III**

**Regression Analysis**: Introduction, least squares curve-fitting methods, Newton's forward formulae, Newton's backward formulae. Interpolation Polynomial, Lagrangian Interpolation (Unequal Intervals), cubic spline interpolation.

**UNIT IV**

**Numerical differentiation:** Three-point Lagrangian formulae.

**Numerical Integration:** Trapezoidal rule, Simpson's 1/3 and 3/8 rules, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

**UNIT V**

**Solution of ordinary Differential Equations-** Introduction to ordinary Differential Equations, Initial and boundary value problems, Euler method, modified Euler, Runge-Kutta $4^{th}$ order method, Predictor Corrector method, Milne's method, Chemical engineering problems involving single, and a system of ODEs.

**Introduction to Partial Differential Equations**: elliptic, parabolic and hyperbolic equations and their applications in chemical engineering.

**Course Outcomes**

At the end of the course the student will be able to

- Solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Siedel and LU decomposition methods
- Solve linear/nonlinear algebraic and transcendental equations using numerical methods
- Apply cure fitting techniques to approximate a function for the given data
- Evaluate definite integral and derivative (for the given data or function) using numerical methods
- Solve ordinary differential equations by Euler's method, modified Euler's method, Runge Kutta method, Predictor Corrector method and Milne's method.
- Apply numerical methods to different Chemical Engineering problems.

**TEXT BOOK:**

1. Numerical methods for Engineers, S.K. Gupta, New Age International (P) Limited, Publishers, 1998
2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI publisher.

**REFERENCE BOOKS:**


1. Mathematical methods in Chemical Engineering, S. Puspavanam, Prentice Hall of India PHI,1998 ISBN 81-203-1262-7
2. Mathematical methods in Chemical and environmental
3. Engineering, Ajay K. Roy, Thomson Learning, 2000 ISBN 981-240-375-2
4. Engineering Mathematics, Volume - II, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.
5. Engineering Mathematics, Volume - II, by G.S.S.Raju, CENGAGE publisher.
6. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S. Chand publication.
7. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
8. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.


**3rd Year, 1st Semester**

## OPEN ELECTIVE -I

## OE1. MEMBRANE TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

1. Explain the basic principles of membrane separation processes.
2. Describe about the characterization of membrane.
3. Introduce the concepts of polarization, fouling, module and process design
4. Review the membrane modules used for the industrial applications
5. Discuss the preparation of synthetic membranes

**UNIT- I**

**Introduction:** Separation processes, Introduction to membrane processes, definition of a membrane, classification of membranes. Preparation of Synthetic membranes: Types of Membrane materials, preparation of Synthetic membranes,

phase inversion membranes, preparation technique for immersion precipitation, and preparation technique for composite membranes.

**UNIT- II**

**Characterization of membranes;** Introduction, membrane characterization, characterization of porous membranes, characterization of non-porous membranes.

Transport in membranes: introduction, driving forces, non-equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

**UNIT- III**

**Membrane Processes:** Introduction, Osmosis, pressure driven membrane processes: Introduction, microfiltration, membranes for microfiltration, industrial applications, ultrafiltration: membranes for ultrafiltration, industrial applications, reverse Osmosis and nano filtration: membranes for reverse osmosis and nanofiltration, industrial applications, Electrically Driven processes: Introduction, electrodialysis, Process parameters, membranes for electrodialysis, applications, Membrane electrolysis, Bipolar membranes, Fuel Cells.

**UNIT- IV**

Concentration driven membrane processes: gas separation: gas separation in porous and non-porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis: membranes for dialysis, applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors.

**UNIT- V**

Polarization phenomenon and fouling: Introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction. Module and process design: Introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

**Course Outcomes:**

At the end of the course, student will be able to

1. Explain various types of membranes and preparation techniques.
2. Understand the characterization and transport in membranes.
3. Understand the underlined principles and importance of ultrafiltration, reverse osmosis, electro dialysis, nano filtration etc., in industrial waste water treatment.
4. Learn gas separation in porous and non-porous membranes.

**Text Books:**

1. Membrane Separations, M.H.V. Mulder, Springer Publications, 2007
2. Rate-Controlled Separations, P. C. Wanket, Elsevier Applied Science, London,1994.

**Reference Books:**

1. Membrane Technology in the Chemical Industry, S.P. Nunes, K.V. Peinemann, Wiley-VCH
2. Membrane Processes in Separation and Purification, J.G.Crespo, K.W.Bodekes, Kluwer Academic Publications.
3. Membrane Separation Processes, K. Nath, PHI Pvt. Ltd., New Delhi,2008.

**3rd Year, 1st Semester**

## OPEN ELECTIVE-I

## OE2. WATER CONSERVATION AND MANAGEMENT

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-Requisites:** Water resources and Preservation methods

**Course Objectives:**

1. To apply concepts of water resources management and design techniques.
2. To plan and design water harvesting and groundwater recharge structures.
3. To design water supply and sanitation system.

**UNIT I**

Introduction: water cycle, water storage, water quality; water conservation in homes; water conservation in the work place, water resources planning. Water resources systems – irrigation management, water quality management, groundwater management, water conveyance and distribution systems.

**UNIT II**

Design Techniques: Environmental Restoration. Evaluate results of participatory mapping of water resources and challenges, soil and water conservation, conservation through reforestation. Check dams for controlling runoff and plugging gullies.

**UNIT III**

Introduction: concept of watershed, need for watershed management, concept of sustainable development and Hydrology of small watersheds. Principles of water harvesting, methods of rainwater harvesting, design of rainwater harvesting structures. Artificial recharge of groundwater in small watersheds, methods of artificial recharge.

**UNIT IV**

Introduction: Epidemiological aspects of water quality- methods for low-cost water treatment - Specific contaminant removal systems. Water quality monitoring

**UNIT V**

Water Conservation in Industries: Conservation of Water for Cooling, Water Conservation in Pre-treatment Plant, Water Conservation in Softening Plants, Water Conservation in Demineralization Plant, Treatment of Condensate, Treatment and Disposal of wastewater in process industry. Water Recycling and Water Audit.

**Course Outcomes:**

At the end of the course, student will be able to

- Explain water resource planning.
- Prepare water auditing to be able to apply the principles to many situations and make recommendations for water conservation measures.
- Design low-cost water management system.
- Predict water quality and conservation.
- Practice industrial water conservation techniques.

**Text Books:**


1. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008
2. Loucks, D.P. and Eelco van Beek (2005), "Water Resources Systems Planning and Management – An introduction to methods, models and applications", Studies and Reports in Hydrology, UNESCO Publishing


**Reference Books:**


1. Mohan Seneviratne., A Practical Approach to Water Conservation for Commercial and Industrial Facilities, 1st Edition, Elsevier Science, 2007.
2. Jeff Sturman, GoenHo, Kuruvilla Mathew., Water Auditing and Water Conservation, IWA Publishing, 2004.
3. Claude E. Boyd., Water Quality: An Introduction, springer Science & Business Media, 2000.
4. Loucks, D.P., Stedinger, J.R. and Haith, D.A. (1982) "Water Resources Systems Planning and Analysis", Prentice Hall Inc. N York
5. Muthy, J. V. S., Watershed Management, New Age International Publishers, 1998

**3rd Year, 1st Semester**

## OPEN ELECTIVE-I
## OE3. ENERGY ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To acquaint the student with the conventional energy sources and their utilization.
- To understand the importance of heat recovery and energy conservation methods and energy audit

**UNIT -I**

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.

**Coal:** origin, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and by-product recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

**UNIT- II**

**Liquid fuels:** petroleum: origin, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels.

Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus.

**UNIT -III**

**Steam Plant:** Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage.

**UNIT -IV**

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

**Energy conservation:** conservation methods in process industries, theoretical analysis, practical limitations.

**UNIT-V**

**Energy auditing:** short term, medium-term, long-term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

**Course Outcomes:**

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

- Explain conventional energy sources and their utilization requirements with reference to Indian Scenario
- Classify different catalytic Cracking and Reforming processes
- Estimate steam production cost and its quality
- Describe energy production and storage for solar and wind
- Explain heat recovery from processes and effective utilization of waste heat

**Text Books:**

1. Fuels, Furnaces and Refractories, O.P.Gupta
2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

**Reference Books:**

1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers
2. Fuel and Energy, Harker and Backhurst, Academic press London 1981
3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

**3rd Year, 1st Semester**

## 6. INSTRUMENTATTION AND PROCESS CONTROL

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Pre Requisites:** Mathematics-II

**Course Objectives:**

1. Describe the various elements of instruments, measurement of temperature, pressure and level in process industries.
2. Define the basics of process control and develop transfer function models for dynamic processes.
3. Draw the block diagrams and analyze process stability

**UNIT- I**

Elements of instruments, static and dynamic characteristics, basic concepts of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer. Industrial thermocouples, thermocouple wires, thermo couple wells. Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level

measurements in pressure vessels. Pressure vacuum and head: liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids.

**UNIT- II**

**Introduction to process dynamics and control:** Laplace transforms, Inverse Laplace transform, Response of First Order Systems. Physical examples of first order systems- Liquid level, mixing process, R- C circuit. Linearization.
Response of first order systems in series- interacting and non- interacting systems, second order systems, transportation lag.

**UNIT- III**

**Control system:** Components of a control system, Servo Vs regulator problem, development of block diagram. **Controllers and final control elements:** Control valve and its construction, PD, PI, PID controllers. **Stability**: Concept of Stability, Stability criterion, Routh test for stability.

**UNIT- IV**

**Root locus**: concept of root locus, rules for plotting the root locus diagram.
**Introduction to frequency response**: Substitution rule, Bode diagrams
**Control systems design by frequency response**: Bode stability criterion, Gain and Phase margins.

**UNIT- V**

**Controller tuning**: Tuning of P, PD, PI, PID controllers, Ziegler- Nichols technique, Cohen and Coon rules.
**Advanced control strategies:** Cascade control, feed forward control, ratio control, Smith predictor.

**Text Books:**

1. Industrial instrumentation by Donald P. Eckman, Wiley eastern, 1950.
2. Process Systems Analysis and Control, 2nd ed., D.R. Coughanowr, McGraw-Hill, 1991

**Reference Books:**

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010
2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

## Course Outcomes:

At the end of the course, student will be able to

1. Illustrate the various instruments for measuring various process variables such as temperature, pressure, flow.
2. Evaluate the transfer functions for various first order and second order examples.
3. Explain the various types of controllers using block diagram along with the concept of stability.
4. Analyze in more detail the stability criteria using various methods.
5. Explain about the various controller tuning techniques.

**3rd Year, 1st Semester**

## 7. REASERCH METHODOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

**Course Objectives:** The objective of this course is

1. To understand the basic concepts of research and research problem
2. To make the students learn about various types of data collection and sampling design
3. To enable them to know the method of statistical evaluation
4. To make the students understand various testing tools in research
5. To make the student learn how to write a research report
6. To create awareness on ethical issues n research

**UNIT I**

**Introduction to Research**

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – Research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of research and its process
- Explain various types of research
- Know the steps involved in research design
- Understand the different research approaches

**UNIT II**

**Sampling Design**

Steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design. Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation. Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of sampling and sampling design

- Explain various techniques in measurement and scaling
- Learn various methods of data collection
- Design survey questionnaires for different kinds of research

**UNIT III**

**Correlation and Regression Analysis**

Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

**LEARNING OUTCOMES: -** After completion of this unit student will

- Know the association of two variables
- Understand the importance of correlation and regression
- Compare and contrast correlation and regression
- Learn various types of correlation
- Apply the knowledge of C&R Analysis to get the results

**UNIT IV**

**Statistical Inference**

Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multivariate Analysis

**LEARNING OUTCOMES: -** After completion of this unit student will

- Know the statistical inference
- Understand the hypothesis testing procedure
- Compare and contrast Parametric and Non-parametric Tests
- Understand the use of chi-square test in investigating the distribution of categorical variables
- Analyze the significance of variance and covariance

**UNIT V Report Writing and Professional Ethics**

Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Learn about report writing
- Understand how to write research paper
- Explain various techniques of interpretation
- Understand the importance of professional ethics in research
- Design a scientific paper to present in the conferences/seminars

**Text Books:**

1. Research Methodology: Methods and Techniques – C.R.Kothari, 2nd Edition, New Age International Publishers.
2. Research Methodology: A Step by Step Guide for Beginners- Ranjit Kumar, Sage Publications

**REFERENCES:**

1. Research Methodology and Statistical Tools – P.Narayana Reddy and G.V.R.K.Acharyulu, 1st Edition, Excel Books, New Delhi.
2. Business Research Methods–Donald R. Cooper & Pamela S Schindler, 9/e,
3. S C Gupta, Fundamentals of Statistics,7th Edition Himalaya Publications

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the basic concepts and its methodologies |
| CO2 | Understand the concept of sampling, research design etc. |
| CO3 | Demonstrate the knowledge of research processes |
| CO4 | Analyze the importance of research articles in their academic discipline |

| | |
|---|---|
| CO5 | Select appropriate testing tools used in research |
| CO6 | Design a research paper without any ethical issues |

**3rd Year, 1st Semester**

## 8. MASS TRANSFER OPERATIONS LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Laboratory Experiments:**

1. Estimation of diffusivity coefficients for vapor in gas
2. Estimation of solid diffusion coefficient in air
3. Steam distillation
4. Simple distillation
5. Evaluation of HETP in packed towers
6. Vapor Liquid Equilibria
7. Batch Drying

8. Evaluation of Mass transfer coefficients for Surface Evaporation
9. Evaluation of Mass transfer coefficients for Wetted wall column
10. Liquid- Liquid Equilibria (Tie line data)
11. Ternary Liquid Equilibria (binodal curve)
12. Leaching
13. Adsorption studies

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**REFERENCE:**

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York
4. Mass transfer operations Laboratory manual by Mr.M.kalyan kumar, lambert publications, June 2019.

**Course outcomes:**

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

- Analyse different types of distillation such as: batch & continuous, flash vaporization, steam distillation and differential distillation.
- Design distillation columns using McCabe Thiele and Ponchon-Savarit methods.
- Demonstrate Azeotropic distillation, extractive distillation and ion exchange.
- Explain types of adsorptions, nature of adsorbents, adsorption equilibrium, Adsorption

**3rd Year, 1st Semester**

## 9. INSTRUMENTATION AND PROCESS CONTROL LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Pre Requisites:** Instrumentation and Process Control

**Course Objectives:**

1. Study about process dynamics and various forms of mathematical models to express them
2. Determine the time lag for first and second order systems.
3. Emphasize theoretical concepts of open and close loop runs on liquid level and liquid temperature.

**List of Experiments:**

1.Calibration and determination of time lag of various first and second order instruments

Major equipment - First order instrument like Mercury-in-Glass thermometer and Overall second order instrument like Mercury-in-Glass thermometer in a thermal well

2. Experiments with single tank system.
   Single tank - Step Response
   Single tank - Impulse Response

3. Experiments with two tank system with interaction.
   Interacting Tanks – Step Response
   Interacting Tanks – Impulse Response

4.Experiments with two tank system without interaction.

Non Interacting Tanks – Step Response

Non Interacting Tanks – Impulse Response

5. Level control trainer

Major equipment - Level control trainer set up with computer

6. Temperature control trainer

Major equipment - Temperature control trainer with computer

7. Experiments on proportional, reset, rate mode of control etc.

Major equipment – PID control apparatus

8. Control valve characteristics

Major equipment – Control valve set up

9. Estimation of damping coefficient for U-tube manometer

Major equipment - U-tube manometer.

**Course Outcomes:**

At the end of the course, student will be able to

1. Calculate the time lag for first and second order systems.
2. Compare and contrast the response for interacting and non-interacting systems.
3. Compare the open and closed loop systems.
4. Evaluate the controller actions for level and temperature control for a given process.
5. Compare the different types of controllers.

**3rd Year, 1st Semester**

## 10. SOCIALLY RELAVANT PROJECT

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0.5 | 0.5 |

**3rd Year, 2nd Semester**

## 1. CHEMICAL REACTION ENGINEERING – II

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

- Learn the importance of RTD and the compartmental models for modelling of Non-ideal flow reacting vessels.
- Calculate the conversions based on segregated flow model, dispersion model and tanks-in-series models.
- Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

**UNIT I**

**Basics of non-ideal flow**: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).

**The dispersion model**: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

**UNIT II**

**The tanks in series model**: pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors

**Earliness of mixing, segregation and RTD**: self-mixing of a single fluid, mixing of two miscible fluids.

**UNIT III**

**Catalysis and Catalytic reactors**: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step.

**Heterogeneous reactions**: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

**UNIT IV**

Solid catalyzed reactions- Experimental methods for finding rates. Deactivating catalysts- mechanisms of catalyst deactivation, the rate and performance equations.

**UNIT V**

**Fluid-fluid reactions**: kinetics- the rate equation.

**Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

**Course Outcomes:**

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

1. Modeling of compartmental models for Non-ideal flow reacting vessels
2. Calculation of conversions based on various models
3. Students can design the fluid-solid reactors.

**Text Books:**

2. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999.
2. Elements of Chemical Reaction Engineering, 4th ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

**Reference Books:**

1. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

**3rd Year, 2nd Semester**

## 2. CHEMICAL PROCESS EQUIPMENT DESIGN

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**OBJECTIVES:**

- Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
- Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books.
- Learn the fabrication techniques and testing methods.
- Learn design and engineering skills directly applied in design, installation and commissioning of equipments.

**UNIT-I**

Basic Considerations in Process Equipment Design: Introduction, general design procedure, fabrication techniques, equipment classification, power for rotational motion, drives for process equipment Materials of Construction: Mechanical properties, materials, corrosion, corrosion prevention, choice of material.

**UNIT-II**

Design Considerations: Introduction, stress created due to static and dynamic loads, design stress, combined stresses and theories of failure, fatigue, brittle fracture, creep, effects of temperature, radiation and fabrication methods. Process Hazards and Safety Mechanisms in Equipment Design: Introduction, hazards in process industries, safety measures, safety measures in equipment design, pressure relief devices.

**UNIT-III**

Material Handling Equipment Design: Piping in fluid transportation process-selection of piping material, design of piping system, pumping of fluids: selection of pumps, design procedures for pumps, compression and expansion of fluids: selection of compressors, fans and blowers, vacuum system equipment, turbines and expanders, design procedures for compressors, turbines and expanders Heat Transfer Equipment Design: Selection of heat exchangers types- key heat

exchanger types available, preliminary selection of heat exchanger types, Design of key heat exchanger types- Double pipe and multiple double pipe exchangers, shell and tube heat exchangers, plate exchangers, compact exchangers, air cooled exchangers.

**UNIT-IV**

Separation Equipment Design: Distillation design procedures for columns with sieve trays, with random packing, with structural packing, Absorption and Stripping design procedures for trayed columns, packed columns separating dilute solutions Equipment Selection for liquid-liquid extraction: Design procedure for liquid-liquid extraction, selection of sorbent for separation by adsorption, basic adsorption cycles, selection of appropriate adsorption cycles, general design for separation by adsorption

**UNIT-V**

Pressure Vessels: Introduction, operating condition, pressure vessel codes, selection of materials, vessels operating at low temperatures and elevated temperatures, Design conditions and stresses. Design of shell and its components, Fabrication, Inspection and Tests.

**TEXT BOOKS:**


1. Joshi‘s Process Equipment Design, Fourth Edition by V. V. Mahajani and S. B. Umarji, Macmillan Publishers India Ltd., 2009.
2. Plant Design and Economics for Chemical Engineers, Fifth Edition by Max. S. Peters, Klans Timmerhaus and Ronald E. West, Mc GrawHill International Edition, 2004.


**REFERENCE BOOKS:**


1. Coulson J.M. and Richardson J.F., Chemical Engineering Vol.VI (An introduction to Chemical Engineering Design), Pergamon Press, 1993. Outcome: The student will be able to do 1. Mechanical design of pressure vessels
2. Process design of separation equipments for distillation, absorption, stripping, liquid-liquid extraction, adsorption
3. Selection of piping materials, pumps, compressors, compressors, fans and blowers, vacuum system equipment, turbines and expanders
4. Design of material handling equipment like piping system, pumps, compressors, turbines and expanders

## 3. ENGLISH LANGUAGE SKILLS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To develop awareness in students of the relevance and importance of technical communication and presentation skills.
2. To prepare the students for placements
3. To train students to use language appropriately for presentations and interviews
4. To enhance the documentation skills of the students with emphasis on formal and informal writing

**UNIT 1**

**LSRW SKILLS**

**Introduction to LSRW Skills – Definition – Importance of LSRW Skills - Advantages and Disadvantages of Oral and Written Skills – Advantages and disadvantages of Written & Speaking skills - Barriers to effective communication**

| OUTCOMES |
|---|
| To recall and memorize the basic concepts of LSRW skills |
| To understand the various components of oral and written skills |
| To apply English language skills to avoid barriers to effective communication |

**UNIT II**

**VERBAL & NON-VERBAL SKILLS**

**Informal and Formal Conversation - Non-verbal Skills–Kinesics, Proxemics, Chronemics, Haptics, Oculesics, Paralinguistic features – Body language for interviews**

| |
|---|
| To understand the basic components of non-verbal communication. |
| To apply the knowledge of the difference between informal and formal conversation in order to meet the demands of work place environment. |
| To analyze non-verbal interpretations in multicultural context. |

**UNIT III**

**ACADEMIC WRITING SKILLS**

**Writing Skills–Art of condensation- summarizing and paraphrasing - Abstract Writing, Synopsis Writing – Formal Letter Writing - Report Writing**

| |
|---|
| To understand the basic components of written communication. |
| To apply knowledge of different formats of written communication needed in work place environment. |
| To analyze the structure of letters, reports etc. |

**UNIT IV**

**CREATIVE WRITING SKILLS**

**Film Review Writing – Creative Writing- Short Story Writing – Speeches for academic settings – Writing Skits – Script for Short Films/Web Series**

| |
|---|
| To apply writing skills in creative writing to meet the demands of documentation in professional life |
| To analyze different figures of speech in creative writing |
| To evaluate different aspects creative and academic writing to become effective at written communication |

**UNIT V**

**PROFESSIONAL SPEAKING SKILLS**

**Job Interviews –Types of Job Interviews – Characteristics of a job interview - Interview Preparation Techniques –How to overcome Stage fright**
**Group Discussions(GD): Importance of Group Discussion- Characteristics of a GD - GD as a tool for selection – GD Strategies – Do's & Don't of GD - GD Vs Debates**

| |
|---|
| To analyze the different aspects of interviews and group discussions |
| To evaluate the group dynamics to excel in group discussions |
| To design and develop strategies to answer effectively in interviews |

**Text Books:**


1. **Effective Technical Communication,** Ashrif Rizvi, TataMcGrahill, 2011
2. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma,3rd Edition, O U Press 2015


**Reference Books:**


1. **Communication Skills by Pushpalatha& Sanjay Kumar, Oxford Univsesity Press**
2. Books on **TOEFL/GRE/GMAT/CAT/IELTS** by Barron's/DELTA/Cambridge University Press.2012.
3. **Soft Skills for Everyone,** Butterfield Jeff, Cengage Publications, 2011.
4. **Management Shapers Series** by Universities Press (India) Pvt Ltd., Himayatnagar, Hyderabad 2008.
5. **Successful Presentations** by John Hughes & Andrew Mallett, Oxford.
6. **Winning at Interviews** by Edgar Thorpe and Showick Thorpe, Pearson
7. Winning Resumes and Successful Interviews by Munish Bhargava, Mc Graw Hill


WEB LINKS

1. **https://blog.allaboutlearningpress.com/listening-comprehension/**
2. **https://www.englishclub.com/**
3. **https://www.helpguide.org/articles/relationships-communication/nonverbal-communication.htm**
4. **https://www.slideshare.net/poojavrs/lsrw-109040479**
5. https://www.slideshare.net/nandapalit/non-verbal-verbal-communication

**3rd Year, 2nd Semester**

## PROFESSIONAL ELECTIVE-II

## PE1. CHEMICAL PLANT DESIGN AND ECONOMICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

**UNIT I**

Introduction, Process Design development. General design considerations, Cost and asset accounting. Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

**UNIT II**

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

**UNIT III**

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self-insurance.

Depreciation: types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

**UNIT IV**

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period, alternative investments, analysis with small investments, increments and replacements.

**UNIT V**

Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

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

1. Explain the design considerations, cash flow and various costs involved in process Industries
2. Calculate different types of interest & Predict the Present worth and annuities
3. Explain types of taxes and Solve problems on depreciation using various methods
4. Analyze alternative investments, pay out period for an investment and rate of return
5. Solve linear programming problems (LPP) by graphical and algebraic methods

**Text Book:**
1. Plant Design and Economics for Chemical Engineering, 4th ed., M.S. Peters and K.D. Timmermans, McGraw-Hill,1991

**Reference Books:**
1. Process Engineering Economics, Schweyer, McGraw-Hill, 2002

**Course Outcomes:**

- Estimate various costs involved in a process industry and evaluate the tax burden of an establishment
- They will be ready with tools to estimate profitability of a company
- Find the replacement costs of an equipment and select best one from different alternatives
- Compute break even period for an investment and rate of return

**3rd Year, 2nd Semester**

**PROFESSIONAL ELECTIVE-II**

**PE2. POLYMER SCIENCE AND ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**
To enable the students

1. To compute molecular weight averages from the molecular weight distribution
2. Condensation polymerization and transition in polymers

**UNIT I**

Introduction; definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

**UNIT II**

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.
Mechanism and kinetics of: Addition or chain polymerization
a) Free radical addition polymerization b) Ionic addition polymerizations
c) Coordination polymerization d) Coordination or step growth or condensation polymerization.

**UNIT III**

Methods of polymerization: mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

**UNIT IV**

Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv) Antioxidants and UV stabilizers v) Blowing agents vi) Coupling agents vii) Flame retardants viii) Inhibitors
Brief description of manufacture, properties and uses of: i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene v) Polytetrafluoroethylene vi) Polymethyl methacrylate vii) Polyvinyl acetate & Polyvinyl alcohol.

**UNIT V**

Brief description of manufacture, properties and uses of: i) Polyesters (Polyethylene terephthalate polycarbonate and unsaturated polyesters) ii) Nylon(Nylon 66) iii) Phenol- Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones
Compounding of polymer resins, brief description of: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

**Course Outcomes:**

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

1. Classify the polymers and also able to identify the structural configurations of any polymer
2. Distinguish the modification of a polymer and also in a position to examine the mechanism of a polymerization
3. Synthesize any elastomer and optimize their deformation properties on applying force
4. Explain the processing of polymer, identify the mode of deformation of a polymer and test the mechanical strength of a polymer

**Text Books:**

1. Polymer Science & Technology, 2nd ed., J.R. Fried, PHI Learning Pvt. Ltd., New Delhi, 2009
2. Plastic materials, J.A. Brydson, Newnes-Butterworth (London) 1989.

**References Books:**

1. Text book of polymer science, F.W.Jr. Bill Meyer, (3rd ed.) John Wiely&sons 1984
2. Introduction to Plastics, J.H. Brison and C.C. Gosselin, Newnes-Butterworth, London 1968.

**3rd Year, 2nd Semester**

## PROFESSIONAL ELECTIVE-II
## PE3. FOOD PROCESSING TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**
To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation.

**UNIT I**
**Food process engineering - Fundamentals**: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

**UNIT II**
**Unit Operations in food industries**: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.
**UNIT III**
**Microwave heating:** Theory of microwave heating, microwave properties of foods, comparison of microwave and conventional heating, benefits of microwave heating, applications in food processing, microwave heating equipment, hazards of microwave heating.
**UNIT IV**
**Mechanical Operations in food processing**: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

**UNIT V**

**Preservation operations:** Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilization Types Pasteurization Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

**Course Outcomes:**

1. Understanding the various causes of food deterioration and food poisoning.
2. Identification of appropriate processing, preservation, and packaging method.
3. Analyze product quality and effect of processing technique on it.

**Text Books**


1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
2. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press, 1989.
3. Fundamentals of Food Engineering, D G Rao, PHI, New Delhi, 2012.

**Reference Books**


1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food Engineering Operations", 2nd Edn., Applied Science, 1976.


**3rd Year, 2nd Semester**

**OPEN ELECTIVE-II**

**OE1. INDUSTRIAL SAFETY AND HAZARDOUS MANAGEMENT**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Have awareness of different hazards in process industries
- Classification of hazards and their identifications
- Precautions in chemical storage and handling
- Learn risk analysis techniques and quantify them

**UNIT I**

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high-cost accidents, reasons for high priority towards safety.

**UNIT II**

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

**UNIT III**

Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

**UNIT IV**

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

**UNIT V**

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

**Course Outcomes**

1. Understand how thorough safety is ensured in an organization.
2. Classify and identify hazards in chemical industries
3. Take precautions in chemical storage and handling
4. Perform fault tree and event tree risk analysis and quantify them
5. Suggest emergency management plans

**Text Book:**

1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl

**Reference Books:**

1. Chemical process safety by Sanders, 6th Ed.,

**3rd Year, 2nd Semester**

## OPEN ELECTIVE -II
## OE2. GREEN TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT I**

**An introduction to environmental issues**: Role of chemical processes and chemical products, Global environmental issues, Air and water quality issues, Ecology.

**Risk concept**: Description of risk, Risk assessment concept, Dose-response, Exposure assessment.

**UNIT II**

**Evaluating exposures:** Occupational exposures: recognition, evaluation, control,

Exposure assessment for chemicals in the ambient environment, Designing safer chemicals.

**Green chemistry**: Green chemistry methodologies, Optimization based frameworks for the design of green chemical synthesis pathway.

**UNIT III**

**Evaluating environmental fate:** Chemical and physical property estimation, Estimating environmental persistence, Estimating ecosystem risk, Classifying environmental risk based on chemical structure.

**UNIT IV**

**Life-cycle concepts**: Life-cycle assessment, Life-cycle impact assessment

**UNIT V**

Material flows in chemical manufacturing, Assessing opportunities for waste exchanges and by-product synergies.

**Text Book**

1. Shonnard, D. Allen, D. Green Engineering: Environmentally Conscious Design of Chemical Processes.

**3rd Year, 2nd Semester**

## OPEN ELECTIVE -II
## OE3. NUCLEAR ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT-1**

**Introduction:** Motivation for Nuclear Energy, India's Nuclear Power Program

**Nuclear Physics:** Nuclear model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half life - Neutron interactions - Cross sections.

**UNIT-II**

**Nuclear Reactions and Reactor Materials**

Mechanism of nuclear fission and fusion - Radio activity - Chain reactions - Critical mass and composition - nuclear fuel cycles and its characteristics - Uranium production and purification - Zirconium, thorium, beryllium.

**UNIT-III**

**Reprocessing**

Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

**UNIT-IV**

**Nuclear Reactors**

Reactors - Types of fast breeding reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding.

**UNIT-V**

**Safety, Disposal and Proliferation**

Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

**Text Book**s:

1. Thomas J.Cannoly, " Fundamentals of Nuclear Engineering ", John Wiley (1978).
2. G,Vaidyanathan," Nuclear Reactor Engineering", Chand Publishers, 2013

**Reference Books**:

1. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
2. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
3. Lipschutz R.D. " Radioactive Waste - Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.

**3rd Year, 2nd Semester**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| **19A65401** | **MANAGERIAL ECONOMICSAND FINANCIAL ANALYSIS(HS-I)** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES:**The objective of this course is | |
|---|---|
| 1 | To inculcate the basic knowledge of micro economics and financial accounting |
| 2 | To make the students learn how demand is estimated for different products, input-outputrelationship for optimizing production and cost |
| 3 | To know the various types of Market Structures & pricing methods and its strategies |
| 4 | To give an overview on investment appraisal methods to promote the students to learnhow to plan long-term investment decisions. |
| 5 | To provide fundamental skills on Accounting and to explain the process of preparingFinancial statements |

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the concepts related to Managerial Economics, financial accounting andmanagement. |
| CO2 | Understand the fundamentals of Economics viz., Demand, Production, cost, revenueand markets |
| CO3 | Apply the concepts of production, cost and revenues for effective business decisions |
| CO4 | Analyze how to invest their capital and maximize returns |
| CO5 | Evaluate the capital budgeting techniques |
| CO6 | Develop theaccounting statements and evaluate the financial performance of businessentity. |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 3 | | | | | | | | | |
| CO2 | | | | | | | | | 3 | | | | | | |
| CO3 | | | | | | | | | | | | 3 | | | |
| CO4 | | | | | | | | | 3 | | | | | | |
| CO5 | | | | | | | | | 3 | | | | | | |
| CO6 | | | | | | | | | 3 | | | 3 | | | |

**SYLLABUS**

**UNIT-I:Managerial Economics**

Introduction – Nature, meaning, significance, functions and advantages. Demand-Concept, Function, Law of Demand - DemandElasticity- Types – Measurement. Demand Forecasting- Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

State the Nature of Managerial Economics and its importance

- Understand the concept of demand andits determinants
- Analyze the Elasticity and degree of elasticity
- EvaluateDemand forecasting methods
- Design the process of demand estimation for different types of demand

**UNIT-II: Production and Cost Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least-cost combination– Shortrun and longrun Production Function- Isoquants andIsocosts, MRTS - Cobb-Douglas Production Function - Laws of Returns - Internal and External Economies of scale. Cost&Break-Even Analysis - Cost concepts and Cost behavior- Break-Even Analysis (BEA) -Determination of Break-Even Point (Simple Problems)-Managerial significance and limitations of Break-Even Analysis.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Define the production function, Input-Output relationship and different cost concepts
- Apply the least-cost combination of inputs
- Analyze the behavior of various cost concepts
- Evaluate BEA for real time business decisions
- Develop profit appropriation for different levels of business activity

**UNIT-III: Business Organizations and Markets**

Introduction – Nature, meaning, significance, functions and advantages.Forms of Business Organizations-Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises.Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition – Monopoly-Monopolistic Competition– Oligopoly-Price-Output Determination - Pricing Methods and Strategies.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Explain the structure of markets, features of different markets and forms of businessorganizations
- Apply the price output relationship in different markets
- Analyze the optimum output levels to maximize profit in different markets
- Evaluate price-output relationship to optimize cost,revenue and profit

**UNIT- IV:Capital Budgeting**

Introduction – Nature, meaning, significance, functions and advantages. Typesof Working Capital,Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals,Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Explain the concept of capital budgeting and its importance in business
- Contrast and compare different investment appraisal methods
- Analyze the process of selection of investment alternatives using different appraisal methods
- Evaluate methods of capital budgeting for investment decision making and for maximizingreturns
- Design different investment appraisals and make wise investments

**UNIT-V: Financial Accounting and Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Concepts and Conventions-Double-Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). ***Financial Analysis*** **-** Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Discuss the concept,convention and significance of accounting
- Apply the fundamental knowledge of accounting while posting the journal entries
- Analyze the process and preparation of final accounts and financial ratios
- Evaluate the financial performance of an enterprise by using financial statements

**Text Books:**


1. Varshney&Maheswari: Managerial Economics, Sultan Chand, 2013.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH, 2019

**References:**


1. Ahuja Hl Managerial economics Schand,3/e,2013
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International, 2013.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage, 2013.


**Data Books Required:**

Present Value Factors table

**3rd Year, 2nd Semester**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 19A65402 | ENTREPRENEURSHIP& INCUBATION (HS-I) | 3 | 0 | 0 | 3 |

| COURSE OBJECTIVES:The objective of this course is | |
|---|---|
| 1 | To make the student understand about Entrepreneurship |
| 2 | To enable the student in knowing various sources of generating new ideas insetting up ofnew enterprise |
| 3 | To facilitate the student in knowing various sources of finance in starting upof a business |
| 4 | To impart knowledge about various government sources which provide financial assistance to entrepreneurs/ women entrepreneurs |
| 5 | To encourage the student in creating and designing business plans |

| COURSE OUTCOMES: At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Concepts related to the Entrepreneurship and Incubators |
| CO2 | Understand the concept of Entrepreneurship and challenges in the world of competition. |
| CO3 | Apply the Knowledge in generating ideas for New Ventures. |
| CO4 | Analyze various sources of finance and subsidies to entrepreneur/women Entrepreneurs. |
| CO5 | Evaluate the role of central government and state government in promoting Entrepreneurship. |
| CO6 | Create and design business plan structure through incubations. |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 3 | | | | | | | | | |
| CO2 | | 1 | | | | 2 | | | 3 | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | | 2 | | | | 1 | | | | | | 3 | | | |
| **CO4** | | 1 | | | | | | | 3 | | | | | | |
| **CO5** | | 3 | | | | | | | 3 | | | | | | |
| **CO6** | | | | | | | 1 | | 3 | | | 3 | | | |

**Syllabus**

**UNIT-I: Entrepreneurship**

Introduction-Nature, meaning, significance, functions and advantages. concept, characteristics- knowledge and skills requirement - process - Factors supporting entrepreneurship - Differences between Entrepreneur and Intrapreneur - entrepreneurial mindset and personality - Recent trends.

**LEARNING OUTCOMES**

At the end if the Unit, the learners will be able to

- Understand theconcept of Entrepreneur and Entrepreneurship in India
- Analyzerecent trends in Entrepreneurship across the globe
- Develop a creative mind set and personality in starting a business.

**UNIT-II: Women Entrepreneurship**

Introduction – Nature, meaning, significance, functions and advantages. Growth of women entrepreneurship in India. - Issues & Challenges - Entrepreneurial motivations.Entrepreneurship Development and Government. Role, of Central and State Government - incentives, subsidies and grants – Export-oriented Units - Fiscal and Tax concessions.

**LEARNING OUTCOMES**

At the end of the Unit, the learners will be able to

- Understand the role of government in promoting women entrepreneurship
- Analyze the role of export-oriented units
- Evaluate the tax concessions available for Women entrepreneurs

**UNIT-III:Product Development**

Introduction – Nature, meaning, significance, functions and advantages. Startup Initiatives - Generating business/ Service idea – Sources and methods –Identifying opportunities - Feasibility study - Market feasibility, technical/operational feasibility, Financial feasibility. Developing business plan, Preparing project report, Presenting business plan to investors.

## LEARNING OUTCOMES

At the end if the Unit, the learners will be able to

- Analyze the sources of new methods in generating business idea
- Evaluate market feasibility, financial feasibility and technical feasibility
- Design and draw business plansin project preparation and prepare project reports

## UNIT-IV:Startups

Introduction – Nature, meaning, significance, functions and advantages. Fundamentals of Business Incubation - Principles and good practices of business incubation- Process of business incubation and the business incubator and how they operate and influence theType/benefits of incubators - Corporate/educational / institutional incubators - Broader business incubation environment - Pre- Incubation and Post - Incubation process - Idea lab, Business plan structure -Value proposition **LEARNING OUTCOMES**

At the end of the Unit, the learners will be able to:

- Understand the importance of business incubation
- Apply brilliant ideas in the process of business incubation
- Analyze the process of business incubation/incubators.
- Design their own business incubation/incubators as viable-business unit.

## UNIT-V: Finance

Introduction – Nature, meaning, significance, functions and advantages. Sources - Long term and Short term - Institutional Finance – Commercial Banks, SFC's and NBFC's in India, Role in small and medium business - Entrepreneurship development programs in India - The entrepreneurial journey- Institutions supporting entrepreneurship development.

## LEARNING OUTCOMES

At the end of the Unit, the learners will be able to

- Understand the various sources of finance in Starting the new venture
- Analyze the role of banks and other financial institutions in promoting entrepreneurshipin India
- Evaluatethe need and importance of MSMEs in the growth of country

## TEXT BOOKS

1. D F Kuratko and T V Rao, **Entrepreneurship** - A South-Asian Perspective – Cengage Learning, 2012. (For PPT,

Case Solutions Faculty may visit :login.cengage.com) 2 .Nandan H, Fundamentals of Entrepreneurship, PHI, 2013

## REFERENCES


1. Vasant Desai,Small Scale Industries and Entrepreneurship, HimalayaPublishing 2012.
2. Rajeev Roy Entrepreneurship, 2nd Edition, Oxford, 2012.
3.B.JanakiramandM.Rizwana‖ Entrepreneurship Development: Text & Cases, Excel Books, 2011.
4.Stuart Read, Effectual Entrepreneurship, Routledge, 2013.


### E-RESOURCES

1. Entrepreneurship-Through-the-Lens-of-enture Capital
2.http://www.onlinevideolecture.com/?course=mba-programs&subject=entrepreneurship
3.http://nptel.ac.in/courses/122106032/Pdf/7_4.pd
4.http://freevideolectures.com/Course/3514/Economics-/-Management-/-Entrepreneurhip/50

**(Elective-I -VI SEMESTER)**
**(w.e.f Academic Year 2019-20)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **BUSINESS ETHICS AND CORPORATE GOVERNANCE** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES :** The objectives of this course are | |
|---|---|
| 1 | To make the student understand the principles of business ethics |
| 2 | To enable them in knowing the ethics in management |
| 3 | To facilitate the student's role in corporate culture |
| 4 | To impart knowledge about the fair-trade practices |
| 5 | To encourage the student in creating knowing about the corporate governance |

## UNIT-I: ETHICS

Introduction – Meaning – Nature, Scope, significance, Loyalty, and ethical behavior - Value systems - Business Ethics, Types, Characteristics, Factors, Contradictions and Ethical Practices in Management- Corporate Social Responsibility – Issues of Management – Crisis Management.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the meaning of loyalty and ethical Behavior
- Explain various types of Ethics
- Analyze the corporate social responsibility of management

## UNIT-II: ETHICS IN MANAGEMENT

Introduction Ethics in production, finance, ,Human Resource Management and, Marketing ,Management - Technology Ethics and Professional ethics - The Ethical Value System – Universalism, Utilitarianism, Distributive Justice, Social Contracts, Individual Freedom of Choice, Professional Codes; Culture and Ethics – Ethical Values in different Cultures, Culture and Individual Ethics.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the meaning of Marketing Ethics

- Compare and contrast technical ethics and professional ethics
- Develop ethical values

**UNIT-III: CORPORATE CULTURE**

Introduction, Meaning, definition, Nature, Scope, Functions, and significance – Cross cultural issues in Ethics - - Emotional Honesty – Virtue of humility – Promote happiness – karma yoga – proactive – flexibility and purity of mind. The Ethical Value System – Universalism, Utilitarianism, Distributive Justice, Social Contracts, Individual Freedom of Choice, Professional Codes; Culture and Ethics – Ethical Values in different Cultures, Culture and Individual Ethics.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Define Universalism Utilitarianism, Distributive
- Understand the corporate culture in business
- Analyze Ethical Value System Ethical Values in different Cultures

**UNIT- IV: LEGAL FRAME WORK**

Law and Ethics, Agencies enforcing Ethical Business Behavior, Legal Impact– Environmental Protection, Fair Trade Practices, legal Compliances, Safeguarding Health and wellbeing of Customers.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand Law and Ethics
- Analyze Different fair-trade practices
- Make use of Environmental Protection and Fair-Trade Practices

**UNIT -V : CORPORATE GOVERNANCE**

Introduction, meaning – scope Nature - Issues, need, corporate governance code, transparency & disclosure, role of auditors, board of directors and shareholders. Global issues, accounting and regulatory frame work, corporate scams, committees in India and abroad, corporate social responsibility. of BODs composition, Cadbury Committee - various committees - reports - Benefits and Limitations.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand corporate governance code
- Analyze role of auditors, board of directors and shareholders in corporate governance
- Implementing corporate social responsibility in India.

**Text books.**

1. Murthy CSV: Business Ethics and Corporate Governance, HPH

2. Bholananth Dutta, S.K. Podder – Corporation Governance, VBH.

**Reference books**

1. Dr. K. Nirmala, Karunakara Readdy : Business Ethics and Corporate Governance, HPH

2. H.R.Machiraju: Corporate Governance

3. K. Venkataramana, Corporate Governance, SHBP.

4. N.M.Khandelwal : Indian Ethos and Values for Managers

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Ethics and Types of Ethics. |
| CO2 | Understand business ethics and ethical practices in management |
| CO3 | Understand the role of ethics in management |
| CO4 | Apply the knowledge in cross cultural ethics |
| CO5 | Analyze law and ethics |
| CO6 | Evaluate corporate governance |

**3rd Year, 2nd Semester**

## 7. CONSTITUTION OF INDIA

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:** The objective of this course is

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and Election Commission of India.
5. To understand the central-state relation in financial and administrative control

**UNIT-I**

**Introduction to Indian Constitution**

Constitution -Meaning of the term - Indian Constitution- Sources and constitutional history - Features– Citizenship – Preamble - Fundamental Rights and Duties - Directive Principles of State Policy.

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History and features of Indian constitution
- Learn about Preamble, Fundamental Rights and Duties

**UNIT-II**

**Union Government and its Administration**

Structure of the Indian Union - Federalism - Centre-State relationship – President's Role, power and position - PM and Council of ministers - Cabinet and Central Secretariat –Lok Sabha - Rajya Sabha - The Supreme Court and High Court - Powers and Functions

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

**UNIT-III**

**State Government and its Administration**

Structure of the State Govt. - Governor - Role and Position -CM and Council of Ministers - State Secretariat- Organization Structure and Functions

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the structure of state government
- Analyze the role of Governor and Chief Minister
- Explain the role of State Secretariat
- Differentiate between structure and functions of state secretariat

**UNIT-IV**

**Local Administration**

District's Administration Head - Role and Importance - Municipalities - Mayor and role of Elected Representatives -CEO of Municipal Corporation Panchayati Raj - Functions– PRI –Zilla Parishath - Elected officials and their roles – CEO, Zilla Parishath - Block level Organizational Hierarchy - (Different departments) - Village level - Role of Elected and Appointed officials - Importance of grass root democracy

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration's role and importance
- Analyze the role of Mayor and elected representatives of Municipalities
- Learn about the role of Zilla Parishath block level organization

**UNIT-V**

**Election Commission**

Election Commission- Role of Chief Election Commissioner and Election Commissionerate - State Election Commission -Functions of Commissions for the welfare of SC/ST/OBC and Women

**LEARNING OUTCOMES: -**After completion of this unit student will

- Know the role of Election Commission
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze the role of state election commission
- Evaluate various commissions viz SC/ST/OBC and women

**Text Books**

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi

2. Subash Kashyap, Indian Constitution, National Book Trust

**REFERENCES:**

1. J.A. Siwach, Dynamics of Indian Government & Politics,

2. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
3. J.C. Johari, Indian Government and Politics, Hans India
4. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi

**E-RESOURCES**:

1.nptel.ac.in/courses/109104074/8
2.nptel.ac.in/courses/109104045/
3.nptel.ac.in/courses/101104065/
4.www.hss.iitb.ac.in/en/lecture-details
5.www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | State the historical background of the constitution making and its importance for building a democratic India. |
| CO2 | Understand the functioning of three wings of the government ie., executive, legislative and judiciary. |
| CO3 | Demonstrate the value of the fundamental rights and duties for becoming good citizen of India. |
| CO4 | Analyze the decentralization of power between central, state and local self-government |
| CO5 | Appraise the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy. |
| CO6 | Develop themselves as responsible citizens and pave way to build a democratic country. |

**3rd Year, 2nd Semester**

## 8. CHEMICAL REACTION ENGINEERING LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Course Objectives:**

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTR in-series.

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor.
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
5. To determine the order of the reaction and the rate constant using a tubular reactor.
6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
8. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient
9. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using tracer
10. Determination of RTD and dispersion number in a tubular reactor using a tracer.

**Course Outcomes:**

- Skills of deriving the kinetic expressions by performing the experiments on batch and continuous flow reactors.
- Understand the effects of non-ideal flow.
- Proficient to estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTR in-series

**3rd Year, 2nd Semester**

## 9. ENGLISH LANGUAGE SKILLS LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

1. To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
2. Further, they would be required to communicate their ideas relevantly and coherently in writing.
3. To prepare all the students for their placements.
4. To initiate them into greater use of the computer in resume preparation, report writing, format making etc.
5. To train them to use language effectively to face interviews, group discussions, public speaking.

### UNIT-I: COMMUNICATIVE COMPETENCY

1. Reading Comprehension
2. Listening comprehension
3. Vocabulary for competitive purpose

| OUTCOMES |
|---|
| To recall and memorize the basic concepts of reading and listening skills |
| To understand the various components to build up vocabulary |
| To apply English language skills to avoid barriers to effective reading and listening |

### UNIT-II: TECHNICAL WRITING

1. Email Writing
2. CV/Resume Writing
3. Mini Project Writing

| |
|---|
| To understand the basic components of writing Emails |
| To apply the knowledge of writing eye catching resumes |
| To analyze different ways of writing a mini project |

**UNIT-III: ORAL PRESENTATION SKILLS**

1. Self-Introduction – Introducing Others – Welcome Speech – Vote of Thanks
2. Oral Presentation-Individual/Impromptu Speeches/ JAM
3. Stage Dynamics– Barriers to Effective Presentation

| |
|---|
| To understand the basic components of speeches |
| To apply knowledge of different forms of presentation. |
| To analyze stage dynamics for effective presentation |

**UNIT-IV:** TECHNICAL **PRESENTATION SKILLS**

1. Information Transfer
2. PPT Presentation
3. Poster Presentation

| |
|---|
| To apply knowledge of different types of pictograms to transfer the information |
| To analyze the techniques of preparing PPTs |
| To evaluate different skills in poster presentation |

**UNIT-V: PROFESSIONAL SKILLS**

1. Group discussions-II
2. Interview skills
3. Answering Strategies

| |
|---|
| To analyze the different aspects of interviews and group discussions |
| To evaluate the group dynamics to excel in group discussions |
| To design and develop strategies to answer effectively in interviews |

REFERENCE BOOKS


1. DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
2. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
3. Train2success.com

1. Objective English for Competitive Exams, Hari Mohana Prasad, 4th edition, Tata Mc Graw Hill.

2. Technical Communication by Meenakshi Raman & Sangeeta Sharma, O U Press 2009.
3. Books on TOEFL/GRE/GMAT/CAT/IELTS by Barron's/DELTA/Cambridge University Press.2012.
4. Handbook for Technical Writing by David A McMurrey & Joanne Buckely CENGAGE Learning 2008.
5. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.
6. Word Power Made Handy, Shalini Verma, S Chand Publications, 2011.
7. Effective Technical Communication, Ashrif Rizvi, TataMcGrahill, 2011.

WEB LINKS

1. https://www.slideshare.net/ruschellecossid/reading-comprehension-56872438

2. https://www.slideshare.net/FiveEEE/listening-comprehension-40031081

3. https://www.slideshare.net/shrutisalunkhe2/english-for-competitive-exams

4. https://www.slideshare.net/nidhipandey16/email-writing-52942112

5. https://www.slideshare.net/aamirmuhammadaamir77/resume-writing-ppt

6. https://www.powershow.com/view/1d8cf2-OWFhN/Mini_Project_Report_Writing_Workshop_powerpoint_ppt_presentation

7. https://www.slideshare.net/8788902/oral-presentations-28994496

8. https://www.slideshare.net/nandapalit/presentation-skills-33500438

9. https://www.slideshare.net/ritikadhameja/group-discussion-46255658

10. https://www.slideshare.net/vikkerkar/interview-skills-presentation

**3rd Year, 2nd Semester**

## 10. SOCIALLY RELAVANT PROJECT

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0.5 | 0.5 |

**-----as per regulation-------**

**IV Year I-Sem**

## 1. TRANSPORT PHENOMENA

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Pre-requisite:** Fluid Mechanics for Chemical Engineers, Process heat transfer, Mass Transfer operations- I & II and Chemical Reaction Engineering I and II

**Course Objectives:**

- Different types of fluids, their flow characteristics and different mathematical models applied to actual situations
- Mechanism of fluids in motion under different conditions.

**UNIT-I**

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

**UNIT -II**

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

**UNIT -III**

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

**UNIT -IV**

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

**UNIT -V**

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent transport, Time smoothing of equation change.

**Course Outcomes:**

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

1. Derive equations of continuity in rectangular and polar coordinates
2. Develop equation of motion, energy and component continuity for rectangular coordinate system.
3. Solve one dimensional steady state problems of momentum, heat and mass transfer using equations of change
4. Formulate time smoothing of equations of change for turbulent transport.

**Text Book:**

1. Transport Phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2nd ed. John Wiley & Sons Inc, U.S.A, 1960.

**Reference Books:**

1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3rded. 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.

**Codes / Tables:** 1. Leonard – Jones potential parameters and critical properties.
2. Equations of change (from Bird)

**IV Year I-Sem**

## 2.OPTIMIZATION OF CHEMICAL PROCESSES

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**OBJECTIVES:**

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

**UNIT I**

**Nature and organization of optimization problems**: Introduction to optimization, scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

**Basic concepts of optimization**: Continuity of functions, unimodal versus Multimodal functions. Convex and Concave functions, convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

**UNIT II**

**Optimization of unconstrained single variable functions:** Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search

**Methods specifying optimum by a point:** Newton's method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

**UNIT III**

**Unconstrained multivariable optimization:** Random search methods, grid search, uni-variate search, multivariable Newton's method, steepest descent method, Conjugate search directions, Conjugate gradient method

.

**UNIT IV**

**Optimization of Unit operations:** Optimal pipe diameter, optimizing recovery of waste heat, optimization of multiple effect evaporator, Determination of optimal reflux ratio for staged distillation column, shell and tube heat exchanger.

**UNIT V**

**Linear programming and applications:** Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method.

**Course Outcomes:**

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

1. Ability to define, understand and explain the concept of Optimization of Chemical Processes
2. Ability to formulate Optimization Problems with given constraints
3. Ability to apply and analyze the optimization criterion for solving problems
4. Ability to investigate constrained and unconstrained optimization techniques
5. Ability to investigate different methods of optimization and to suggest a technique for specific problem
6. Ability to solve problems using advanced optimization techniques like Genetic algorithms and other optimization techniques for industrial problems of relevance especially chemical industries

**Text Books:**


1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.
2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000


**Course Outcomes:**

1. Knowledge of optimization to formulate the problems and analyze the optimization criterion for solving problems
2. Apply different methods of optimization and to suggest a technique for specific problem
3. Advanced optimization techniques like Genetic algorithms and other optimization techniques can be used to solve the industrial problems of relevance to the chemical industry

**IV Year I-Sem**

## Professional Elective-III

### PE1.INDUSTRIAL POLLUTION & CONTROL ENGINEERING:

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations.

**UNIT I :** Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards. Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self-purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

**UNITII:** General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry. Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and Ozones, hydrocarbons, particulate matter.

**UNIT III :** Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects.

**UNIT IV**: Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

**UNIT V:** Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra-filtration, chlorination, ozonation, treatment and disposal. Hazardous waste management: nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes:

health and environmental effects, treatment and disposal: treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**TEXT BOOKS:**

1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.
2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**REFERENCES**:

1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**OUTCOMES:**

1. Understand the different types of wastes generated in an industry, their effects on living and non-living things.
2. Understand environmental regulatory legislations and standards and climate changes.
3. Understand about the quantification and analysis of wastewater and treatment.
4. Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
5. Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.

**IV Year I-Sem**

## PE2. INTERFACIAL AND COLLOIDAL SCIENCE

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

Pre Requisites: NIL

**Course Objectives:**

1. Understand the basic nomenclature, concepts and tools of colloid and interface science and engineering; multi-phase nano-systems; mechanics and thermodynamics on small scales.
2. Explain the difference between the surface and bulk dominated regimes, their behavior and exploitation of nano-systems.
3. Importance of various components of interfacial science in different chemical engineering industries viz. food, paint and pharmaceutical industries are emphasized.

**UNIT I**

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, Brownian Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

**UNIT II**

Surfactants micelles, films and their properties: Introduction, Surfactants and their Properties, Emulsions and Microemulsions, foams. Emulsion polymerization, liquid-liquid extraction& membranes.

**UNIT III**

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces. Measurement of Surface and Interfacial Tension, Measurement of Contact Angle

**UNIT IV**

Intermolecular and Surface Forces: Introduction, Vanderwalls Forces. Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

**UNIT V**

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants. Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

**Text Books:**

1. Interfacial Science: An Introduction by G.Barnes, I.Gentle, Oxford University Press, USA, 2006.
2. Foundations of Colloid Science by R. J. Hunter, 2nd edition, Oxford University Press, USA, 2001.

**Reference Books:**

1. Principles of Colloid and Surface Chemistry, Third edition, Revised and Expanded, Paul C. Hiemenz and Raj Rajagopalan.
2. Physical Chemistry of Sciences, 6th edition, A. Adamson, 1997.
3. Colloid and Interface Science by Pallab Ghosh, PHI, New Delhi.

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

1. Distinguish between colloid and interface and explain properties of colloid dispersion
2. Explain the differences between surfactants, emulsions
3. Apply the methods for measurement of contact angle, surface tension and interfacial tension 4. Explain about the various forces acting on colloids
5. Explain about the adsorption evaluating techniques.

**IV Year I-Sem**

**Professional Elective-III**

## PE3. TECHNOLOGY OF PHARMACEUTICALS AND FINE CHEMICALS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT I**

A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

**UNIT II**

Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals - sulfacetamide, paracetamol, riboflavin, nicotinamide,

Outlines of Preparation, properties, uses and testing of the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, paramino salicylic acid, isonicatinic acid hydrazide.

**UNIT III**

Manufacture with flowsheets, properties, uses and testing of the following Pharmaceuticals – aspirin, penicillin, calcium gluconate.

**UNIT IV**

Manufacture with flowsheets, properties, uses and testing of the following ferric ammonium citrate, pthallic anhydride and phenol fluorobenzene process and benzene sulfate process, other processes in outline only.

**UNIT V**

Tablet making and coating, granulation equipments, Preparation of capsules, extraction of crude drugs. Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous sterilization and radiation sterilization, suitable example to be discussed.

**Course Outcomes:**

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

1. Understand the principle of plant design in Pharmaceutical Industry
2. Understand the knowledge of base chemicals and drug intermediates
3. Understand kinetics, thermodynamics and plant construction material for the production of bulk drugs and fine chemicals

**Text Books:**

1. Remington’s Pharmaceutical Science,16th ed, Mac publishing company, 1980.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley & Sons,. 1965.

**References Books:**

1. Blently’s Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins,
2. B Tindell and Box,. Oxford University Press, London, 1977

**IV Year I-Sem**

## Open Elective-III

## OE1. BASICS OF NANOTECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Basic knowledge of nanotechnology, classification and properties of nanomaterials
- Various methods of synthesis of nanomaterials
- Applications of nanomaterials

**UNIT I**

Introduction: History and Scope, Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

**UNIT II**

Unique Properties of Nanomaterials: Microstructure and Defects in Nanocrystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behaviour: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

**UNIT III**

Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

**UNIT IV**

Synthesis Routes: Bottom-up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly

**UNIT V**

Top-down approaches: Mechanical alloying, Nano-lithography.

Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing Spark plasma sintering.

Applications of Nanomaterials: Nano-electronics, Nano sensors, Nano catalysts, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications

**Text Books**

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

**Reference Books:**

1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L.Schodek
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
6. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University press.

**IV Year I-Sem**

**Open Elective-III**

## OE2. SOLID WASTE MANAGEMENT

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery energy recovery from a given waste data using case standing

**Unit I**

**Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

**General aspects** Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

**Unit II**

**Engineered systems:** Typical generation rates. Estimation and factors effecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

**Unit III**

**Processing Techniques:** Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

**Unit IV**

**Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

**Unit V**

**Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Course Outcomes:**
The student should be able to:

1. 1.Apply his knowledge of characterization of waste and develop a suitable management plan
2. Assess the cost of transportation laboratory processing of solid waste
3. Identify hazardous nature of waste if any and can suggest suitable dumping methods.
4. Suggest processing waste for material for energy recovery.
5. Develop a management plan for land filling composting deep well injection for non-recoverable waste.

**Text Books:**
1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
2. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.

**Reference Books:**
1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**IV Year I-Sem**

**Open Elective-III**

## OE3. PROCESS INTENSIFICATION

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-Requisites**: Process heat transfer, Mass Transfer-I, Mass Transfer-II

**Course Objectives:**

1. Explain the concept of Process Intensification.
2. Define the limitations of intensification for the chemical processes.
3. Describe the techniques of intensification to a range of chemical processes.

### UNIT I

**Introduction to Process Intensification (PI)**: sustainability-related issues in process industry, definitions of Process Intensification, fundamental principles and techniques of PI, the original ICI PI strategy, benefits of PI and obstacles to PI, Issues in designing of a sustainable, inherently safer processing plant

### UNIT-II

**PI Approaches**: STRUCTURE - PI approach in spatial domain, ENERGY - PI approach in thermodynamic domain, SYNERGY - PI approach in functional domain and TIME - PI approach in temporal domain. **Mechanisms involved in PI:** Mechanisms of intensified heat transfer, mass transfer, electrically enhanced processes, micro fluidics

### UNIT –III

**Application of PI techniques to heat transfer**: Compact & micro heat exchangers.
**Application of Pi techniques to reactors**: Spinning disc reactors, oscillatory baffled reactors (OBR), Rotating reactors, Micro reactors, membrane reactors, micro reactors, Reactive separation/ super critical operation and other intensified reactor types.

### UNIT-IV

**Intensification of Separation Processes:** Distillation, Centrifuges, membranes, drying, precipitation and crystallization. **Intensified Mixing**: Inline mixers, mixing on spinning disk, induction heated mixer

### UNIT –V

Application areas of PI:Petrochemicals and Fine Chemicals: Refineries, Bulk Chemicals, Fine Chemicals, Fine Chemicals and Pharmaceuticals, bio processing. Offshore Processing, Nuclear Industries, Food and drink water sector, Textiles, Aerospace, biotechnology

**Course Outcomes:**

At the end of the course, student will be able to

1. Be familiar with process intensification in industrial processes.
2. Assess the values and limitations of process intensification, cleaner technologies and waste minimization options.
3. Measure and monitor the usage of raw materials and wastes generating from production and frame the strategies for reduction, reuse and recycle.
4. Process challenges using intensification techniques.
5. Describe the applications of process intensification in various chemical industries.

**Text Books:**

1 David Reay, Colin Ramshaw, Adam Harvey, Process Intensification-Reengineering for efficiency, sustainability and flexibility, Butterworth Heinemann, (Elsevier) 2008.

2. Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, Marcel Dekker 2003

**Reference Books:**

1. Frerich Johannes Keil, Modeling of process intensification, Wiley 2007
2. Juan Gabriel Segovia Hernandez, Andrian Bonilla-Petericiolet, Process Intensification in Chemical Engineering: Design optimization and control, Springer 2016.

**IV B. Tech- I Sem(Chem)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 19A75401 | **MANAGEMENT SCIENCE** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES :** The objectives of this course are | |
|---|---|
| 1 | To provide fundamental knowledge on Management, Administration, Organization & its concepts. |
| 2 | To make the students understand the role of management in Production |
| 3 | To impart the concept of HRM in order to have an idea on Recruitment, Selection, Training &Development, job evaluation and Merit rating concepts |
| 4 | To create awareness on identify Strategic Management areas & the PERT/CPM for better Project Management |
| 5 | To make the students aware of the contemporary issues in management |

**Syllabus**

**UNIT- I:INTRODUCTION**

Management-Concept and meaning-Nature-Functions-Management as a Science and Art and both. Schools of Management Thought-Taylor's Scientific Theory-Henry Fayol's principles-Eltan Mayo's Human relations-Systems Theory- **Organisational Designs**-Line organization-Line & Staff Organization-Functional Organization-Matrix Organization-Project Organization-Committee form of Organization-Social responsibilities of Management.

**LEARNING OUTCOMES:**At the end if the Unit, the learners will be able to

- Understand the concept of management and organization
- Analyze the organization chart & structure for an enterprise.
- Apply the concepts & principles of management in real life industry.
- Evaluate and interpret the theories and the modern organization theory.

**UNIT-II:OPERATIONSMANAGEMENT**

Principles and Types of Plant Layout-Methods of Production (Job, batch and Mass Production), Work Study- Statistical Quality Control- Deming's contribution to Quality. **Materials Management -** Objectives- Inventory-Functions - Types, Inventory Techniques-EOQ-ABC Analysis-Purchase Procedure and Stores Management- **Marketing Management -**Concept- Meaning - Nature-Functions of Marketing - Marketing Mix- Channels of Distribution -Advertisement and Sales Promotion- Marketing Strategies based on Product Life Cycle.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Understand the core concepts of Management Science and Operations Management
- Apply the knowledge of Quality Control, Work-study principles in real life industry.
- Analyze Marketing Mix Strategies for an enterprise
- Evaluate Materials departments &Determine EOQ
- Create and design advertising and sales promotion

**UNIT-III:HUMAN RESOURCES MANAGEMENT (HRM)**

HRM- Evolution of HRM - Definition and Meaning – Nature-Managerial and Operative functions--Job Analysis -Human Resource Planning(HRP)–Process of Recruitment&Selection- Training and Development-Performance Appraisal-Methods of Performance Appraisal – Placement-Employee Induction-Wage and Salary Administration.

**LEARNING OUTCOMES:**At the end if the Unit, the learners will

- Understand the concepts of HRM in Recruitment, Selection, Training & Development
- Apply Managerial and operative Functions
- Analyze the need of training
- Evaluate performance appraisal
- Design the basic structure of salaries and wages

**UNIT-IV:STRATEGIC& PROJECT MANAGEMENT**

Strategy Definition& Meaning-Vision - Mission- Goals- Corporate Planning Process- Environmental Scanning-Steps in Strategy Formulation and Implementation-SWOT Analysis
**Project Management-** Network Analysis- Programme Evaluation and Review Technique (PERT) - Critical Path Method (CPM) Identifying Critical Path - Probability of Completing the project within given time - Project Cost Analysis - Project Crashing (Simple problems).

**LEARNING OUTCOMES:** At the end of the Unit, the learners will be able to

- Understand Mission, Objectives, Goals & strategies for an enterprise
- Apply SWOT Analysis to strengthen the project
- Analyze Strategy formulation and implementation
- Evaluate PERT and CPM Techniques
- Creative in completing the projects within given time

**UNIT -V:Contemporary Issues In Management**

The concept of Management Information System(MIS)- Materials Requirement Planning (MRP)- Customer Relations Management(CRM)- Total Quality Management (TQM)- Six Sigma Concept- Supply Chain Management(SCM)- Enterprise Resource Planning (ERP)- Performance Management- Business Process Outsourcing (BPO) - Business Process Re-engineering and Bench Marking -Balanced Score Card-Knowledge Management.

**LEARNING OUTCOMES**At the end if the Unit, the learners will be able to

- Understand modern management techniques
- Apply Knowledge in Understanding in modern
- Analyze CRM,MRP,TQM
- Evaluate Six Sigma concept and SCM

**Text Books:**

1. A.R Aryasri, Management Science, TMH, 2013
2. Stoner, Freeman, Gilbert, Management, Pearson Education,New Delhi, 2012.

**References:**

1. Koontz & Weihrich, Essentials of Management, 6/e, TMH, 2005.
2. Thomas N.Duening & John M.Ivancevich, ManagementPrinciples and Guidelines,Biztantra.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Samuel C.Certo, Modern Management, 9/e, PHI, 2005

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Management ,and its Functions |
| CO2 | Understand the concepts & principles of management and designs of organization in a practical world |
| CO3 | Apply the knowledge of Work-study principles & Quality Control techniques in industry |
| CO4 | Analyze the concepts of HRM in Recruitment, Selection and Training & Development. |
| CO5 | Evaluate PERT/CPM Techniques for projects of an enterprise and estimate time & cost of project & to analyze the business through SWOT. |
| CO6 | Create Modern technology in management science. |

**IV B. Tech- I Sem(Chem)**

**(w.e.fAcademic Year 2019-20)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **ORGANISATIONAL BEHAVIOUR** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES :** | |
|---|---|
| 1 | **Toenablestudent's comprehension of organizational behavior** |
| 2 | **To offer knowledge to students onself motivation, leadership and management** |
| 3 | **To facilitate them to become powerful leaders** |
| 4 | **To Impart knowledge about group dynamics** |
| 5 | **To make them understand the importance of change and development** |

**Syllabus**

**Unit-I: Introduction**

, Meaning, definition, nature,scope and functions - Organizing Process – Making organizing effective -Understanding Individual Behavior –Attitude -Perception - Learning – Personality.

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the concept of OrganizationalBehavior
- Contrast and compare Individual& Group Behavior andattitude
- Evaluate personality types

**Unit-II: Motivation and Leading**

Theories of Motivation- Maslow'sHierarchy of Needs - Hertzberg's Two Factor Theory - Vroom's theoryof expectancy - McCLelland's theory of needs–Mc Gregor's theory X and theory Y– Adam's equity theory – Locke's goal setting theory– Alderfer'sERG theory - Leadership–research,theories, traits - LeadersVs Managers.

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the concept of Motivation
- Analyze theTheories of motivation
- Explain how employees are motivated according to Maslow's Needs Hierarchy

**Unit-III: Organizational Culture**

Introduction – Meaning, scope, definition, Nature - Orgnanizational Climate - Leadership - Traits Theory–Managerial Grid - Transactional Vs Transformational Leadership - Qualities of goodLeader - Conflict Management -Evaluating Leader- Women and Corporate leadership.

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the theconcept of Leadership
- Contrast and compare Traits theoryand Managerial Grid
- Distinguish the difference betweenTransactional and Transformational Leadership
- Evaluate the qualities of good leaders

**Unit-IV:Group Dynamics**

Introduction – Meaning, scope, definition, Nature- Types of groups - Determinants of groupbehavior - Group process – Group Development - Group norms - Group cohesiveness - Small Groups - Group decision making - Team building - Conflict in the organization– Conflict resolution

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand theconcept of Group Dynamics
- Contrast and compare Group behavior and group development
- Evaluate how to resolve conflicts in the organization

**Unit-V:Organizational Change and Development**

Introduction –Nature, Meaning, scope, definition and functions- Organizational Culture - Changing the Culture – Change Management – Work Stress Management - Organizational management – Managerial implications of organization's change and development

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the importance of organizational change and development
- Apply change management in the organization
- Analyze work stress management
- Evaluate Managerial implications of organization

**TEXT BOOKS**:

1. Luthans, Fred, OrganisationalBehaviour, McGraw-Hill, 12 Th edition 2011 2. P Subba Rao,OrganisationalBehaviour,HimalyaPublishing House 2017

**References**


- McShane, Organizational Behaviour, TMH 2009
- Nelson,OrganisationalBehaviour, Thomson, 2009.
- Robbins, P.Stephen, Timothy A. Judge, OrganisationalBehaviour, Pearson 2009.

- Aswathappa,OrganisationalBehaviour,Himalaya, 2009

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Organizational Behavior ,its nature and scope. |
| CO2 | Understand the nature and concept of Organizational behavior |
| CO3 | Apply theories of motivation to analyze the performance problems |
| CO4 | Analyze the different theories of leadership |
| CO5 | Evaluate group dynamics |
| CO6 | Develop as powerful leader |

**IV B. Tech- I Sem(Chem)**

**(w.e.f academic year 2019-20)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **Business Environment** | 3 | 0 | 0 | 3 |

| **Course Objectives** | |
|---|---|
| 1 | To make the student understand about the business environment |
| 2 | To enable them in knowing the importance of fiscal and monitory policy |
| 3 | To facilitate them in understanding the export policy of the country |
| 4 | To Impart knowledge about the functioning and role of WTO |
| 5 | To Encourage the student in knowing the structure of stock markets |

**Syllabus**

**Unit-I:Overview of Business Environment**

Introduction – meaning Nature,Scope ,significance, functions and advantages. Types- Internal & External, Micro and Macro. Competitive structure of industries -Environmental analysis-advantages & limitations of environmental analysis& Characteristics of business.

**Learning Outcomes: -**After completion of this unit student will

- Understand the concept of Business environment
- Classify various types of business environment
- Evaluate the environmental analysis in business
- Discuss the Characteristics of Business.

**Unit-II:Fiscal Policy**

Introduction – Nature, meaning, significance, functions and advantages. Public Revenues - Public Expenditure - Public debt - Development activities financed by publicexpenditure - Evaluation of recent fiscal policy of GOI. Highlights of Budget- Monetary Policy - Demand and Supply of Money –RBI -Objectives of monetary and credit policy - Recent trends- Role of Finance Commission.

**Learning Outcomes: -**After completion of this unit student will

- Understand the concept of public revenue and public Expenditure
- Identify the functions of RBI and its role
- Analyze the Monitory policy in India
- Know the recent trends and the role of Finance Commission in the development of our country
- Differentiate between Fiscal and Monitory Policy

**Unit-III:India's Trade Policy**

Introduction – Nature, meaning, significance, functions and advantages. Magnitude and direction of Indian International Trade - Bilateral and Multilateral TradeAgreements - EXIM policy and role of EXIM bank -Balance of Payments– Structure & Major components - Causes for Disequilibrium in Balance of Payments - Correction measures.

**Learning Outcomes:-**After completion of this unit student will

- Understand the role ofIndian international trade
- Understand and explain the need for Export and EXIM Policies
- Analyze causes for Disequilibrium and correction measure
- Differentiate between Bilateral and Multilateral Trade Agreements

**UNIT-IV:World Trade Organization**

Introduction – Nature, meaning, significance, functions and advantages. Organization and Structure - Role andfunctions of WTO in promoting world trade - Agreements in the Uruguay Round –TRIPS, TRIMS, and GATT - Disputes Settlement Mechanism - Dumping and Anti-dumping Measures.

**Learning Outcomes: -**After completion of this unit student will

- Understand the role of WTO in trade
- AnalyzeAgreements on trade by WTO
- Understand the Dispute Settlement Mechanism
- Compare and contrast the Dumping and Anti-dumping Measures.

**Unit-V:Money Markets And Capital Markets**

Introduction – Nature, meaning, significance, functions and advantages. Features and components of Indian financial systems - Objectives, features and structure of money markets and capital markets - Reforms and recent development – SEBI - StockExchanges - Investor protection and role of SEBI.

**Learning Outcomes: -**After completion of this unit student will

- Understand the components of Indian financial system
- Know the structure of Money markets and Capital markets
- Analyze the Stock Markets
- Apply the knowledge in future investments
- Understand the role of SEBI in investor protection.

**TEXT BOOKS**:

1. Francis Cherunilam (2009), International Business: Text and Cases, Prentice Hall of India.
2. K. Aswathappa, Essentials of Business Environment: Texts and Cases & Exercises 13th Revised Edition.HPH2016

**REFERENCE BOOKS**:

1.K. V. Sivayya, V. B. M Das (2009), Indian Industrial Economy, Sultan Chand Publishers, New Delhi, India.
2. Sundaram, Black (2009), International Business Environment Text and Cases, Prentice Hall of India, New Delhi, India.
3. Chari. S. N (2009), International Business, Wiley India.
4.E. Bhattacharya (2009), International Business, Excel Publications, New Delhi.

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define Business Environment and its Importance. |
| CO2 | Understand various types of business environment. |
| CO3 | Apply the knowledge of Money markets in future investment |
| CO4 | Analyze India's Trade Policy |
| CO5 | Evaluate fiscal and monitory policy |
| CO6 | Develop a personal synthesis and approach for identifying business opportunities |

**IV Year I-Sem**

## 6.PROCESS SIMULATION LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Objective**: To make the student familiar with software's and simulation of chemical processes equipment.

The following experiments have to be conducted using C and MATLAB

2. General introduction to MATLAB
3. Functions (log, exp, conv, roots).
4. Matlab Scripts and function files
5. Gravity Flow tank.
6. Three CSTRs in series – open loop
7. Three CSTRs in series – Closed loop
8. Non isothermal CSTR
9. Binary Distillation column
10. Batch Reactor isothermal; Batch reactor non isothermal – closed loop
11. Isothermal batch reactor – open loop
12. Heat Exchanger
13. Interacting System- two tank liquid level
14. Non interacting system-two tank liquid level
15. Plug flow reactor
16. Bubble point calculations
17. Dew point calculations

**Text Books**:

1. A Guide to MATLAB for Chemical Engineering Problem Solving, Kip D. Hauch
2. Understanding MATLAB A Textbook for Beginners by S.N. Alam

**Pre-requisite**: Fluid mechanics for chemical Engineers, Process Heat transfer, Mass transfer operation- 1 & 2, Chemical Reaction Engineering.

**Course Outcomes:**

1. Helps to interconnect knowledge of mathematics, science, and engineering to real world problems.
2. Helps to identify, formulate, and solve engineering problems

(for ex: most of chemical engineering problems are based on transport equations consisting broader areas of kinetics, thermodynamics and mass transfer which can be thoroughly solved using MATLAB inbuilt functions)

- The complex multi component distillation column design can be modeled and simulated
- System of ordinary and partial differential equations obtained in multiple reactors in series/parallel can be solved
- Process control and optimization of reactors can be handled easily

3. "Genetic algorithms" can be implemented at a more pronounced way via MATLAB to solve various linear and non linear models of chemical engineering systems.
4. Most fascinating approach of Artificial Neural Networks (ANN) for electrical related concepts of chemical engineering systems can also be well handled in MATLAB
5. Steady state and unsteady state problems of chemical engineering and allied fields can be modeled and solved using MATLAB

**IV Year I-Sem**

## 7.PROCESS EQUIPMENT DESIGN AND DRAWING LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Objectives:** To make the student familiar with design and drawing aspects of chemical processes equipments.

1. Drawing of flow sheet symbols.
2. Drawing of instrumentation symbols.
3. Drawing of instrumentation diagrams.
4. Mechanical aspects chemical equipment design and drawing of following equipment.
    a) Double pipe heat exchanger
    b) Shell and tube heat exchanger
    c) Evaporator
    d) Distillation column
    e) Batch reactor.

**Text Book:**

1. Process Equipment Design by M. V. Joshi
2. Chemical Process Equipment Design and Drawing, S.C. Maidargi, PHI, 2013

**Reference Books**:

1. Process Equipment Design by Brownell and Young
2. Chemical Process Equipment Design by Bhattacharya
3. Process Equipment Design by Wallas

**Pre-requisite:** Chemical Process equipment design

**Course Outcome:**

- Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

**IV Year II-Sem**

## Professional Elective - IV
## PE1. BIOCHEMICAL ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Study introduction to the application of chemical engineering principles in biochemical systems.
- Be enabled to understand the biological systems and kinetics of enzymatic reactions.
- Learn the kinetics of growth of microorganisms, hence be able to control the process.
- Be able to design equipments for handing biological processes.
- Study Operations utilized in the purification of biological products enable them to recommend, install and easily learn to operate the equipments.

**UNIT I**

Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

**UNIT II**

Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors. Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores

**UNIT III**

Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Design and analysis of biological reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation process.

**UNIT IV**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall $k_La$' estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

**UNIT V**

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.

**Course Outcomes:**

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

1. Classify microorganisms based on the structure and characteristics of various types of cells
2. Analyze the kinetics of enzyme catalyzed reactions
3. Explain the methods of enzyme immobilization and the applications of immobilized enzymes
4. Evaluate the kinetics of cell growth including substrate utilization and product formation
5. Demonstrate the design and analysis of various types of bioreactors
6. Identify various downstream processing strategies for product recovery and purification

**TEXT BOOKS:**

1. Biochemical Engineering Fundamentals, 2nd ed., J.E. Bailey and D.F. Ollis, McGraw-Hill, New York, 1987.

2. Bioprocess Engineering, 2nd ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.

**REFERENCES:**

1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.

2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon, 2005.

**IV Year II-Sem**

**Professional Elective - IV**
**PE2. COMPUTATIONAL FLUID DYNAMICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Fluid mechanics for chemical engineers, process heat transfer, mass transfer operations, chemical reaction engineering, process modeling & simulation

**Course Objective:** This subject deals with different mathematical methods like finite difference techniques to solve Navier - Stokes equations & other fluid flow problems

**UNIT I**
Introduction - Finite difference methods- finite element method - finite volume method- Treatment of boundary conditions- Governing differential equations. Finite difference methods - Taylor's series - Errors associated with FDE- FDE formulation for steady state heat transfer problems.

**UNIT II**
Cartesian, cylindrical and spherical coordinate systems- boundary conditions- Un steady state heat conduction Explicit Method - Stability criteria - Implicit Method - Crank Nickolson method - 2-D FDE formulation ADI- ADE. Finite volume method - Generalized differential equation, Basic rules for control volume approach, Source term linearization, boundary conditions. Un-steady state one, two, three-dimensional heat conduction.

**UNIT III**
Convection and diffusion, different methods i.e., upwind scheme, Exponential scheme, Hybrid scheme, power law scheme, calculation of flow field, staggered grid method, pressure and velocity corrections, SIMPLE Algorithms & SIMPLER (revised algorithm). Solution methods of elliptical, parabolic and hyperbolic partial differential equations in fluid mechanics - Burgers equation.

**UNIT IV**
Formulations for incompressible viscous flows - vortex methods -pressure correction methods.

**UNIT V**
Treatment of compressible flows- potential equation, Navier - Stokes equation - flow field dependent variation methods, boundary conditions. Linear fluid flow problems, 2-I) and 3- 1) fluid flow problems.

**Course Outcomes:**

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

1. Derive governing equations of fluid flow and heat transfer
2. Discretize the equations using Finite difference and volume formulation
3. Solve the discredited equations using different techniques
4. Apply pressure velocity coupling algorithms
5. Simplify Navier-Stokes equation to a given flow problem along with boundary conditions
6. Explain grid generation techniques

**Text Books:**

1. Numerical heat transfer and fluid flow - S.V. Patankar
2. Computational Fluid Dynamics, T.J. Chung, Cambridge University
3. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

**IV Year II-Sem**

## Professional Elective - IV
## PE3. FUEL CELL TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-Requisites**: Hydrogen energy and fuel cells

**Course Objectives:**

1. To describe how to produce, store, use hydrogen and show the difficulties.
2. To present hydrogen applications especially fuel cells.
3. To describe working principle of fuel cell.
4. To describe manufacture and working principle of SOFC

**UNIT- I**

**Overview of Fuel Cells:** What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

**UNIT- II**

**Fuels for Fuel Cells:** Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others, liquid hydrogen and compressed hydrogen-metal hydrides, alkaline fuel cell.

**UNIT- III**

**Fuel cell electrochemistry:** electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents, current density, power density, potential and thermodynamics of fuel cell, Introduction to direct methanol fuel cell.

**Fuel cell process design:** Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

**UNIT- IV**

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling.

**UNIT- V**

**Fuel processing:** Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, $CO_2$ and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs.

**Course Outcomes:**

At the end of the course, student will be able to

1. Learn working principle of fuel cells.
2. Understand the hydrogen production and storage methods.
3. Select the suitable materials for electrode, membrane for fuel cells.
4. Be familiar with fuel cell types and their applications.

5. Design and stack making process.

**Text Books:**

1. Hoogers G., Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.

**Reference Books:**

1. F. Barbir, PEM Fuel Cells: Theory and Practice, 2nd Ed., Elsevier/Academic Press, 2013.
2. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003.
3. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY 2006.

**IV Year II-Sem**

## OPEN ELECTIVE- IV
## OE1. DESIGN AND ANALYSIS OF EXPERIMENTS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Which factors affect a given experiment?
- Find the most significant factor for an experiment.
- Calculate the factor levels that optimize the outcome of an experiment.
- Factorial Design of experiments.

**UNIT- I**

Introduction to probability, probability laws, Baye's theorem. Probability distributions, parameters and statistics. Normal and t-distributions, central limit theorem, random sampling and declaration of independence significance tests

**UNIT- II**

Randomization and blocking with paired comparisons significance tests and confidence interval for means, variances, proportions and frequencies.

**UNIT-III**

Analysis of variance, experiments to compare k-treatment means, Two-way factorial designs, blocking, Yate's algorithm

**UNIT- IV**

Fractional factorial designs at two levels, concept of design resolution, Simple modeling with least squares (regression analysis), Matrix versions of normal equations

**UNIT- V**

Mechanistic model building, Empirical and mechanistic models, model building process, model testing with diagnostic parameters.

**Course Outcomes:**

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

1. Predict how many numbers of experiments are to be carried out, given the number of important factors
2. Design an experiment and calculate the factor levels that optimize a given objective
3. Use response surface methodology to optimize the process, by considering curvature effects
4. Understand strategy in planning and conducting experiments

**Text Book:**

1. Statistics for experimenters by G.E.P. Box, William G. Hunter and J.S. Hunter, John Wiley & Sons.

**Reference Book:**

1. "Design and analysis of experiments" by D.C. Montgomery, 2nd edition John Wiley and sons, New York (1984).

**IV Year II-Sem**

## OPEN ELECTIVE- IV
## OE2. CORROSION ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

The course will enable the students to:

1. Be introduced to the principles of electrochemistry as well as the essential elements of electrochemical corrosion.
2. Lay a foundation for understanding the forms of corrosion, the mechanisms of corrosion, electrochemical methods.
3. Develop the thermodynamic and kinetic aspects of electrochemistry, including potential-pH
4. (Pourbaix) diagrams, mixed potential theory, and the theory and application of polarization.
5. Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

**UNIT- I**

**Introduction**

Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

**UNIT-II**

**Forms of Corrosion**

Uniform attack, galvanic, crevice, pitting, inter granular, selective leaching, erosion and stress corrosion – Mechanisms, testing procedures and their protection.

**UNIT- III**

**Electrode kinetics and polarization phenomena**

Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes.

**UNIT IV**

**Methods of corrosion prevention and control**

Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control.

**UNIT-V**

**Industry Approach**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment. -Ferritic, Austenitic steels and stainless steels- Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**Course Outcomes:**

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

1. Understand the electrochemical and metallurgical behaviour of corroding systems
2. Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion
3. Select or choose the testing procedures for corroding systems
4. Evaluate the polarization behaviour of corroding systems
5. Design of suitable materials, methods to combat corrosion
6. Predict the function of corrosion inhibitors

**TEXT BOOKS:**

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.
2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).

**REFERENCE:**

1. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).

**IV Year II-Sem**

## OPEN ELECTIVE- IV
## OE3. RENEWABLE ENERGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre Requisites:** Knowledge of various Energy Sources

**Course Objectives:**

1. Understand the various forms of conventional energy resources.

2. Summarize the present energy scenario and the need for energy conservation

3. Explain the concept of various forms of renewable energy

**UNIT I**

INTRODUCTION

World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Environment - Economy - Energy and Sustainable Development, Energy planning. Classification of Energy resources, Advantages and Disadvantages of Non-Conventional source of energy, Renewable energy resources - potentials -achievements – applications.

**UNIT II**

SOLAR ENERGY

Basic concepts, Solar thermal systems – Flat plate and concentrating collectors, Solar passive space - Solar heating and cooling techniques – Solar desalination – Solar Pond - Solar cooker - Solar dryers-Solar furnaces - Solar pumping, Solar greenhouse- Solar thermal power plant –Solar photo voltaic conversion – Solar cells – types of PV technologies, PV applications.

**UNIT III**

WINDENERGY

Introduction-Background-Availability- wind power plants, Power from the wind, Wind energy conversion systems, site characteristics, Wind turbines types – Horizontal and vertical axis-design principles of wind turbine, Magnus effect- Performance. Wind energy Applications – New developments - Safety and environmental aspects

**UNIT IV**

BIOMASS ENERGY

Biomass – usable forms- composition- fuel properties – applications, Biomass resources, Biomass conversion technologies - direction combustion - pyrolysis – gasification -anaerobic digestion, Bioethanol and Biodiesel Production – Recent developments. Energy farming, Biogas

technology - Family biogas plants, Community and institutional biogas plants – design consideration – applications.

**UNIT V**

OTHER RENEWABLE ENERGY SOURCES

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy Fuel cell technology - types, principle of operation – applications. Hydrogen energy production - Storage system.

**Text Books:**


1. Rai. G.D. "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.
2. Sukhatme. S.P. "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.


**Reference Books:**


1. Kothari. P, K C, Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd., New Delhi, 2008
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
4. Twidell. J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.
5. Tiwari. G.N. Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.


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

1. Describe the need of renewable energy resources, historical and latest developments.
2. Describe the use of solar energy in different applications like - heating, cooling, desalination, power generation, drying, cooking etc.
3. Describe the need of Wind Energy and Biomass energy resources
4. Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations
5. Evaluate the potential of fuel cells, wave power, tidal power and geothermal principles and their applications.