Course Description

1st Semester

Course Name: Mathematics-I **Course Code: 18B11MA111**
L-T-P scheme: 3-1-0 **Credits: 4**

Prerequisite: Students should have basic knowledge of Algebra and calculus.

Objective: This course is aimed:

- To introduce the calculus of functions of two variables and applicability of derivatives and integrals of vector functions to Analytical geometry and physical problems.
- To make students aware of the basic mathematical concepts and methods which will help them in learning courses in engineering and Technology.

Learning Outcomes:

Course Outcome	Description
CO1	Understand the rank, eigen values, eigen vectors, diagonalization of matrix; compute inverse of matrix by Caley-Hamilton theorem.
CO2	Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, and solve it by Gauss elimination method.
CO3	Interpret derivatives and integrals of multivariable functions geometrically and physically; implement multivariable calculus tools in engineering, science, optimization, and understand the architecture of surfaces in plane and space etc.
CO4	Know about piecewise continuous functions, Laplace transforms and its properties; use of Laplace transform and inverse transform for solving initial value problems.
CO5	Realize importance of line, surface and volume integrals, Gauss and Stokes theorems and apply the concepts of vector calculus in real life problems.
CO6	Formulate mathematical models in the form of ordinary differential equations and learn various techniques of getting solutions of linear differential equations of second order.

Course Contents:

Unit 1: Algebra of matrices, Determinants, Rank, Gauss elimination method, Eigen values and vectors. Quadratic forms.

Unit 2: Partial differentiation. Taylor's series. Maxima and minima. Jacobians**,** Double integrals,
Unit 3: Differential Equations with constants coefficients.
Unit 4: Gradient, divergence and curl. Line and surface integrals, Normal and tangent to a surface. Gauss and Stokes theorems, Equations to a line, plane, curve and surfaces.
Unit 5: Laplace transforms.

Methodology:

The course will be covered through lectures supported by tutorials. There shall be 3 Lectures per week where the teacher will explain the theory, give some examples supporting the theory and its applications. About 12 Tutorial Sheets covering whole of the syllabus shall be given. Difficulties and doubts shall be cleared in tutorials. Apart from the discussions on the topics covered in the lectures, assignments/ quizzes in the form of questions will also be given.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Syllabus covered upto Test-1
Test-2	25 Marks	Syllabus covered upto Test-2
Test-3	35 Marks	Full Syllabus
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials, lecture slides and books on mathematics-1 will be available on the JUET server.

Books

1. Erwin Kreyszig: Advanced Engineering Mathematics, Wiley Publishers.
2. Lipshuts, S., Lipsom M.: Linear Algebra, 3rd Ed, Schaum series 2001.
3. B. V. Raman: Higher Engineering Mathematics, McGraw-Hill Publishers.
4. R.K. Jain, S.R.K. Iyenger: Advanced Engineering Mathematics, Narosa Publishing House, New Delhi.
5. Thomas, G.B., Finney, R.L.: Calculus and Analytical Geometry, 9th Ed., Addison Wesley,1996.
6. Grewal, B.S. : Higher Engineering Mathematics, Khanna Publishers Delhi.

Title of Course: Physics-I Course Code:18B11PH111
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Objective: Broadly, the study of Physics improves one's ability to think logically aboutthe problems of science and technology and obtain their solutions. The present courseis aimed to offer a broad aspect of those areas of Physics which are specificallyrequired as an essential background to all engineering students for their studies inhigher semesters. The course intends to impart sufficientscientific understanding of different phenomena associated with Special relativity, Modern Physics, Statistical physics, atomic physics, and lasers.

Course Outcomes:

Course Outcome	Description
CO1	Describe the limitations of Newton's laws and explain when special relativity become evant, Learn to Apply the principles of Special Relativity to an extended range of problems volving particle kinematics
CO2	Demonstrate the ability to explain the concepts related to the consequences of Special Relativity, the nature of space-time and related dynamic observables
CO3	Acquired a profound understanding of inadequacy of classical mechanics regarding phenomena related to microscopic level, Become well versed with the experimental developments, historical account and importance of probabilistic interpretation
CO4	Understand the basic quantum mechanical ideas and relevant mathematical framework, approach the solution of one dimensional time independent Schrodinger equation
CO5	Appreciate the importance of applying statistical ideas to explore thermodynamic variables, Developed ability to identify and apply appropriate statistical method for describing the assembly of microscopic particles, comprehend basic properties and working of Laser systems

Course Contents:

Unit-I (Theory of Special Relativity): Frames of reference, Galilean transformation, Michelson MorleyExperiment, Postulates of special theory of relativity, time dilation and lengthcontraction, twin paradox, Lorentz transformations, addition of velocities, RelativisticDoppler effect, Mass variation with velocity, Mass-energy relation.

Unit-II (Introduction to Modern Physics):

Quantization of Radiation, Black body radiation, Rayleigh-Jeans law, Planck's law of radiation Wien's law, Stefan's law, Photoelectric effect Compton scattering, Atomic spectra,Bohr model of hydrogen atom, Frank hertz experiment,Matter waves, de Brogliehypothesis, Davisson Germer experiment

Unit III Quantum Mechanics

Wave packets, phase and group velocity, Heisenberg's uncertainty principle, Schrödinger wave equation and its applications tothe free particle in a box, potential barrier and Harmonic oscillator

Unit-IV (Statistical Mechanics): Maxwell-Boltzmann, Bose-Einsteinand Fermi-Dirac distributions and their applications.

Unit- VLaser Physics& Applications

Fundamental ideas of stimulated and spontaneous emission, Einstein's coefficients, Principle and working of laser,Different types of lasers (He-Ne Laser, Ruby Laser, Semiconductor Laser),Applications of Lasers

Text Books and References:

1. A. Beiser, Perspectives of Modern Physics, Tata McGraw Hill.
2. J R Taylor, C D Zafiratos, M A Dubson, Modern Physics for Scientist &
1. Engineers, Pearson Education.
2. K Krane, Modern Physics, Wiley India
3. J Bernstein, P M Fishbane, S. Gasiorowicz, Modern Physics, Pearson
4. Education.
5. B. B. Laud, Laser and Non-Linear Optics, New Age International (P) Ltd.
6. R. Resnick, Relativity, New Age.

Title: English **Code: 18B11HS111**
L-T-P scheme: 2-1-0 **Credit: 3**
Prerequisite: None

Objective:

1. To enable understanding of basics of communication in Business environment.
2. To provide insight into structural aspect of communication in business.
3. To impart knowledge about communication theory and develop skills in oral and non verbal communication.
4. To improve skills as critical readers, thinkers, listener and writer.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the basic concept of verbal/ nonverbal skills to understand the role of effective communication in personal & professional success.
CO2	Describe drawbacks in listening patterns and apply listening techniques for specific needs.
CO3	Develop the understanding to analyze, interpret and effectively summarize a variety of textual content
CO4	Discuss a given technical/non-technical topic in a group setting and arrive at generalizations/consensus.
CO5	Create effective presentations
CO6	Create professional and technical documents that are clear and adhering to all the necessary convention.

Course Content:

Unit-1: Concept and Nature of Communication : Definition of Communication, Process & Stages of Communication, Barriers to Communication, Channels of Communication.

Unit-2: Listening Skills: The listening process**,** Importance of listening,Purpose and types of listening**,** Hearing and listening, Listening with a purpose, Barriers to listening.

Unit-3: Speaking/Oral Skills: Importance of acquiring oral skills, Visual aids, Body Language, Delivery, Pronunciation, Use of connectives Organization of matter: Metadiscourse features, Textual organization, 7 C'S of effective communication , Improving vocabulary by learning Root words in English, Some foreign words, Reading comprehension, Some important synonyms and antonyms, commonly confused words, Etiquettes & grooming.

Unit-4: Reading Skills: Skimming and Scanning, Intensive and extensive reading, SQ3R Technique

Unit-5: Writing Skills: Business letters, Memo, Circulars, Notices, Report writing, resume writing, Agenda & Minutes writing, Tips on clear writingTranslation- Hindi to English, Translation -English to Hindi.

Unit-6: Introduction to Modern Communication Media: Technology based communication tools, Committee types, Advantages, Conferences, Audio-video conferencing, Barriers and overcoming negative impact.

Unit-7: Public Speaking and Interviewing Strategies: Speech Preparation, Theory of group discussion, Participation in Group discussion, Oral presentation, Power point presentation ,Tips for successful job interview, Do's and don'ts while appearing for interview, Mock interview, Some interview questions, Telephonic interview tips, Resume writing

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3,& Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Teaching Methodology:

The course will be taught with the aid of lectures, handouts, case studies, Task-based language learning, and comprehensive language learning through language lab.

Learning Resources:

Lecture slides and e-books on ENGLISH (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

1. K.K. Sinha- Business Communication (Galgotia Publications)

Reference Books:

1. R.C. Bhatia- Business Communication (Ane Books Pvt. Ltd.)
2. P.D. Chaturvedi – Business Communication (Pearson Education, 1st Edition 2006).
3. Lesikar RV & Pettit Jr. JD – Basic Business Communication: Theory & Application (Tata Mc Graw Hill, 10th Edition)
4. Wren & Martin, High School English Grammar & Composition – S. Chand & Co. Delhi.
5. Raman Meenakshi & Sharma Sangeeta, Technical Communication-Principles & Practice –O.U.P. New Delhi. 2007.
6. Mitra Barum K., Effective Technical Communication – O.U.P. New Delhi. 2006.

7. Better Your English- a Workbook for 1st year Students- Macmillan India, New Delhi.
8. Raymond Murphy,' Essential English Grammar', Cambridge University Press.

Title: Software Development Fundamentals **Code: 18B11CI111**
L-T-P scheme:3-1-0 **Credit: 4**

Prerequisite: There is no prerequisite in this course; however, students having any prior experience of programming are desirable.

Objective:

1. To provide exposure to problem-solving through programming.
2. To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.

Learning Outcomes:

Course Outcome	Description
CO1	Makes students gain a broad perspective about the uses of computers in engineering industry.
CO2	Develops basic understanding of computers, the concept of algorithm and algorithmic thinking.
CO3	Develops the ability to analyze a problem, develop an algorithm to solve it.
CO4	Develops the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general.
CO5	Introduces the more advanced features of the C language

Course Content:

Unit-1:Introduction to Programming: Basic computer organization, operating system, editor, compiler, interpreter, loader, linker, program development. Variable naming, basic function naming, indentation, usage and significance of comments for readability and program maintainability. Types of errors, debugging, tracing/stepwise execution of program, watching variables values in memory. Constants, Variables and data Types Character Set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of Variables, assigning values to variables, typedef, and Defining symbolic constants. printf & scanf function.

Unit-2:Operators and Expression: Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operators, Special Operators, Evaluation of expressions, Precedence of arithmetic operators, Type conversions in expressions, Operator precedence and associativity.

Management Input and Output Operators: Introduction, reading a character, writing a character, formatted input, formatted output.

Unit-3: Decision Making Branching: Introduction, Decision making with IF statement, the IF-ELSE statement, nesting of IF-ELSE statement, ELSE-IF ladder, SWITCH statement, ternary operator, and the GOTO statement.

Looping: Introduction, the WHILE statement, the DO statement, The FOR statement, Break and Continue.

Unit-4: Array: Introduction, One-dimensional arrays, Two-dimensional arrays, arrays, Concept of Multidimensional arrays.

Handling of Character strings: Introduction, Declaring and initializing string variables, reading string from terminal, writing string to screen, String, Operations: String Copy, String Compare, String Concatenation and String Length (using predefined functions & without using them), Table of strings.

Unit-5: User-Defined Functions (UDF): Introduction, need for user-defined functions, the form of C function, elements of UDF, return values and their types, Calling a function, category of functions, Nesting of functions, Recursion, Functions with arrays, The scope and Lifetime of variables in functions, multi file program.

Structures and Unions: Introduction, Structure definition, declaring and initializing Structure variables, accessing Structure members, Copying & Comparison of structures, Arrays of structures, Arrays within structures, Structures within Structures, Structures and functions, Unions.

Unit-6: Pointers: Introduction, understanding pointers, Accessing the address of variable, Declaring and initializing pointers, accessing a variable through its pointer, Pointer expressions, Pointer increments and scale factor, Pointers and arrays, Pointers & character strings, Pointers & Functions, Function returning multiple values, Pointers and structures.

File Management in C and CONSOLE I/O: Introduction, Defining files and its Operations, Error handling during I/O operations, Random access files, Command line arguments. Types of files, File vs. Console, File structure, File attributes, Standard i/o, Formatted i/o, Sample programs.

Teaching Methodology:

This course is introduced to help students understand the discipline of programming. The programming language used to teach this course is C. Starting from the basic computer architecture, the student will slowly be exposed to program designing and later to programming fundamentals. The entire course is broken down into six separate units, from fundamentals of programming to some complex programming structures like pointers. This theory course is well complemented by a laboratory course under the name Software Development Fundamentals Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage

Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 20-30% from coverage till Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage till Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Software Development Fundamentals (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Programming in ANSI C by E. Balguruswamy, Tata Mc-Graw Hill.
[2] Programming With C, Schaum Series.

Reference Books/Material:

[1] The 'C' programming language by Kernighan and Ritchie, Prentice Hall
[2] Computer Programming in 'C' by V. Rajaraman, Prentice Hall
[3] Programming and Problem Solving by M. Sprankle, Pearson Education
[4] How to solve it by Computer by R.G. Dromey, Pearson Education

Web References:

[1] http://www2.its.strath.ac.uk/courses/c/
Notes on C programming by University of Strathclyde Computer Centre. This tutorial was awarded the NetGuide Gold Award during the 1990s.
[2] http://www.princeton.edu/~achaney/tmve/wiki100k/docs/C_%28programming_language%29.html
This site contains notes on C programming from Princeton University, USA.
These are very useful for students who are learning C as their first programming Language.
[3] http://www.stat.cmu.edu/~hseltman/Computer.html
Online reference material on Computers and Programming from Carnegie Mellon University, Pittsburgh, USA
[4] http://projecteuler.net/
Collection of mathematical problems which make you use your programming skills

Title: Physics Lab-I **Code: 18B17PH171**
L-T-P scheme:0-0-2 **Credit: 1**

Learning Outcomes

Course Outcome	Description
CO1	Demonstrate ability to collect experimental data and understanding the working procedures within the precautionary limits
CO2	Acquired the ability to analyze the experimental data and related errors in a reflective, iterative and responsive way
CO3	Developed understanding of the basic concepts related to Modern Physics, Basic Solid State Physics and Optics
CO4	Acquired a first hand and independent experience of verifying Kirchoff's circuit laws and related concepts e.g. resistivity, measurement of resistance
CO5	Appreciate the importance of the laboratory work culture and ethics that is intended to impart features like regularity, continuity of self evaluation and honesty of reporting the data

List of Experiments

1. To study the variation of magnetic field along the axis of Helmholtz Galvanometer and to determine its reduction factor.
2. To determine the resistance per unit length of a Carey Foster's bridge and to obtain the specific resistance of a given wire.
3. To determine the wavelengths of spectral lines Red, Green and Violet of mercury using plane transmission grating.
4. To determine the specific rotation of cane sugar solution using Bi-quartz polarimeter.
5. To observe Newton's rings and to determine the wavelength of sodium light.
6. To study the CRO and function generator by producing the following waveforms.
   i. 10kHz, 8Vp-p(sine wave, square wave, triangular wave)
   ii. 4kHz, 6Vp-p(sine wave, square wave, triangular wave)
   iii. 10kHz, 8Vpeak(sine wave, square wave, triangular wave)
   iv. 4kHz, 6V_{peak}(sine wave, square wave, triangular wave)
7. To verify the Kirchhoff's current law.
8. To verify the Kirchhoff's voltage law.

Title: Software Development Lab **Code: 18B17CI171**
L-T-P scheme:0-0-4 **Credit: 2**

Prerequisite: Experience in programming is desirable.

Objective:

1. To provide exposure to problem-solving through programming.
2. To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
3. To give the student hands-on experience with the concepts.

Learning Outcomes:

Course Outcome	**Description**
CO1	Makes students gain a broad perspective about the uses of computers in engineering industry.
CO2	Develops basic understanding of computers, the concept of algorithm and algorithmic thinking.
CO3	Develops the ability to analyze a problem, develop an algorithm to solve it.
CO4	Develops the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general.
CO5	Introduces the more advanced features of the C language

Course Content:
The following assignments will be carried out in synchronization with the theory classes.

Unit-1: Introduction to programming Environment (Linux commands, editing tools such as vi editor, sample program entry, compilation and execution). Development of programs using multiple arithmetic and logical operators. Programs for Roots of quadratic equation, conversion of units etc.

Unit-II: Programs using simple control statements such as if else, while, do while etc. Making a program for a calculator for example. Extracting the digits of an integer, reversing digits, finding sum of digits etc.

Unit-III: Programs using For loop, switch statement etc. For example, Finding average of numbers, printing multiplication tables etc. Checking for primes, generation of Armstrong numbers. Generation of the Fibonacci sequence, Finding the square root of a number, calculation of factorials, printing various patterns using for loop. The greatest common divisor of two integers, Raising a number to large power.

Unit-IV: Programs using Arrays: declaring and initializing arrays. Program to do simple operations with arrays. Strings – inputting and outputting strings. Using string functions such as strcat, strlen etc. Writing simple programs for strings without using string functions.Finding the

maximum number in a set, Array order reversal, Finding maximum number from an array of numbers Removal of duplicates from an ordered array,

Unit-V: Selection/ Bubble/ Insertion sort, create a linked list, traverse a linked list, insert a node and delete a node form the list. Recursion and related examples such as Tower of Hanoi, computing factorial etc. Practice sessions and sessions for missed labs

Units to Lab Mapping:

Unit	Labs
I	1, 2, 3
II	4, 5
III	6, 7, 8
IV	9, 10, 11
V	12, 13, 14

Teaching Methodology:

This course is introduced to help students understand the discipline of programming. The programming language used to teach this course is C. Starting from the programming environment setup, the student will slowly be exposed to program designing and later to programming fundamentals. The entire course is broken down into six separate units, from fundamentals of programming to some complex programming structures like pointers. This theory course is well complemented by a laboratory course under the name Software Development Fundamentals Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams		**Marks**	**Coverage**
P-1		15 Marks	**Based on Lab Exercises: 1-6**
P-2		15 Marks	**Based on Lab Exercises: 7-13**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Software Development Fundamentals Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

1. Programming in ANSI C by E. Balguruswamy, Tata Mc-Graw Hill.
2. Programming With C, Schaum Series.

Reference Books/Material:

1. The 'C' programming language by Kernighan and Ritchie, Prentice Hall
2. Computer Programming in 'C' by V. Rajaraman, Prentice Hall
3. Programming and Problem Solving by M. Sprankle, Pearson Education
4. How to solve it by Computer by R.G. Dromey, Pearson Education

Web References:

1. http://www2.its.strath.ac.uk/courses/c/
   a. Notes on C programming by University of Strathclyde Computer Centre. This tutorial was awarded the NetGuide Gold Award during the 1990s.

2. http://www.princeton.edu/~achaney/tmve/wiki100k/docs/C_%28programming_language%29.html
   a. This site contains notes on C programming from Princeton University, USA. These are very useful for students who are learning C as their first programming Language.

3. http://www.stat.cmu.edu/~hseltman/Computer.html
   a. Online reference material on Computers and Programming from Carnegie Mellon University, Pittsburgh, USA

4. http://projecteuler.net/
   a. Collection of mathematical problems which make you use your programming skills

Title:Workshop **Code: 18B17ME171**
L-T-P scheme: 0-0-3 **Credit: 1.5**

Prerequisite: Students must have the knowledge of fundamental principles of Physic and Chemistry upto class 12^{th} which helps them to understand the various process of Workshop Lab.

Objective:

1. To demonstrate students, the basic manufacturing processes of Workshop lab: Carpentry, Fitting, Welding, Machining and Casting Processes.
2. To develop effective skills in students to identify the manufacturing process with its applications
3. To be able to perform basic manufacturing processes safely.

Learning Outcomes:

Course	Description
CO1	Identify the various processes of manufacturing.
CO2	Capable to explain the use of various holding, measuring, marking and cutting tools
CO3	Prepare a useful job by performing the various processes in proper sequence safely
CO4	Apply Bernoulli's theorem to analyze the liquid metal velocity in casting process.
CO5	Develop the skills to join two metallic specimen using welding process
CO6	Work as a team on a project

Course Content:

Carpentry Shop

1. To study about various tools/equipments used in carpentry shop
2. To make Cross lap /T joint as per given specification
3. To make Cross lap /T joint as per given specification

Foundry Shop

1. To study about various tools used in foundry shop.
2. To prepare a green sand mould with the help of a given pattern.
3. To perform permeability test on moulding sand

Machine Shop

1. To study various machine tools such as lathe, milling, shaper, drilling, grinding, EDM drill and cutting tools used by them.
2. To perform turning, step turning and taper turning operations on lathe machine
3. To perform threading operation on the lathe machine

Fitting Shop

1. To study about various tools used in fitting shop.
2. To make a fitting job as per given drawing.

Welding Shop

1. To study various types of welding processes available in the workshop such as Electric arc welding, TIG and MIG welding, gas welding and spot resistance welding,
2. To prepare welding joint by using Electric arc welding/gas welding
3. To prepare welding joint by using Spot Resistance welding

Teaching Methodology:

This Lab course has been introduced to help a student to learn with hand-on experience on machines. The entire course is broken down into fourteen experiments. Experiments are performed different shop wise by taking the proper safety precautions. Workshop lab includes five shops namely: Carpentry, Foundry, Machining, Fitting and Welding. Basic principles of manufacturing processes are applied to prepare a job. Students learn here how to handle the real world problems by using technical skills. The way of experimentation here realizes the students that they are now moving on an Engineering path. This Lab course will enable a student to learn with hand-on experience.

Evaluation Scheme:

Exams		**Marks**	**Coverage**
P-1		15 Marks	Based on Lab Experiments: 1-7
P-2		15 Marks	Based on Lab Experiments: 8-14
Day-to-Day Work	Viva	20 Marks	70 Marks
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Laboratory Manual available in Lab. Study material of Workshop Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Books:

[1] "Workshop Technology Volume- I & II", B.S. Raghuvanshi, Dhanpat Rai & Co.

[2] "Workshop Technology Volume-I & II", Khanna Publisher.

Reference Books:

[1] "Workshop Technology Vol.- 1, 2, 3 & 4", Butterworth-Heinemann.

[2] "Material Science & Engineering", W. D. Callister, John Wiley

Web References:

[1] https://nptel.ac.in/courses/112/107/112107219/

[2] https://nptel.ac.in/courses/112/107/112107144/

IInd Semester

Course Title: Mathematics-2 **Code: 18B11MA201**
L-T-P scheme: 3-1-0 **Credits: 4**
Prerequisite: Students should have basic knowledge of differential equations and calculus.
Objective: This course is aimed

- To introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of fundamental concepts of Complex Analysis.
- To equip students with the concepts of ordinary and partial differential equations and how to solve them with different methods.

Learning Outcomes:

Course Outcome	This course will enable the students to:
CO1	Understand the concepts of limit, continuity, differentiability, analyticity, singularities, contour integration, Taylor and Laurent's series expansion of function complex variable.
CO2	Learn various techniques of getting solutions of linear ordinary and partial differential equations of second order,
CO3	Visualize complex numbers as points of $\mathbb{R}^2$, two path test for non-existence of limit, orthogonal trajectories, connected domain, conformal mapping.
CO4	Use Laurent series to evaluate complex integrals and classify the singularities of a function, conformal mapping in modeling and solving boundary value problems, power series method to solve linear differential equations.
CO5	Apply Cauchy residue theorem in evaluation of real integrals and separation of variables method in the solution of heat, wave and Laplace equation
CO6	Formulate mathematical models in the form of ordinary and partial differential equations to problems arising in mechanical, chemical and physical disciplines.

Course Content:

Unit-1: Functions of complex variable, analytical functions and Cauchy-Riemann equations, Conformal mapping, Poles and singularities, complex integration, Taylor's and Laurent's series, Cauchy residue theorem, contour integration and their application.

Unit-2: Second order linear differential equations, Convergence of series, convergence tests, solution of D.E. in series, Bessel functions; Legendre and Chebyshev polynomials, Orthogonality.

Unit-3: Second order partial differential equations and classification, one dimensional wave and diffusion equations with their applications. Laplace and Poisson equations. Use of Green's function.

Methodology:

The course will be covered through lectures supported by tutorials. Apart from the discussions on the topics covered in the lectures, assignments and quizzes in the form of questions will also be given for practice.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Syllabus covered upto Test-1
Test-2	25 Marks	Syllabus covered upto Test-2
Test-3	35 Marks	Full Syllabus
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials, lecture slides and books on mathematics-2 will be available on the JUET server.

Books

1. Kreyszig, Erwin : Advanced Engineering Mathematics, John Wiley & Sons, Inc.
2. Simmons, G.F. : Differential Equations with Applications, 2nd Ed., McGrawHill, 1991.
3. Brown, J.W., Churchill, R.V. : Complex Variables and Applications, 6th Ed., McGrawHill, 1996.
4. Prasad, C : a) Mathematics for Engineers
   b) Advanced Mathematics for Engineers, Prasad Mudranalaya, 1982.
5. Grewal, B. S. : Higher Engineering Mathematics, Khanna Publishers Delhi.

Title: Electrical Circuit Analysis **Code: 18B11EC212**

L-T-P scheme: 3-1-0 **Credit: 4**

Prerequisite: Not Applicable

Objective:

1. To learn thebasic concepts of electrical engineering.
2. To analyze the various electrical circuit with the help of practical.

Learning Outcomes:

Course Outcome	Description
CO1	Be aware of basic essentials of electrical circuit
CO2	Apply theorems for finding the solutions of network problems
CO3	Analysis the behavior of direct current transients
CO4	Realize the performance of two port network parameters
CO5	Be familiar with the role of alternating current in home and industry
CO6	Evaluate the performance of various alternating current circuits

Course Content:

Unit I: Basic Electrical Circuit: Electromotive Force , Terminal Voltage; Resistance (R), Inductance (L) and Capacitance (C) from (i) Circuit, (ii) Energy, and (iii) Geometrical Points of View; Voltage Divider, Current Divider; Star-Delta Transformation; Voltage Source and Current Source, Source Transformation, Combination of Sources; Controlled (Dependent) Sources.

Unit II: Network Analysis and Network Theorems: Kichhoff's Circuit Law (KCL), Kichhoff's Voltage Law (KVL), Loop-Current Analysis, Mesh Analysis, Node-Voltage Analysis, Choices of Method of Analysis. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Reciprocity Theorem.

Unit III: DC Transients: Simple RL Circuit, Time Constant, Decay and Growth of Current; Simple RC Circuit, Discharging of a Capacitor, Charging of a Capacitor.

Unit IV: Two Port Networks: Impedance parameters, Admittance parameters, Hybrid parameters, Equivalent circuits of all the parameters, Symmetry and Reciprocity conditions.

Unit V: Alternating Voltage and Current: Physical Model for a Sinusoid, Phase and Phase Difference; Average Value, Effective Value, Form Factor and Peak Factor; Concept of Phasors, Addition of Phasors Using Complex Numbers; Non sinusoidal Waveforms; Power and Power Factor; Behaviour of *R*, *L* and *C* in AC Circuits.

Unit VI: AC Circuits: Series RL Circuit, Complex Impedance; Series RC Circuit, Complex Power; Parallel RL Circuit; Parallel RC Circuit; Series RLC Circuit and its Phasor Diagram; Parallel RLC Circuit and its Phasor Diagram, Q factor, Resonance in series parallel RLC circuits.

Teaching Methodology:

This course is introduced to help students for understanding the basic concept of electrical engineering. Initially an overview of basic terminology of electrical circuit along with various component needed for circuits will be discussed briefly. In the first part, Direct Current (DC) related issued are elaborated through various theorems. Later on DC transient is evaluated on various circuits. In the second part, Alternating Current (AC) is described by different parameters and phasor diagrams. At the end, ac circuits and resonance condition has been evaluated.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15	Based on Unit-1 &Unit-2
Test-2	25	Based on Unit-3& Unit-4 and around 30% from coverage of Test-1
Test-3	35	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10	Based on all Units
Tutorials	5	Based on all Units
Quiz	5	Based on all Units
Attendance	5	Based on attendance in the theory classes
Total	**100**	

Learning Resources:

Tutorials and lecture slides on theory course will be added from time to time and a digital copy of study material will be available on the JUET server.

Text Books:

[1] "Basic Electrical Engineering", D.C. Kulshreshtha, McGraw Hill Education, 2009.
[2] "Engineering Circuit Analysis", W.H. Hayt, J. E. Kemerlay and S.M. Durbin, 6th edition, McGraw Hill, 2006.
[3] "Introduction to Electric Circuits", R.C. Dorf & J.A. Svoboda, John Wiley, 2004.

Reference Books:

1. "Network Analysis", V. Valkenburg, Prentice-Hall India Ltd., 2001.
2. "Basic Electrical Engineering", A. Chakrabarti, S. Nath, C. K.Chanda, Tata McGraw Hill Publishing Co, 2008.
3. "Principles of Electrical Engineering", V. D. Toro, Prentice Hall of India.

Web References:

[1] https://www.rapidtables.com/electric/index.html
[2] https://library.automationdirect.com/basic-electrical-theory/

Journals References:

[1] International Journal of Circuit Theory and Application Wiley publication
[2] International Journal of Circuits and Electronics

Title: Engineering Mechanics **Code: 18B11ME211**
L-T-P scheme: 3-1-0 **Credit: 4**
Prerequisite: Students must have already studied courses, “Basic Mathematics” and “Physics”

Objective:

4. Enable students to apply their knowledge of mathematics, science, and engineering in order to expand this knowledge into the vast area of "Rigid Body Mechanics".
5. To enhance students' ability to design by framing the solution of open ended problems.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the various laws of mechanics
CO2	Describe the equivalent force systems
CO3	Develop the equations of equilibrium for various force systems
CO4	Identify and use various methods for analyzing the forces in machines and structures
CO5	Apply concepts of kinematics and kinetics of particles to analyze practical problems.
CO6	Demonstrate and deployment basic knowledge of engineering mechanics for solving real-world problems

Course Content:

Unit-1: Introduction: Idealization of mechanics, Concept of rigid body, External forces (body forces & surface forces), Laws of mechanics.

Unit-2:Force Systems and Equilibrium: Introduction to vector, Statically equivalent force systems (planar and spatial), Free body diagram, Equations of equilibrium and their applications to various system of forces, Variational mechanics.

Unit-3: Structures and Machines: Plane trusses, Space trusses, Method of joints, Method of section, Graphical method, Frames and machines.

Unit-4: Distributed Forces and Moment of Inertia: Centroid of composite figures, Area moment of inertia, Mass moment of inertia, Principal axes and principal moment of inertia.

Unit-5:Friction: Introduction of friction, Laws of friction, Wedge, Screw, Belt, and Rolling friction.

Unit-6:Beams: Different support & loading conditions of Beam, Shear force diagram (SFD), Bending moment diagram (BMD).

Unit-7:Kinematics and Kinetics of Rigid Bodies: Velocity and acceleration, Rotation of rigid bodies, Rolling motion, Plane motion of rigid bodies, Effective forces on a rigid body, D'Alembert's principle, Force, Mass and Acceleration, Work and energy, Impulse and momentum.

Teaching Methodology:

This course is introduced to help students in applying their knowledge of mathematics, science and engineering in order to explore the vast area of rigid body mechanics and to enhance students' ability to design machines and mechanisms by framing the solution of open ended problems. The entire course is divided into seven separate units: Introduction, Force Systems and Equilibrium, Structures and Machines, Distributed Forces and Moment of Inertia, Friction, Beams and Kinematics and Kinetics of Rigid Bodies. These sections have been framed to impart a systematic understanding of the basic laws of forces, static and dynamic equilibrium conditions and finally implement these laws to solve the real-world problems. This theory course is well complemented by a laboratory course under the name Engineering Mechanics Lab in the same semester. This Lab course will enable a student to learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2 and Unit-3
Test-2	25 Marks	Based on Unit-4, Unit-5, Unit-6 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Engineering Mechanics (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Engineering Mechanics Vol. I-Statics, by J. L. Meriam and L.G. Kraige, John Wiley & Sons Inc. 6th Edition.

[2] Engineering Mechanics Vol. II-Dynamics, by J. L. Meriam and L.G. Kraige, John Wiley & Sons Inc. 6th Edition.

Reference Books/Material:

[1] Engineering Mechanics: Statics and Dynamics, Hibbeler, R.C. (2007), Pearson Prentice Hall, Upper Saddle River, NJ, 13th Edition.

[2] Engineering Mechanics, S.Timoshenko, D.H.Young, McGraw Hill Book Co.

Web References:

[3] https://nptel.ac.in/courses/112103109/

[4] https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/

[5] https://freevideolectures.com/course/2264/engineering-mechanics

[6] https://www.coursera.org/learn/engineering-mechanics-statics-2

Journals References:

[1] Journal of Engineering Mechanics - ASCE

[2] Mechanical Engineering & Mechanics, Springer

[3] International Journal for Theoretical and Applied Mechanics, Association for Engineering Mechanics

[4] Probabilistic Engineering Mechanics, Elsevier

[5] International Journal of Mechanics and Materials in Design, Springer

[6] Journal of Engineering Mechanics and Machinery, Clausius Scientific Press

Title: Engineering Chemistry **Code: 21B11CL212**

L-T-P Scheme:3-1-0 **Credit: 4**

Prerequisite: The students must be aware of basic Chemistry upto class 12^{th}. Basic knowledge of chemistry helps them to correlate in various division of Engineering during this course.

Objective:

The purpose behind this course is to make the students familiar with the concepts of the Chemistry and to understand the significance of Chemistry in various field of the Engineering (Chemical,Mechanical and Civil Engineering).

Course LearningOutcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in still deep interests in learning chemistry; develop broad and balanced knowledge and understanding of key chemical concepts, principles, and theories related to chemistry; and equip students with appropriate tools of analysis to tackle issues and problems in the field of chemistry.
CO2	Describe the real world problems, challenges with application of the Chemistry in various fields of engineering (Chemical, Mechanical and Civil Engineering).
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in chemistry.
CO4	Identify and use of various analytical techniques in the Chemical, Mechanical and Civil Engineering project management.
CO5	Apply experimental demonstration and validation by using various analytical techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in chemistry and related areas or in multidisciplinary areas that involve chemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT

Unit 1: Alloys

Purpose of making alloys; Types of alloys; Alloy steels; Light alloys; Cast alloys; Copper alloys; Nickel alloys; Nickel iron alloys; Nickel chromium alloys; Super alloys; Lead alloys; Bearing alloys; Modes of formation of alloys; Preparation of alloys; Treatment of alloys.

Unit 2: Corrosion

Types of corrosion; Dry and wet corrosion; Chemical corrosion; Factors promoting corrosion; Galvanic corrosion; Atmospheric corrosion; Open air corrosion; Water corrosion; Pitting corrosion; Inter granular corrosion; Waterline corrosion; Corrosion fatigue; Prevention of corrosion.

Unit 3 : Protective / Metallic Coatings

Coating processes; Hot dipping; Metal cladding; Electroplating; Displacement or immersion plating; Cementation; Metal spraying or metalized coatings; Organic coating.

Unit 4: Adhesives

Introduction; Classification & preparation of adhesives; Animal glue; other protein adhesives; Starch adhesive; Synthetic resin adhesives; Rubber based adhesives; Cellulose and silicate adhesives; Uses of adhesives.

Unit 5: Paints and Pigments

White pigments; white lead; Characteristics of pigments; Zinc oxide; Physical properties of pigments; Characteristics of pigments; Blue pigments; Ultramarine blue; Cobalt blue and iron blue; Red pigments; Red lead; Yellow pigments; Paints; Distempers; Manufacture; Emulsion paint; Varnishes; Lacquers.

Unit 6: Lubricants

Properties of lubricants; Classification of lubricants; Substances used as lubricants; Additives for lubricating oil; Lubricants of mineral origin; Synthetic lubricants; Lubricating greases; Chemical properties of greases; Selection of lubricants.

Teaching Methodology:

This course comprises 3 lectures and 1 tutorial per week. The course content is divided into 42 lectures and 14 tutorials.The lectures will be conducted in both, white board and PowerPoint presentation, modes. At the end of this course student will be able to understand the significance of the basic Chemistry in various field of engineering such as paints, lubricants, adhesives etc.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 and Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4 (70 %) and around 30% from coverage of Test-1

Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] P.C Jain & M. Jain 'Engineering Chemistry'. Dhanpat Rai &Co.(pvt.) Ltd.
[2] Puri Sharma & Pathania " Physical Chemistry"Vishal Publishing Co. 2002
[3] Puri Sharma & Pathania " Inorganic Chemistry"Vishal Publishing Co. 2002

Reference Book:

[1] Shashi Chawala 'Theory and Practical of Engineering Chemistry'. Dhanpat Rai & co.(pvt.) Ltd.
[2] S.S. Dara "A Text book of Engineering Chemistry". S.Chand & Company Ltd. 2008

Title: Engineering Mechanics Lab **Code: 18B17ME271**
L-T-P scheme: 0-0-2 **Credit: 1**
Prerequisite: Students must have already studied the course, "Engineering Mechanics"
Objective:

1. To demonstrate students, the basic principles of Engineering Mechanics: Statics and Dynamics.
2. To develop effective skills in students to observe experimental data and to analyze the results.

Learning Outcomes:

Course Outcome	Description
CO1	Verify the various laws of mechanics
CO2	Determine mechanical advantage, velocity ratio and efficiency of various lifting machines
CO3	Evaluate co-efficient of friction between two mating surfaces
CO4	Estimate the forces in machines and structures
CO5	Apply concepts of kinematics and kinetics of particles to analyze practical problems.
CO6	Work as a team on a project

Course Content:

Experiment-1: To verify the triangle law of forces

Experiment-2: To verify the parallelogram law of forces

Experiment-3: To verify the polygon law of forces

Experiment-4: To verify Lami's theorem

Experiment-5: To determine the co-efficient of friction between wood and other surfaces

Experiment-6: To find the moment of inertia of flywheel

Experiment-7: To determine the mechanical advantage, velocity ratio and efficiency of a screw jack

Experiment-8: To determine the mechanical advantage, velocity ratio and efficiency of Worm and Wheel

Experiment-9: To determine the mechanical advantage, velocity ratio and efficiency of the Winch Crab

Experiment-10: To find the forces in a member of a Triangular Truss

Experiment-11: To find the forces in a member of a Warren Truss

Experiment-12: To find the forces in a member of a Pratt Truss

Experiment-13: To find the forces in a member of a Joint Roof Truss

Teaching Methodology:

This Lab course has been introduced to help a student to learn with hand-on experience on machines. The entire course is broken down into thirteen experiments. Each experiment includes engineering mechanics principles applied to various machines in order to help a student gain more experience as Mechanical Engineer. This lab course is well complemented by a theory course under the name Engineering Mechanics in the same semester in order to enable the student to get acquainted, learn and discuss the technical details of the underlying principles of mechanics and mechanisms in machines and structures. This Lab course will enable a student to learn with hand-on experience.

Evaluation Scheme:

Exams		**Marks**	**Coverage**
P-1		15 Marks	**Based on Lab Exercises: 1-7**
P-2		15 Marks	**Based on Lab Exercises: 8-13**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:
Laboratory Manual available in Lab. Study material of Engineering Mechanics Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Engineering Mechanics Vol. I-Statics, by J. L. Meriam and L.G. Kraige, John Wiley & Sons Inc. 6th Edition.

[2] Engineering Mechanics Vol. II-Dynamics, by J. L. Meriam and L.G. Kraige, John Wiley & Sons Inc. 6th Edition.

Reference Books/Material:

[1] Engineering Mechanics: Statics and Dynamics, Hibbeler, R.C. (2007), Pearson Prentice Hall, Upper Saddle River, NJ, 13th Edition.

[2] Engineering Mechanics, S.Timoshenko, D.H.Young, McGraw Hill Book Co.

Web References:

[1] https://nptel.ac.in/courses/112103109/

[2] https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/

[3] https://freevideolectures.com/course/2264/engineering-mechanics

[4] https://www.coursera.org/learn/engineering-mechanics-statics-2

Journals References:

[1] Journal of Engineering Mechanics - ASCE

[2] Mechanical Engineering & Mechanics, Springer

[3] International Journal for Theoretical and Applied Mechanics, Association for Engineering Mechanics

[4] Probabilistic Engineering Mechanics, Elsevier

[5] International Journal of Mechanics and Materials in Design, Springer

[6] Journal of Engineering Mechanics and Machinery, Clausius Scientific Press

Title: Engineering Drawing & Design Lab **Code: 18B17ME272**
L-T-P scheme: 0-0-1 **Credits: 1.5**

OBJECTIVE

[1] Enables students to learn the concepts of graphic communication, their role in sanitary construction.

[2] Make familiar with different drawing equipment, technical standards and procedures for construction of geometric figures.

[3] Equipped with the skill that enables them to convert pictorial to orthogonal representations.

Course Content:

Unit-1: Study and construction of lines, lettering, dimensioning, plane scales, diagonal scales, construction of different methods used for the construction of conic curves.
Unit-2: Study and construction of geometrical construction, cycloidal curves, involutes and helix

Course Outcome	Description
CO1	**Outline** the objectives of scale and develop the imagination and mental visualization capabilities for correlating the geometrical details of objects.
CO2	To **develop** the constructional ability for a different curve.
CO3	To**Describe** BIS rules for orthogonal projection andunderstand the fundamental concept of orthogonal projection for point, line, plane and solids.
CO4	Understand and **apply** orthogonal projection for solids, section and intersection of solid objects/structures
CO5	To **apply** the skill of development of surfaces of three dimensional objects for evaluation of black size of the components.
CO6	**Demonstrate** computer aided drafting tools and techniques using CAD software's

etc.
Unit-3: Orthogonal projection of point in all possible positions, Study and construction of projection of line and its applications (inclined to both planes), and projection of planes (inclined to both planes).

Unit-4: Study and construction of projection of solids (right circular cone, prism, pyramid and cylinders), and true shape of sections,
Unit-5: Study and construction of oblique projection and development of surface, isometric view using orthogonal projection on isometric scales.

Unit-6: Introduction to basic and editing command of CAD software, 2-D drafting, surface modeling, and 3-D geometrical model.

Teaching Methodology:

This course is introduced to build the imagination and established the correlation between the real object and engineering drawing and CAD developed by the design engineers and the requirement of the production engineers of the different units.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-7**
P-2		15 Marks	**Based on Lab Exercises: 8-14**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

The study material of engineering drawing & design lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

1. Bhatt, N.D., Engineering Drawing,

Reference Books:

2. Gill, PS, A Text Book of Engineering Drawing (Geometrical Drawing)
3. Dhananjay A J, Engineering Drawing with an introduction to Auto CAD, Mc Graw Hill

Title: Electrical Circuit Analysis lab **Code: 18B17EC272**
L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: Not applicable

Objective:

3. To analyze the various dc network theorem.
4. To learn theac fundamental concepts.

Learning Outcomes: In reference to Electrical Circuit Analysis (18B11EC212), the students will be able to:

Course Outcome	Description
CO1	Be aware of basic laws of electrical circuit
CO2	Apply theorems for finding the solutions of network problems
CO3	Calculate the power from electrical circuits
CO4	Analysis the behavior of direct current transients
CO5	Realize the performance of two port network parameters
CO6	Evaluate the performance of various alternating current circuits

Course Content:

Unit-1;Labexercises based on basic law's of electrical circuits
Unit-2;Lab exercises based on various dc theorems such as superposition, Thevenin's
Unit-3; Lab exercises based on power calculation with the help of maximum power transfer
Unit-4; Lab exercises based on transient analysis of electrical circuits
Unit-5;Lab exercises based on different two-port network
Unit-6;Lab exercises based on ac fundamental circuits

Teaching Methodology:

This lab course is introduced to help students for understanding the basic concept of electrical engineering. Initially an overview of basic terminology of electrical circuit along with various component needed for circuits will be discussed briefly. In the first part, Direct Current (DC) related issued are elaborated through various theorems. Later on DC transient is evaluated on various circuits. In the second part, Alternating Current (AC) is described by different parameters and phasor diagrams. At the end, ac circuits and resonance condition has been evaluated.

Evaluation Scheme:

Exams	Marks		Coverage
P-1	15 Marks		**Based on Lab Exercises: 1-7**
P-2	15 Marks		**Based on Lab Exercises: 8-14**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	

	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:
Study material of Electrical Circuit Analysis Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Books:
[4] "Basic Electrical Engineering", D.C. Kulshreshtha, McGraw Hill Education, 2009.
[5] "Engineering Circuit Analysis", W.H. Hayt, J. E. Kemerlay and S.M. Durbin, 6th edition, McGraw Hill, 2006.
[6] "Introduction to Electric Circuits", R.C. Dorf & J.A. Svoboda, John Wiley, 2004.

Reference Books:
4. "Network Analysis", V. Valkenburg, Prentice-Hall India Ltd., 2001.
5. "Basic Electrical Engineering", A. Chakrabarti, S. Nath, C. K.Chanda, Tata McGraw Hill Publishing Co, 2008.
6. "Principles of Electrical Engineering", V. D. Toro, Prentice Hall of India.

Web References:
[3] https://www.rapidtables.com/electric/index.html
[4] https://library.automationdirect.com/basic-electrical-theory/

Journals References:
[3] International Journal of Circuit Theory and Application Wiley publication
[4] International Journal of Circuits and Electronics

Title: Chemistry Lab **Code: 18B17CL272**

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: The students must be aware of basic Chemistry Experiment upto class 12^{th}. Basic knowledge of chemistry helps them to correlate in various division of Engineering during this lab.

Objective:

The purpose behind this course is to make the students familiar with the concepts of the Chemistry Experiment and to understand the significance of Chemistry in various field of the Engineering (Chemical,Mechanical and Civil Engineering).

Course LearningOutcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in still deep interests in learning chemistry; develop broad and balanced knowledge and understanding of key chemical concepts, principles, and theories related to chemistry; and equip students with appropriate tools of analysis to tackle issues and problems in the field of chemistry.
CO2	Describe the real world problems, challenges with application of the Chemistry in various fields of engineering (Chemical, Mechanical and Civil Engineering).
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in chemistry.
CO4	Identify and use of various analytical techniques in the Chemical, Mechanical and Civil Engineering project management.
CO5	Apply experimental demonstration and validation by using various analytical techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in chemistry and related areas or in multidisciplinary areas that involve chemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

LIST OF EXPERIMENT

1. To determine the dissolve oxygen (DO) in the given water samples.
2. To determine the pH and conductivity of the given water samples.
3. To determine the relative viscosity of given unknown liquids.
4. To determine the relative surface tension of the given unknown liquid.

5. To determine the equivalence point by using pH metric titration of strong acid and weak base.
6. To determine the alkalinity of a given water sample.
7. Determination of total hardness of water by complexmetric titration using EDTA.
8. To find out the strength of unknown solution of oxalic acid & sodium hydroxide with the help of N/20 oxalic acid solution by double titration.
9. Confirmation of hetro-elements e.g. N, S, Cl, Br and I by Lassaigne's test.
10. Detection of functional groups e.g. aldehyde, alcohol, carboxylic and ketone in the given organic compound.
11. To prepare urea formaldehyde resin by condensation reaction. (Bakelite).
12. Evaluation of physical properties of oils e.g. saponification value and acid value.
13. Separation of pigments/colored ions by paper/column chromatography.
14. Separation of parameter by using TLC.

Teaching Methodology:

This course planned in 14 lab experiment and each experiment having 2 hours practical exposure in Chemistry lab. Their continuous evaluation will be performed in each week and weightage given during finalizing of the grade sheet. At the end of this course student will be able to: Understand the significance of the basic Chemistry in various field of engineering.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	Based on Lab Exercises: 1-7
P-2		15 Marks	Based on Lab Exercises: 8-14
Day-to-Day Work	Viva	20 Marks	70 Marks
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	

Total	100 Marks

Learning Resources:

Study material of Web Technology Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book

1. Organic Chemistry Lab Technique, Lisa Nichols Publisher, by Lisa Nichols, Butte Community College.
2. Practical Chemistry Labs, by Leonard Saland, **Manufacturer:** Walch Education015116

Reference Book

1. Green Chemistry, by Sally A. Henrie, CRC Press Published March 18, 2015.
2. Drinking Water Chemistry: A Laboratory Manual by Barbara Hauser, CRC Press Published August 21, 2001.

3rd Semester

Title: Chemical Process Calculations **Code: 18B11CL311**
L-T-P scheme: 3-1-0 **Credit: 4**

Prerequisite: NIL

Objective:

This course deals with applications of conservations principles in various unit operations and unit process. This course is designed to enable students to make a clear understanding and applications of conservation principles in physical and chemical processes in chemical and allied industries.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of mass and energy balance.
CO2	Understand different system of units used in chemical engineering calculations.
CO3	Describe various unit operations used in the chemical engineering.
CO4	Develop material and energy balance equations for different unit operations used in chemical engineering.
CO5	Apply overall and component material balance along with energy balance on processes like drying, evaporator, reactors etc.
CO6	Demonstrate a complete process involving recycling and purge.

Course Content:

UNIT-1: INTRODUCTION

Concept of unit operations and unit processes. Importance of chemical process calculations.

UNIT-2: UNITS AND DIMENSIONS

Dimensions of various parameters. Systems of units. Conversion factors.

UNIT-3: STOICHIOMETRIC AND COMPOSITION RELATIONSHIPS

Stoichiometric relations. Composition of mixtures and solutions. Density and specific gravity.

UNIT-4: MATERIAL BALANCE IN SYSTEMS INVOLVING PHYSICAL CHANGES

Overall and component material balances. Material balance problems involving simultaneous equations for simple systems. Material balance problems involving recycle.

UNIT-5: MATERIAL BALANCE IN SYSTEMS INVOLVING CHEMICAL REACTIONS

Chemical reactions and their stoichiometry. Concept of yield and conversion. Solving material balance problems involving single and multiple chemical reactions.

UNIT-6: GASES, VAPORS, LIQUIDS AND SOLIDS

Phase diagram, Ideal gas law, relationships for real gases and compressibility factory charts, Vapor pressure of liquids. Humidity and saturation. Psychrometric charts.Material balance involving condensation and vaporization**.**

UNIT-7: ENERGY BALANCES

Concepts and units. Heat capacity. Calculation of enthalpy changes. The general energy balance. Energy balance for systems involving chemical reactions.

UNIT-8: UNSTEADY STATE MATERIAL AND ENERGY BALANCES

Material and energy balances in unsteady state systems with examples.

UNIT-9: MATERIAL AND ENERGY BALANCES VIA COMPUTER CODES

Analysis of the degrees of freedom. Flow-sheeting codes. Building blocks, stream partitioning, tearing and convergence. Block concept. Incidence matrix, occurrence matrix and precedence matrix.

Teaching Methodology:

This course is introduced to help students understand basic principles of process calculations employed for different unit operations. The entire course is broken down into following separate units: Intorduction, units and dimensions, material balance, energy balance, calculations on gases and vapors, unsteady state balance. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2 & Unit-3
Test-2	25 Marks	Based on Unit-4 , Unit-5 & Unit-6 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	

Total	**100 Marks**

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Bhatt, B.I. and Vora, S.M., "Stoichiometry" 3rd ed., Tata McGraw Hill, New Delhi, 1996.
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", 6th ed., Prentice Hall of India, New Delhi, 1996.

REFERENCE BOOKS:

1. Rao, Ch. Durga Prasad and Murthy, D.V.S., "Process Calculations for Chemical Engineers", MacMillan India, New Delhi.
2. Hougen, O.A., Watson, K.M., and Ragatz, R.A., "Chemical Process Principles. Part I", 2nd ed., John Wiley Int. Ed./CDS Publishers, New Delhi, 1995.

Title: Fluid and Fluid Particle Mechanics **Code: 18B11CL312**
L-T-P scheme: 3-1-0 **Credit: 4**

Prerequisite:NIL

Objective:

This subject has been designed to acquaint various industrial fluid & fluid-Particle operations. The course is designed so that a student can able to handle industrial fluid & fluid-Particle flow problems. This course mainly deals with basic fluid & fluid-Particle flow phenomena, problem associated with metering and transportation of different kinds of industrial fluids.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the scope and importance of fluid & fluid particle mechanics.
CO2	Understand fluid statics, fluid flow phenomena, and various equations related to fluid flow.
CO3	Describe flow of incompressible fluids.
CO4	Explain flow of other than incompressible fluid flows and mixing and agitation.
CO5	Know about properties, screening, and size reduction of solids.
CO6	Gain knowledge about solid-liquid separation methods.

Course content:

Unit-1:

Scope and applications of fluid mechanics. Review of nature and properties of fluids and related concepts of pressure and hydrostatic equilibrium. Barometric equation. Various types of Manometers.

Unit-2:

Velocity fields, velocity gradients and shear stress fields in laminar flow, Viscosity and Kinematic viscosity. Newtonian and Non-Newtonian fluid behavior. Turbulance. Reynolds number. Transition from laminar to turbulent flow for flow in conduits and flow past immersed bodies. Nature of turbulence. Eddy viscosity. Flow in boundary layers. The laminar and turbulent portions of boundary layer flow. Theory of boundary layer applied to flow in pipes.

Unit-3:

Equation of continuity. Equations of motion. Equation of mechanical energy Bernoulli equation with and without friction term. Correction terms in Bernoulli equation. Applications of Bernoulli equation.

Unit-4:

Laminar flow of Newtonian fluids. Hagen-Poiseuille equation. Turbulent flow in pipes. Skin friction and shear stress at wall in a cylindrical tube. Universal velocity distribution law and its limitation. Von Karman equation. Friction factor, effect of roughness parameter. Friction loss in Non-newtonian fluid flow. Flow through non-circular cross-section. Newtonian and Non-newtonian fluid flow through coils.

Unit-5:

Basic relationships for compressible flow. Adiabatic and isothermal flow of compressible fluids through orifices and pipes.

Unit-6:

Motion of particles through fluids. Flow through beds of solids. Fluidization. **Unit-7:**

Agitation and mixing of fluids: Commonly used impellers for mixing. Flow patterns and power consumption of different impellers. Applications for blending suspension of solids, dispersion of gas and mixing of non-Newtonian fluids. Selection of agitation system.

Two phase flow: Types and regimes of flow in horizontal and vertical pipes. Phase held up and pressure drop correlations.

Unit-8:

Properties of solids&screening: Density, specific gravity, hardness, brittleness, and friability, Screen analysis and particle size distribution.

Size reduction of solids: Energy of size reduction. Kick's law. Bond's law. Rittingers law, Work index.

Unit-9:

Sedimentation : Theory of settling and sedimentation. Terminal settling velocity. Free and hindered settling of spherical and non-spherical particles.

Filtration**:** Mechanism of filtration. Basic equations. Constant volume and constant rate filtration. Rate expressions with cake and filter cloth resistance.

Teaching Methodology:

This course is introduced to help students understand basic principles of Fluid and Fluid Particle Mechanics. The entire course is broken down into following separate units: fluid statics, fluid flow phenomena, fluid flow equations, flow of incompressible and compressible fluids, flow past immersed bodies, agitation and mixing of fluids, solid-solid separation, fluid-solid separation, and size reduction of solids. Each section includes multiple topics to help a student gain deeper understanding of the subject. This theory course is well complemented by two laboratory courses under the name Fluid Mechanics Lab and Fluid Particle Mechanics Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 to Unit-3
Test-2	25 Marks	Based on Unit-4 to unit-6, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Brown, G.G., "Unit Operations", CBS Publishers, New Delhi, 1995.
2. Coulson and Richardson, "Chemical Engineering-Volume II", 5th Ed.- Butterworth-Heinemann- 2002.
3. McCabe,W.L., Smith,J.C. and Harriott P, "Unit Operations of Chemical Engineering", 6th ed. Tata McGraw Hill, New Delhi, 2001.
4. Coulson,J.M., Richardson, J.F. Backhurst, J.R., and Harder J.H., "Coulson & Richardson's Chemical Engineering Vol 1 & 2", Pergamon Press.

Reference Books:

5. Gupta, S.K., "Momentum Transfer Operations" Tata McGraw Hill, New Delhi, 1982.
6. Bird, R.B., Stewart, W.E. and Lightfoot, E.N., "Transport Phenomena", 2nd ed., Wiley Eastern, New Delhi, 2002.
7. Gupta, V., and Gupta, S.K., "Fluid Mechanics and Its Applications", 1984.

Title: Chemical Engineering Thermodynamics **Code: 18B11CL314**
L-T-P scheme: 3-1-0 **Credit: 4**

Prerequisite: NIL

Objective:

The purpose of this subject is to present Thermodynamics from a chemical engineering view point. The course is designed so that student can deals with transformation of energy from one form to another, transformation of energy into work, maximum work available from any process.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of thermodynamics in chemical engineering.
CO2	Understand basic laws of thermodynamics.
CO3	Describe various processes like isothermal, adiabatic, isochoric etc.
CO4	Develop expressions for different processes using first and second law of thermodynamics.
CO5	Apply the expressions for estimating the efficiency of compressors, turbines, refrigerators etc.
CO6	Demonstrate the concepts of thermodynamics in phase equilibrium.

Course Content:

UNIT-1: INTRODUCTION

The scope of thermodynamics. Definition of terms. Zeroth law of thermodynamics and temperature

UNIT-2: FIRST LAW OF THERMODYNAMICS

The first law of thermodynamics. Concepts of open and closed systems, state and path functions, reversible and irreversible processes, equilibrium, and phase rule. Energy balance for closed systems. Mass and energy balance for open systems.

UNIT-3: VOLUMETRIC PROPERTIES OF PURE FLUIDS

PVT behaviour of pure substances. The ideal gas. Equations of state. Generalized representation for gases and liquids. Estimation of critical properties.

UNIT-4: HEAT EFFECTS

Sensible heat effects. Latent heat of pure substances. Standard heats of formation. Estimation of heat of formation by group contribution method. Standard heats of reaction and combustion. Heat effects of industrial reactions.

UNIT-5: SECOND LAW OF THERMODYNAMICS

Statements of second law of thermodynamics. Reversible and irreversible processes. Entropy. Mathematical statement of the second law. Microscopic interpretation of entropy. Calculation

of entropy changes, ideal work and lost work. Applications of first and second laws to steady/unsteady processes in open/closed systems. Applications to compression and expansion processes.

UNIT-6: THERMODYNAMIC PROPERTIES OF FLUIDS

Thermodynamic relations for homogeneous phases. Residual properties. Calculation of residual properties using equations of state. Two- phase systems. Thermodynamic property diagrams. Tables of thermodynamic properties. Generalised property correlations.

UNIT-7: REFRIGERATION AND LIQUEFACTION

The Carnot engine and Carnot refrigerator. Vapor compression cycles. Choice of refrigerant. Absorption refrigeration. Heat hump. Liquefaction processes.

UNIT-8:SOLUTION THERMODYNAMICS

Fundamental property relation. Chemical potential and phase equilibria. Partial properties. Ideal gas mixture. Ideal solution. Real solution. Excess properties. Fugacity in solution. Concept of activity and activity co-efficient. Property changes of mixing. Models for liquid phase.

UNIT-9: PHASE EQUILIBRIUM

General equations of equilibrium. Vapour-liquid equilibrium in miscible binary and multi component systems. Azeotropy. Prediction and correlation of activity coefficients. Group contribution methods for activity coefficients. Liquid phase: Immiscibility. Vapour-liquid equilibrium in systems with partially miscible liquid phase. Liquid-liquid equilibrium.

UNIT-10: SOLUBILITY OF GASES AND SOLIDS IN LIQUIDS

Solubility of gases in nonpolar and polar liquids and in aqueous solutions. Solubility of solids in liquids.

UNIT-11: CHEMICAL REACTION EQUILIBRIA

Chemical reaction equilibria in homogenous and heterogeneous systems. Methods for equilibria in complex multireaction systems. Electrochemical reactions and fuel cells.

Teaching Methodology:

This course is introduced to help students understand basic principles of thermodynamics in various equipment used in the chemical industries. The entire course is broken down into following separate units: Intorduction, First law of thermodynamics, Volumetric properties of fluids, second law of thermodynamics, heat effects, Refrigeration, Phase Equilibria. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2 , Unit-3 & Unit-4
Test-2	25 Marks	Based on Unit-5 , Unit-6 , Unit-7 & Unit-8 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-9 , Unit-10 & Unit-11 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOK:

1. Smith, J.M, VanNess, H.C. and Abbott, M.M., "Chemical Engineering Thermodynamics", 6th ed., Tata McGraw Hill, New Delhi, 2001.

REFERENCE BOOKS:

1. Balzheiser, R.D., Samuels, M.R., and Eliassen, J.D., "Chemical Engineering Thermodynamics", Prentice Hall, 1972.
2. Daubert, T.E, "Chemical Engineering Thermodynamics" McGraw Hill.
3. Hougen, O.A., Watson, K.M. and Ragatz, R.A., "Chemical Process Principles – Part II" Wiley/CBS, New Delhi, 1995.
4. Kyle " Chemical Engineering Thermodynamics"
5. Prausnitiz, J.M., Lichtenthaler, R.N. and and deAzevedo, E.G. "Molecular Thermodynamics of Fluid Phase Equilibria", Prentice Hall, 1986.
6. Rao, Y.V., "Chemical Engineering Thermodynamics"
7. Reid, R.C., Prausmitz, J.M. and Poling, B.E., "The Properties of Gases and Liquids', 4th ed., McGraw Hill, New Delhi, 1968.
8. Sandler S.I., "Chemical Engineering Thermodynamics" Wiley, New York, 2004.

Title: Organic Chemistry **Code: 18B11CL313**

L-T-P Scheme: 3-1-0 **Credit: 4**

Prerequisite: The students must be attended Chemistry at 2nd Semester of B.Tech. Course. Basic knowledge of chemistry helps them to correlate in various division of Chemical Engineering during this course.

Objective:

The purpose behind this course is to make the students familiar with the concepts of the Organic Chemistry and to understand the significance of Organic Chemistry in various field of the Chemical Engineering. The emphasis of this course would be essentially on Organic Chemistry, which is a backbone of Chemical Industry. Stereochemistry The laboratory emphasis would be on different aspects of Organic Chemistry. At the end of the course, the students will have elaborate knowledge of industrially important Organic Chemistry substantiated by a relevant laboratory experience.

Course LearningOutcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in still deep interests in learning Organic Chemistry; develop broad and balanced knowledge and understanding of key chemical concepts, principles, and theories/mechnism related to Organic Chemistry; and equip students with appropriate tools of analysis to tackle issues and problems in the field of Chemical Engineering.
CO2	Describe the real world problems, challenges with application of the Organic Chemistry in various fields of Chemical Engineering.
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Organic Synthesis.
CO4	Identify and use of various analytical techniques in the Chemical Engineering project management.
CO5	Apply experimental demonstration and validation by using various analytical techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in Organic Chemistry and related areas or in multidisciplinary areas that involve Organic Chemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT

Unit 1- FUNDAMENTALS OF ORGANIC CHEMISTRY

Types of bonds in organic compounds. Electronic effects operating in organic molecules: Inductive effect; Electromeric effect; Mesomeric effect; Hyperconjugative effect; Resonance and Resonance energy; Homolytic and Heterolytic Bond Fission; Reactive Intermediates: Generation, Structure, Stability and general reactions of Carbocations, Carbanions, Free radicals and Carbenes; Attacking reagents: Electrophiles and Nucleophiles; Organic reactions, their mechanisms and examples: Substitution reactions (Nucleophilic; Electrophilic), Addition reactions, Elimination reactions,; Aromaticity and aromatic character: Introduction, Discussion of aromatic character of benzene, furan, pyrrole, thiophene, pyridine, Huckel rule**.**

Unit 2- INDUSTRIALLY IMPORTANT ORGANIC CHEMISTRY

Organic compounds of nitrogen: a) Nitro compounds: Nitration of benzene, Properties and synthetic uses b) Diazonium salts: Preparation of diazonium salts of benzene, Their synthetic applications c) Amines: Preparation and reactions of primary amines. Sulphonation of aromatic compounds: Sulphonating agents, Mechanism of sulphonation, Chlorosulphonation, Reactions of aromatic sulphonic acids and chlorosulphonyl arenas. Phenol: Methods of preparation, Acidity, General reactions (salt formation, o-alkylation, acylation, halogenation, oxidation, carboxylation)

Unit 3- IMPORTANT NAMED REACTIONS

Mechanism and applications of the reactions and rearrangements namely: Aldol condensation, Cannizaro, Perkin, Reformatsky reaction, Stobbe condensation, Darzen's condensation, Dieckmann condensation, Pinacol-Pinacolon rearrangement, Benzil-Benzilic acid rearrangement, Beckmann rearrangement, Fischer-Indole synthesis, Meerwein-Pondroff-Vereley reaction, Pechman reaction, Oppeneauer oxidation, , Waagner-Meerwein rearrangement, Friedel-Crafts, Diels-Alder, Knoevanagel's, Gattermann, Kolbe's, Gattermann-Koch, Sommelet reaction, Ullmann reaction, Wurtz reaction, Wurtz-Fittig reaction, Witting reaction, Wolf-Kischner reaction, Mechanism and industrial application of rearrangements such as Claisen, Curtius and Fries rearrangement

Unit 4- STEREOCHEMISTRY

Elements of symmetry: Center, Plane, Axis of symmetry, Chirality, Concept of stereoisomerisms, Classification of stereoisomers, enantiomers and diastereoisomers, racemates, Formation, types and methods of resolution, projection formula, absolute configuration (R & S), Stereochemistry of compounds containing two asymmetric carbon atoms, Conformation around the C-C bond in acyclic compounds, Structures of cycloalkanes, Different strains in cyclic compounds, Cyclohexane conformations, Stereochemistry of di-substituted cyclohexanes, Geometrical isomerism, E-Z nomenclature.

Unit 5- PHOTO CHEMISTRY

Teaching Methodology:

This course planned in 3 lectures, one tutorial and 2 hours practical exposure in Organic Chemistry lab. The course content divided in two 42 lectures, 14 tutorials. The lectures will be conducted in both manner white board and PowerPoint presentation .At the end of this course

student will be able to: Understand the significance of the basic Organic Chemistry in various field of engineering.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 and Unit-2
Test-2	25 Marks	Based on Unit-2& Unit-3 (70 %) and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

[1] G.R Chatwal 'Reaction Mechanism and Reagents in Organic Chemistry.
[2] P.C Jain & M. Jain 'Engineering Chemistry'
[3] S. Glasstone 'Physical Chemistry'

REFERENCE BOOKS:

[4] A. Bahl & B.S Bahl 'Advanced Organic Chemistry'
[5] I.L Finar 'Organic Chemistry' Volume I
[6] R.T Morrison and R.N Boyd 'Organic Chemistry'
[7] I.L Finar 'Stereochemistry and the Chemistry of Natural Products' Volume II
[8] Eliel 'Stereochemistry of Carbon Compounds'
[9] P.W Atkins 'Physical Chemistry' .

Title: Managerial Economics **Code: 18B11HS311**
L-T-P scheme: 2-1-0 **Credit: 3**
Prerequisite: None
Objectives:

1. The course is concerned with the application of economic principles and methodologies to key management decisions within organizations.
2. It provides principles to foster the goals of the organization, as well as a better understanding of the external business environment in which an organization operates.
3. It is fundamentally a unique way of thinking about problems, issues and decisions that managers face in each of the functional areas of the organization as well as the strategic ones faced by general managers.

Learning Outcomes:

Course Outcome	Description
CO1	Outline what managerial economics is and how micro and macro economics differ from each other.
CO2	Describe basic concepts & elasticities of demand.
CO3	Develop an understanding of factors of production.
CO4	Identify different types of cost.
CO5	Apply logic to understand different market structures viz Perfect Competition; Monopoly; Monopolistic Competition; and Oligopoly.
CO6	Deploy and be proficient in contribution and break even analysis

Course Content :

Unit-1 : Introduction to Managerial Economics & Macro-economic Concepts: Definition of Economics, Meaning & Scope of Managerial Economics, Micro & Macro Economics concepts – National income, GDP, Inflation, Monetary Policy, Fiscal Policy, SLR, CRR, Concept of economic profit, Opportunity Cost, Discounting principle, time value of money, Equi marginal utility

Unit-2 : Demand Analysis: Law of demand**,** Individual & market demand, Determinants of market demand, Marginal Utility theory, Elasticity of demand – Price, Income, Cross, Advertising ,Theory of Consumer choice using Indifference Curve analysis, Demand forecasting techniques – Delphi , Survey , Time series analysis, Correlation, Regression analysis

Unit-3: Production Theory and Analysis: Production with one variable, optimal employment of a factor of production, Cobb Douglas production function, Productionwith two variable inputs, Production Isoquants, Production Isocosts, Optimal employment of two inputs, the expansion path, Basics of Supply, Market Equilibrium

Unit-4: Cost Theory and Analysis : Cost concepts – Opportunity, Explicit, Marginal, Incremental and Sunk, Relation between Production & Cost, Short run cost function, Long run cost function, Special topics -Profit contribution analysis, Break Even analysis

Unit-5 :Pricing under Different Market Structures : Perfect Competition - Determination of Price output relationship in short run, long run, Monopoly - Determination of Price output relationship in short run & long run , Price discrimination, Monopolistic Competition - Determination of Price output relationship in short run &long run , Product Differentiation ,Oligopoly -Types ,Determination of Price output relationship ,Kinky demand curve {Stickiness of Price},Price leadership model, Collusive and Non Collusive Oligopoly

Teaching Methodology:

Teaching methodology in this course involves classroom lectures as well tutorials. The tutorials allow a closer interaction between the students and the teacher as each student gets individual attention. In tutorials, the teacher will be keeping track of each student's progress and address her/his individual difficulties. Written assignments and projects submitted by students as part of the course will also discussed in tutorials.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Reference Books/Material:

[1] Osborne, M. (2004), An introduction to game theory. Oxford University Press.

[2] Snyder, C., Nicholson, W. (2010), Fundamentals of microeconomics. Cengage Learning.

[3] Varian, H. (2010), Intermediate microeconomics: A modern approach, 8th ed. W. W. Norton.

[4] Bergstrom, T., Varian, H. (2014),Workouts in intermediate microeconomics. W. W. Norton

[5] Bernheim, B., Whinston, M. (2009). Microeconomics. Tata McGraw-Hill.

[6] Mankiw, N. (2007). Economics: Principles and applications, 4th ed. Cengage Learning.

[7] Snyder, C., Nicholson, W. (2010). Fundamentals of microeconomics. Cengage Learning.

Title: Fluid Mechanics Lab **Code:18B17CL371**

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: Students must be studying the course ***"Fluid and Fluid Particle Mechanics"*** simultaneously.

Objective:

This course will provide a basic understanding of flow measurements usingvarious types of flow measuringdevices, calibration and losses associated withthese devices.

Learning Outcomes:

Course Outcome	Description
CO1	Gain knowledge how to measure pressure, discharge, and velocity of fluid flow.
CO2	Characterize laminar and turbulent flows.
CO3	Demonstration of the mass, momentum, and energy equations.
CO4	Understand the working of different types of flow measuring equipments.
CO5	Learn to calibrate flow measuring devices used in pipes and channels.
CO6	Study major and minor losses in pipes.

Course Content:

List of experiments:

1. Verification of Bernoulli's Theorem.
2. Determination of Frictional Losses in Pipes of different diameters.
3. Determination of Minor Losses in Pipe.
4. Reynolds Dye Experiment for Flow Characterization.
5. Calibration of Venturimeter.
6. Calibration of V- Notch and Rectangular Notch.
7. Calibration of Orifice meter.
8. Calibration of Pitot Tube.
9. Determination of Metacentric Height.
10. Determination of C_c, C_v and C_d of an Orifice.

Teaching Methodology:

This lab is introduced to help students understand basic principles of fluid mechanics. The entire course is broken down into following separate sections: characterization of flow, flow equations, flow measuring devices, and losses in pipe flow. Each section includes some relevant experiments to help a student gain deeper understanding of the topic. This lab course is well complemented by a theory course under the name 'Fluid and Fluid Particle Mechanics' in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage
P-1	15 Marks	**Based on Lab Exercises: 1-5**

P-2		15 Marks	**Based on Lab Exercises: 6-10**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Fluid Mechanics Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Books:

1. Brown, G.G., "Unit Operations", CBS Publishers, New Delhi, 1995.
2. Coulson and Richardson, "Chemical Engineering-Volume II", 5th Ed.- Butterworth-Heinemann- 2002.
3. McCabe,W.L., Smith,J.C. and Harriott P, "Unit Operations of Chemical Engineering", 6th ed. Tata McGraw Hill, New Delhi, 2001.
4. Coulson,J.M., Richardson, J.F. Backhurst, J.R., and Harder J.H., "Coulson & Richardson's Chemical Engineering Vol 1 & 2", Pergamon Press.

Reference Books:

5. Gupta, S.K., "Momentum Transfer Operations" Tata McGraw Hill, New Delhi, 1982.
6. Bird, R.B., Stewart, W.E. and Lightfoot, E.N., "Transport Phenomena", 2nd ed., Wiley Eastern, New Delhi, 2002.
7. Gupta, V., and Gupta, S.K., "Fluid Mechanics and Its Applications", 1984.

Title: Fluid Particle Mechanics Lab **Code:18B17CL372**
L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: Students must be studying the course ***"Fluid and Fluid Particle Mechanics"*** simultaneously.

Objective:

Understand the basic principle of various mechanical operations, construction and working of equipments.

Learning Outcomes:

Course Outcome	Description
CO1	Learn how to do particle size distribution analysis.
CO2	Solve and analyze problems of size reduction.
CO3	Demonstration of working of size reduction equipments.
CO4	Know about the fluid-solid separation methods.
CO5	Work out fluid-solid separation based problems.
CO6	Analyze mixing process.

Course Content:

List of experiments:

1. To find out Rittinger's Constant, Kick's Constant and Bond's Constantby Jaw Crusher.
2. To determine Rittinger's Constant, Bond's Constant, Kick's constant and Work Index by Hammer Mill.
3. To find the specific surface and critical speed of Ball Mill.
4. To determine the terminal velocity, collective efficiency and cut diameter by a Cyclone Separator.
5. To study the effect of the froth floatation in the recovery of given sample from the mixture.
6. Evaluation of Specific cake resistance (α) and medium resistance (R) by Plate and Frame Filter Press.
7. To determine the specific cake resistance for the given slurry by Vacuum Leaf Filter.
8. To determine the screen effectiveness by performing a sieve analysis.
9. To determine terminal setting velocity of solids by Elutriator.
10. To study the operation of sigma mixer.

Teaching Methodology:

This lab is introduced to help students understand basic principles of fluid particle mechanics. The entire course is broken down into following separate sections: screening, size reduction, fluid-solid separations, and mixing. Each section includes some relevant experiments to help a student gain deeper understanding of the topic. This lab course is well complemented by a theorycourse under the name 'Fluid and Fluid Particle Mechanics' in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-5**
P-2		15 Marks	**Based on Lab Exercises: 6-10**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Fluid Particle Mechanics Lab(will be added time to time): Digital copy will be available on the JUET server.

Text Books:

1. McCabe, W.L., Smith, J.C., and Harriot, P., Unit Operations of Chemical Engineering, McGraw-Hill (2005).

2. Richardson, J.F., Harker, J.H. and Backhurst, J.R., Coulson and Richardsons Chemical Engineering, Vol. 2, Butterworth-Heinemann (2007).

Reference Books:

1. Foust, A.S, Wenzel, L.A, Clump, C.W., Maus, L. and Anderson, L.B., Principles of Unit Operations, John Wiley (2008).

2. Perry, R.H, and Green, D.W., Perry's Chemical Engineers' Handbook, McGraw Hill (2007).

3. Narayanan, C.M. and Bhattacharya, B.C., Mechanical Operations for Chemical Engineers Incorporating Computer Aided Analysis, Khanna Publishers (2005).

Title: Organic Chemistry Lab **Code: 18B17CL373**

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: The students must be aware of basic Chemistry Experiment at 2nd Semester. Basic knowledge of Organic Chemistry helps them to correlate in various division of Engineering during this lab.

Objective:

The purpose behind this course is to make the students familiar with the concepts of the Chemistry Experiment and to understand the significance of Orgaic Chemistry in various field of the Chemical Engineering.

Course LearningOutcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in still deep interests in learning chemistry; develop broad and balanced knowledge and understanding of key chemical concepts, principles, and theories related to chemistry; and equip students with appropriate tools of analysis to tackle issues and problems in the field of chemistry.
CO2	Describe the real world problems, challenges with application of the Chemistry in various fields of engineering (Chemical, Mechanical and Civil Engineering).
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in chemistry.
CO4	Identify and use of various analytical techniques in the Chemical, Mechanical and Civil Engineering project management.
CO5	Apply experimental demonstration and validation by using various analytical techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in chemistry and related areas or in multidisciplinary areas that involve chemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

LIST OF EXPERIMENTs

1. Preparation of organic compounds, their purification and determination of physical constant (at least 2)
2. Identification of organic compounds
    a. Single Organic compounds (at least 6)
    b. Binary mixture of solid organic compounds (at least 3)
3. Organic estimation:
    a. Estimation of phenol
    b. Estimation of aniline
4. Industrially important preparations:

a. Aspirin (Drug)
a. Bakelite (Polymer)

Teaching Methodology:

This course planned in 14 lab experiment and each experiment having 2 hours practical exposure in Chemistry lab. Their continuous evaluation will be performed in each week and weightage given during finalizing of the grade sheet. At the end of this course student will be able to: Understand the significance of the basic Chemistry in various field of engineering.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	Based on Lab Exercises: 1-7
P-2		15 Marks	Based on Lab Exercises: 8-14
Day-to-Day Work	Viva	20 Marks	70 Marks
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		100 Marks	

Learning Resources:

Study material of Web Technology Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book

[1] Organic Chemistry Lab Technique, Lisa Nichols Publisher, by Lisa Nichols, Butte Community College.

[2] Practical Chemistry Labs, by Leonard Saland, **Manufacturer:** Walch Education 015116.

[3] Kumar, H. Singh, G. Saxena 'Advanced Practical Chemistry Vol I: Systematic Qualitative Organic Analysis Preparation and Quantitative Analysis'.

[4] Kumar, H. Singh, G. Saxena 'Advanced Practical Chemistry Vol III: Experimental Physical Chemistry'

Reference Book

[1] Green Chemistry, by Sally A. Henrie, CRC Press Published March 18, 2015.

[2] Drinking Water Chemistry: A Laboratory Manual by Barbara Hauser, CRC Press Published August 21, 2001.

4th Semester

Course Title: Numerical methods **Code: 18B11MA411**
L-T-P scheme: 3-1-0 **Credits: 4**

Prerequisite: Students should have basic knowledge of calculus, differential equations and matrix algebra.

Objectives:

To make students aware of the concepts of numerical methods necessary for solving complicated mathematical problems numerically.

Learning Outcomes:

Course Outcome	This course will enable the students to:
CO1	Understand the concepts of finite differences, interpolation, extrapolation and approximation.
CO2	Learn various techniques of getting numerical solutions of system of linear equations and check the accuracy of the solutions.
CO3	Obtain numerical solutions of algebraic and transcendental equations.
CO4	Solve initial and boundary value problems in differential equations using numerical methods.
CO5	Work out numerical differentiation and integration whenever and wherever routine methods are not applicable.
CO6	Apply numerical methods to diverse situations in physics, engineering and in other mathematical contexts.

Course Content:

Unit-1: Solution of linear system of equations- Direct and iterative methods. Eigen values and Eigen vectors, Jacobi and Householder methods. Solution of a single and a system of non-linear equations

Unit-2: Interpolation and Approximation

Unit-3: Numerical differentiation, Numerical Integration, Gauss quadrature

Unit-4: Initial and boundary value problems in ODE, Numerical solution of PDE by finite difference method, Method of weighted residuals (MWR).

Methodology:

The course will be covered through lectures supported by tutorials. Apart from the discussions on the topics covered in the lectures, assignments and quizzes in the form of questions will also be given for practice.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Syllabus covered upto Test-1
Test-2	25 Marks	Syllabus covered upto Test-2
Test-3	35 Marks	Full Syllabus
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials, lecture slides and books on numerical methods will be available on the JUET server.

Text Books

1. "Applied Numerical Analysis", Gerald C.F., Wheatley P.O.,Pearson Education India; 7e, 2007.
2. "Numerical Methods", Jain, Iyengar &Jain, New age Int. Publication (P) Ltd, 6e.
3. "Numerical Methods", Grewal, B. S., Khanna Publisher; Eleventh edition, 2013.
4. "Advanced Engineering Math.", Erwin Kreyszig, John Wiley & Sons, INC.
5. "Introductory Methods of Numerical Analysis", S.S. Sastry, Prentice Hall India Ltd.

Title: Environmental Science **Code: 18B19GE399**

L-T-P Scheme:2-0-0 **Credit: 2**

Prerequisite: The students must be aware of basic Environmental Science upto class 12th. Basic knowledge of Environmental Science helps them to correlate in various division of Engineering during this course.

Objective:

The purpose behind this course is to make the students familiar with Environment (surrounding) and to understand the significance/importance of natural resource, biodiversity, environment pollution and impact of intervention of human being in the Ecosystem. This course is mandatory for all branches of the Engineering and Sciences.

Course Learning Outcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in learning the significance and importance of environment in their life.
CO2	Describe the real world problems, challenges with the suitable case study based on conservation (natural resource and biodiversity), ecosystem, socio-economic development and remedial measure of the various pollutions (air, water, soil, noise and radiation).
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in their surrounding (the Environment).
CO4	Identify and use of various techniques for solving the Environmental Problems.
CO5	Apply filed visit and justification by using various analytical techniques.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in the Environmental Science and related multidisciplinary areas that involve Environmental Science and help to develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT

Modules	Description	No. of lectures
Unit 1:	**Introduction to Environmental Science:** Multidisciplinary nature of environmental science; components of environment –atmosphere, hydrosphere, lithosphere and biosphere. Scope and importance; Concept of sustainability and sustainable development.	2
Unit 2:	**Ecosystems:** What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems:	4

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

Unit 3: **Natural Resources:** Renewable and Non-renewable Resources 5

• Land Resources and land use change; Land degradation, soil erosion and desertification.

• Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

• Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

• Heating of earth and circulation of air; air mass formation and precipitation.

• Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4: **Biodiversity and its conservation:** Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots. • India as a mega-biodiversity nation; Endangered and endemic species of India. • Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ 4

Conservation of biodiversity. • Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5: **Environmental Pollution:** Environmental pollution: types, causes, effects and controls; Air, water, soil, chemical and noise pollution. • Nuclear hazards and human health risks. • Solid waste management: Control measures of urban and industrial waste. • Pollution case studies. 5

Unit 6: **Environmental Policies & Practices:** Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.• Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC). 4

• Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context.

Unit 7: **Human Communities and the Environment** Human population and growth: Impacts on environment, human health and welfares. 4

• Carbon foot-print.

• Resettlement and rehabilitation of project affected persons; case studies.

• Disaster management: floods, earthquakes, cyclones and landslides.

• Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan.

• Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

• Environmental communication and public awareness, case studies (e.g., CNG
vehicles in Delhi).

Unit 8:	**Field Work:** Visit to a local area to document assets-river / forest / grassland /hill / mountain. polluted sites(Urban, rural ,industrial, agriculture), plants, insects, bird, Ecosystem (pond, river, hill slopes etc)	4
	Total	32

Teaching Methodology:

The core module Syllabus for Environment Science includes class room teaching and Field Work. The syllabus is divided into eight units covering lectures. The first seven units will cover 28 lectures, which are class room based to enhance knowledge skills and attitude to environment. Unit eight is based on field activities which will be covered in 4 lecture hours and would provide student firsthand knowledge on various local environmental aspects. Field experience is one of the most effective learning tools for environmental concerns. This moves out of the scope of the text book mode of teaching into the realm of real learning in the field, where the teacher merely acts as a catalyst to interpret what the student observes or discovers in his/her own environment. Field studies are as essential as class work and form an irreplaceable synergistic tool in the entire learning process. Course material provided by UGC for class room teaching and field activities is utilized.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 Unit 2 and Unit-3
Test-2	25 Marks	Based on Unit-4& Unit-5 (70 %) and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 to Unit-7 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

Text Book

[1] Bharucha Erach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, Ahmadabad – 380013, India.
[2] De Anil Kumar, Environmental Chemistry, Wiley Eastern Ltd, 2007.
[3] Agarwal KC, 2001. Environmental Biology, Nidhi Publishers Ltd. Bikaner.

Reference Book

[1] 3. Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480pgs.
[2] Clark R B, Marine Pollution, Clanderson Press, Oxford (TB).2001.
[3] Cunningham WP, Cooper TH, Gorhani E & Hepworth MT, 2001. Environmental Encyclopedia, Jaico Publishing House, Mumbai, 1196 pgs.
[4] Gleick HP, 1993. Water in Crisis, Pacific Institute for Studies in Development, Environment and Security. Stockholm Environmental Institute, Oxford University Press, 473pgs.
[5] Heywood VH, and Watson RT, 1995. Global Biodiversity Assessment. Cambridge University Press 1140pgs.
[6] Jadhav H and Bhosale VM, 1995. Environmental Protection and Laws. Himalaya Publishing House, Delhi 284pgs.
[7] Mckinney ML and Schoch RM, 1996. Environmental Science Systems and Solutions. Web enhanced edition, 639pgs.

Title: Heat Transfer Operations **Code: 18B11CL411**

L-T-P scheme: 3-1-0 **Credit: 4**
Prerequisite: PHYSICS-I

Objective:

This course is designed so that students can deal with industrial heat transfer processes.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of heat transfer operations in chemical industries.
CO2	Understand basic principles of heat transfer like conduction, convection and radiation.
CO3	Identify and solve the problems based on basic principles of heat transfer.
CO4	Develop the concepts about phenomena of boiling and condensation.
CO5	Describe heat exchangers and evaporators.
CO6	Demonstrate the process design of different types of heat exchangers and evaporators

Course content:

Unit-1:
Mechanisms of heat flow, conduction, natural and forced convection, radiation heat transfer to fluids without and with phase change. [1]

Unit-2:
Basic laws of conduction. Concept of resistance to heat transfer. Steady state conduction through single and compound resistances in series. Insulation & critical radius. Extended Heat transfer, Numerical and graphical methods for unsteady state conduction. [5]

Unit-3:
Dimensional analysis and dimensionless numbers. Mean temperature difference. Individual film and overall heat transfer by forced convection in laminar flow for fluids in circular pipes. [6]

Unit-4:
Heat transfer by forced convection in turbulent flow. Heating and cooling of fluids in forced convection. Natural convection heat transfer. Steady and unsteady state heat transfer in agitated vessels. [6]

Unit-5:
Heat transfer from condensing vapors. Heat transfer to boiling liquids. [3]

Unit-6:
Black body radiation. Stefan-Boltzmann law. Planck's law. Wien's displacement law. Kirchoff's law. Gray body radiation. Radiation between surfaces. View factors. Radiation from non-luminous gases and luminous flames. Combined conduction, convection and radiation. Design of furnaces. [6]

Unit-7:
Types of heat exchange equipment and their utility. Criterion of selection. Design of shell and tube heat exchangers, multi-pass exchangers. [5]

Unit-8:
Kern's method and Donohue equation to estimate shell side heat transfer coefficient. Effectiveness. NTU method. [5]

Unit-9:
Types of tubular evaporators. Performance capacity and economy. Design of single effect evaporator with negligible and appreciable heat of dilution. Multiple effect evaporators. Methods of feeding. Capacity and economy. Design of multiple effect evaporators with effect of liquid head and boiling point elevation. Vapour recompression. [5]

Teaching Methodology:

This course is introduced to help students understand basic principles of heat transfer along with the design of heat transfer equipments like double pipe heat exchanger, shell & tube heat exchanger, evaporator, etc. The entire course is broken down into following separate units: conduction, convection, radiation, heat exchange equipments, evaporators. Each section includes multiple topics to help a student gain deeper understanding of the subject. This theory course is well complemented by a laboratory course under the name Heat Transfer Operations Lab-I in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 to Unit-3
Test-2	25 Marks	Based on Unit-4 to unit-6, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text book:

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", 6th ed, Tata McGraw Hill, New Delhi, 2001.

Reference books:

2. Brown, G.G., "Unit Operations", CBS Publishers, New Delhi, 1995.
3. Kern, D.Q., "Process Heat Transfer" McGraw Hill, New delhi, 1965
4. Kreith, F., Bohn, M.S., "Principles of Heat transfer", 6th edition, Thomson Learning, 2001
5. Holman, J.P., "Heat Transfer", 9th edition, McGraw Hill, 2001

Title: Mass Transfer Operations **Code: 18B11CL412**
L-T-P scheme: 3-1-0 **Credit: 4**
Prerequisite:NIL

Objective:

Objective of designing of this course is to develop the fundamental understanding of basic mass transfer processes associated in chemical and allied industries.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of mass transfer operations in chemical industries.
CO2	Understand different types of mass transfer coefficients.
CO3	Describe the use of appropriate unit operation for a given separation.
CO4	Develop equations for estimating diffusivity in different phases.
CO5	Apply principles of mass transfer to find out the number of stages.
CO6	Demonstrate the complete design of distillation and absorption column.

Course Content:

UNIT – 1 INTRODUCTION

Mass transfer operations and their importance. Methods of conducting mass transfer operations. Diffusional operations and equilibrium stages**.**

UNIT – 2 DIFFUSION AND MASS TRANSFER BETWEEN PHASES

Theory of diffusion. Prediction of diffusivities. Mass transfer theories. Mass transfer coefficients.

UNIT – 3 EQUIPMENT FOR GAS-LIQUID OPERATIONS

Equipment where gas is dispersed such as bubble columns, mechanically agitated contactors, and tray towers. Equipment where liquid is dispersed such as spray towers, packed towers and wetted-wall towers. Tray towers vs packed towers**.**

Unit – 4 DISTILLATION

Vapor-liquid equilibrium. Relative volatility. Flash vaporization. Differential distillation. Continuous rectification of binary systems. Method of McCabe and Thiele. Method of Ponchon and Savarit. Batch distillation. Low pressure distillation. Azeotropic and extractive distillation. Steam distillation.

Unit – 5 GAS ABSORPTION

Equilibrium solubility of gases in liquids. Material balances. Countercurrent multistage operations. Equilibrium stages and transfer units. Stage efficiency. Packings and packed tower internals.Sizing of packed towers. Absorption from lean and rich gases. Absorption in plate columns.

UNIT – 6 HUMIDIFICATION OPERATIONS

Humidification and dehumidification. Definitions. Humidity charts and their usage. Air conditioning, Countercurrent, co-current and cross-current operations. Mass and heat balances in bulk and interfaces.

UNIT – 7 DRYING

Wet bulb, dry bulb and adiabatic saturation temperatures. Humidity. Drying mechanism. Drying rate curves. Estimation of drying time

UNIT – 8 CRYSTALLIZATION

Solubility curves. Theories of crystallization. Nucleation and crystal growth. CSD, MSMPR operation. Population balance method..

Teaching Methodology:

This course is introduced to help students understand basic principles of mass transfer along with the design of mass transfer equipment like absorption column, distillation column etc. The entire course is broken down into following separate units:
Diffusion, Equipment for mass transfer, absorption, distillation, humidification. Each section includes multiple topics to help a student gain deeper understanding of the subject. This theory course is well complemented by a laboratory course under the name Mass Transfer Operations Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2& Unit-3
Test-2	25 Marks	Based on Unit-4& Unit-5 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 to Unit-8 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit Operations of Chemical Engineering", 6thed., McGraw Hill, New Delhi, 2001.
2. Treybol, R.E., "Mass-Transfer Operations", 3rd ed., McGraw Hill, New Delhi, 1981.
3. Dutta, B. K., " Principles of Mass Transfer and Separation Processes", 4th ed., PHI, New Delhi, 2010

REFERENCE BOOKS:

1. Cussler, E.D., "Diffusion Mass Transfer in Fluid Systems", Cambridge Univ. Press, Cambridge, 1984.
2. Foust, A.S., "Principles of Unit Operations", 2nd ed., Wiley, New York, 1980.
3. Geankopolis, C.J., "Transport Processes and Unit Operations", 3rd ed., Prentice Hall India, New Delhi, 1993.
4. Smith, B.D., "Design of Equilibrium Stage Processes", McGraw Hill, New York, 1980

Title: Heat Transfer Operations Lab – I **Code: 18B17CL471**
L-T-P scheme: 0-0-2 **Credit: 1**
Prerequisite: Students must be studying the course ***"Heat Transfer Operations"*** simultaneously.

Objective:

The laboratory course is aimed to provide the practical exposure to the students with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation & boiling.

Learning Outcomes:

Course Outcome	Description
CO1	Get familiar with the phenomena of heat transfer by conduction and determine thermal conductivity of liquid and solid.
CO2	Understand the significance of fin and determine fin efficiency.
CO3	Know about convection heat transfer and determine heat transfer coefficients in case of natural and forced convection.
CO4	Learn about radiation heat transfer and determine the emissivity of test plate.
CO5	Demonstrate the functioning of heat exchangers.
CO6	Describe the concepts of boiling and condensation.

Course Content:

Unit-1:

Lab Exercises based on conduction -

1. To determine the thermal conductivity of a liquid.
2. To determine the thermal conductivity of the composite wall.
3. To determine the thermal conductivity of metal bar.

Unit-2:

Lab Exercises based on fin –

1. To study the temperature distribution along of a pin fin under free and forced convection.

Unit-3:

Lab Exercises based on convection –

1. To find out the heat transfer coefficient of a vertical cylinder in natural convection.
2. To find out the heat transfer coefficient in forced convection.

Unit-4:

Lab Exercises based on radiation –

1. To find out the emissivity of a test plate.

Unit-5:

Lab Exercises based on heat transfer equipments –

1. To calculate overall heat transfer coefficient for double pipe heat exchanger.
2. To calculate overall heat transfer coefficient for shell and tube heat Exchanger.

Unit-6:

Lab Exercises based on boiling –

1. Determination of critical heat transfer coefficient for boiling.

Teaching Methodology:
This lab is introduced to help students understand basic principles of heat transfer and functioning of heat transfer equipments like double pipe heat exchanger, shell & tube heat exchanger, evaporator, etc. The entire course is broken down into following separate units:
conduction, convection, radiation, heat exchange equipments, evaporators, and boiling & condensation. Each section includes some relevant experiments to help a student gain deeper understanding of the topic. This lab course is well complemented by a theory course under the name Heat Transfer Operations in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-5**
P-2		15 Marks	**Based on Lab Exercises: 6-10**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Heat Transfer Operations Lab – I (will be added time to time): Digital copy will be available on the JUET server.

Text book:

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", 6th ed, Tata McGraw Hill, New Delhi, 2001.

Reference books:

2. Brown, G.G., "Unit Operations", CBS Publishers, New Delhi, 1995.
3. Kern, D.Q., "Process Heat Transfer" McGraw Hill, New delhi, 1965
4. Kreith, F., Bohn, M.S., "Principles of Heat transfer", 6th edition, Thomson Learning, 2001
5. Holman, J.P., "Heat Transfer", 9th edition, McGraw Hill, 2001.

Title: Mass Transfer Operations Lab **Code: 18B17CL472**
L-T-P scheme: 0-0-2 **Credit: 1**
Prerequisite:NIL

Objective:

Objective of designing of this course is to develop the fundamental understanding of basic mass transfer processes associated in chemical and allied industries.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of mass transfer operations in chemical industries.
CO2	Understand applications and use of various mass transfer coefficients.
CO3	Describe the use of appropriate unit operation for a given separation.
CO4	Implement equations for estimating diffusivity in different phases.
CO5	Apply principles of mass transfer to find out the number of stages.
CO6	Demonstrate the complete working of various mass transfer equipment.

Course Content:

LIST OF EXPERIMENTS:

1. To determine diffusion coefficient or diffusivity, of given liquid (acetone) in air by using ARNOLD's cell.
2. To find the absorption efficiency of the mechanical agitator vessel.
3. To verify Rayleigh's Equation by carrying out differential distillation of Binary Mixture.
4. To determine the effective interfacial area a, as a function of the superficial liquid velocity, $V_{L,}$ in a packed column using the theory of Gas Absorption accompanied by fast chemical reaction.
5. To study the operation of a packed bed batch rectification column under constant or total reflux condition.
6. To carry out steam distillation.
7. Wetted Wall Column.
8. Diffusion coefficient of solid in air.
9. Rotary Dryer.

Teaching Methodology:

This course is introduced to help students understand basic principles of mass transfer along with the design of mass transfer equipment like absorption column, distillation column etc. The entire course is broken down into following separate units:

Diffusion, Equipment for mass transfer, absorption, distillation, humidification. Each section includes multiple topics to help a student gain deeper understanding of the subject. This lab course is well complemented by a theory course under the name Mass Transfer Operations in the same semester that helps a student learn and discuss the technical details of the underlying technologies.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-6**
P-2		15 Marks	**Based on Lab Exercises: 7-9**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Mass Transfer Operations Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Laboratory Manual available in Lab
[2] Study material available in related folder of Server
[3] Treybol, R.E., "Mass-Transfer Operations", 3rd ed., McGraw Hill, New Delhi, 1981.
[4] Dutta, B. K., " Principles of Mass Transfer and Separation Processes", 4th ed., PHI, New Delhi, 2010

Reference Books/Material:

5. Cussler, E.D., "Diffusion Mass Transfer in Fluid Systems", Cambridge Univ. Press, Cambridge, 1984.
6. Foust, A.S., "Principles of Unit Operations", 2nd ed., Wiley, New York, 1980.
7. Geankopolis, C.J., "Transport Processes and Unit Operations", 3rd ed., Prentice Hall India, New Delhi, 1993.
8. Smith, B.D., "Design of Equilibrium Stage Processes", McGraw Hill, New York, 1980

5th Semester

Title: Chemical Reaction Engineering **Code: 18B11CL511**
L-T-P scheme: 3-1-0 **Credit: 4**

Prerequisite:NIL

Objective: The objective of this course is the successful design and operation of chemical reactors**.**

Learning Outcomes:

Course Outcome	Description
CO1	Outline the significance of chemical reactors in various process industries.
CO2	Understand different reaction mechanisms along with kinetic expressions for homogeneous reactions.
CO3	Describe different types of reactors for carrying out reactions.
CO4	Develop performance equations for reactors such as batch, PFR and CSTR.
CO5	Apply material and energy balance equations for the design of adiabatic and non-isothermal reactors.
CO6	Demonstrate the complete design of all the reactors.

Course Content:

UNIT-1: INTRODUCTION

Examples of various types of reactions. Reversible vs. irreversible reactions. Homogeneous and heterogeneous reactions. Catalytic and non catalytic reactions, auto-catalytic reactions. Rate of reactions, order and molecularity.

UNIT-2: REACTION KINETICS OF HOMOGENEOUS SYSTEMS

Formulation and solution of rate equations for simple and complex reactions in batch reactor. Effect of thermodynamic equilibrium. Temperature dependence. Reaction mechanism and influence on reaction kinetics, plausible mechanism via reaction kinetics.

UNIT-3: ANALYSIS OF EXPERIMENTAL DATA

Integral methods of analysis of data. Order of reaction. Reversible and irreversible reaction. Non catalytic, homogeneous catalyzed, and auto catalytic reactions. Reactions in parallel or/and series. Differential method of analysis of data. Partial analysis of rate of reaction. Analysis of complete rate of reaction.

Unit – 4: TYPES OF REACTORS

Ideal batch reactor and concept of batch time. Flow reactors and concepts of space time/space velocity and holding time/residence time. Ideal mixed flow reactor (MFR) and plug flow reactor (PFR).

Unit – 5: DESIGN OF SINGLE REACTIONS

Single reactor-performance of reversible and irreversible first order/pseudo first order, second order reactions for MFR, PFR. Graphical and analytical techniques. Combination of reactors-PFR in series/parallel, unequal sized MFR in series, performance of the above for first and

second order reactions. Recycle reactor and auto catalytic reaction. Semibatch reactor and recycle reactors.

Unit – 6: DESIGN FOR COMPLEX REACTIONS

Irreversible reactions in series/parallel with same/different order in various combination. Reversible reactions in series/parallel applications.

Unit – 7: TEMPERATURE AND PRESSURE EFFECTS

Single reaction-endothermic/exothermic effects. Effect of temperature on thermodynamic equilibrium and heats of reaction. Effect of temperature on reactor performance for adiabatic non adiabatic operation. Case of exothermic reactions in mixed reactors. Optimum temperature progression. Multiple reactions- Effect on product distributions. Temperature and scale effect on productivity of reactor. Various problems based on the design of non-isothermal reactors are to be solved by using various numerical methods.

Unit – 8: NONCATALYTIC HETEROGENEOUS REACTIONS

Various models, case of film diffusion, ash diffusion and chemical reaction controlling.

Unit – 9: KINETICS OF FLUID-FLUID REACTIONS

Chemical Reaction with mass transfer

Unit – 10: CATALYTIC HETEROGENEOUS REACTIONS

Physical adsorption and chemisorption. Surface area and pore size distribution. Langmuir-Hinshelwood model. General mechanism for solid catalyzed fluid phase reaction. Special cases intrinsic kinetics and various cases of adsorption and reaction stage control. Effectiveness factor. Experimental method for study of heterogeneous catalytic reactions.

Teaching Methodology:

This course is introduced to help students understand basic principles of different types of reactors along with their design employed in the chemical industries for carrying out homogeneous reactions. The entire course is broken down into following separate units: Intorduction, Reaction kinetics, Analysis of experimental data, Types of reactors and their design, design of single and parallel reactions, Heat effects, introduction to catalytic heterogeneous reactions. Each section includes multiple topics to help a student gain deeper understanding of the subject. This theory course is well complemented by a laboratory course under the name Chemical Reaction Engineering Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2 , Unit-3 & Unit-4
Test-2	25 Marks	Based on Unit-5 , Unit-6 , Unit-7 & Unit-8 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-9 & Unit-10 and around 30% from coverage of Test-2
Assignment	10 Marks	

Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Levenspiel , O., "Chemical Reaction Engineering", John Wiley and Co. (latest edition)
2. Smith, J. M., "Chemical Engineering Kinatics", McGraw Hill (Latest edition)
3. Laidler, K. J., "Chemical Kinetics" Tata McGraw Hill, 1973

REFERENCES BOOKS:

1. Haugen, O. A., and Watson, K. M., "Chemical Process Principles" part-3, "Kinetics and Catalysis", John Wiley, 1964
2. Hill, C. G., "Chemical Reaction Engineering"
3. Walas, "Reaction Kinetics for Chemical Engineers", Tata McGraw Hill, 1959
4. Sharma, M. M., and Daraiswami, L. K., "Heterogeneous Reactions" vol.-1, John Wiley.

Title: Instrumentation and Process Control **Code: 18B11CL512**
L-T-P scheme: 3-1-0 **Credit: 4**
Prerequisite:NIL

Objective:

The objective this course is to provide basic knowledge about primary as well as secondary instruments. Need of process control in chemical industries.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the basic concepts of process control.
CO2	Understand instruments characteristics and sensors for important process variables.
CO3	Describe types of valves and valve characteristics.
CO4	Know about process dynamics, modes of control, and transient behaviour of closed loops.
CO5	Demonstrate the stability & performance analysis of control systems.
CO6	Explain digital control system, advanced control strategies, and application of process control in common industrial operations.

Course content:

Unit-1:

Motivation for process control, concept of feed back and feed forward control, process dynamics in time, Laplace and frequency domains. Concept of stability and optimal control.

Unit-2:

Instrumentation: General performance and characteristics of instruments, Errors and their types. Calibration standards. Different types of sensors. Sensors for important process variables such as temperature, pressure, flow and level.

Unit-3:

Control valves: Types of valves, inherent effective valve characteristics. Selection and sizing of valves.

Unit-4:

Process dynamics: Models for first and second and higher order systems. Linearization. Response to step, ramp, sinusoidal, pulse and impulse inputs.

Unit-5:

On-off, proportional, integral, derivative and their combinations. Open loop behavior of controllers. Closed loop transfer functions for servo and regulator problems. Transient behavior of closed loop.

Unit-6:

Stability & performance analysis of control systems: Use of Root locus and Frequency Response analyses. Gain margin and phase margin in controller tuning. Performance criterion-IAE, ISE and IATE. Ziegler-Nichols and Cohen-Coon rules**.**

Unit-7:

Digital control systems: Fundamentals of digital control. A/D, D/A converters. Introduction to Z-transforms. Direct Digital Controls and Distributed Control Systems.

Advanced control strategies: Ratio control, cascade and adaptive controls. **Unit-8:**

Applications of process control: Control strategies for common industrial operations such as heat exchanger, distillation column and reactors.

Teaching Methodology:
This course is introduced to help students understand basic principles of Instrumentation and Process Control. The entire course is broken down into following separate units: instrumentation, control valves, process dynamics, modes of control, stability analysis, tuning of controller, digital control system, and application of control for common industrial operations. Each section includes multiple topics to help a student gain deeper understanding of the subject. This theory course is well complemented by a laboratory course under the name Instrumentation and Process Control Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 to Unit-3
Test-2	25 Marks	Based on Unit-4 to Unit-6, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 to Unit-8 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Luyben, W.L., "Process Modelling, Simulation and Control for Chemical Engineers", McGraw Hill International Edition, 1990.
2. Bequette W., "Process Control: Mathematical Modeling and Simulation and Control", Prentice Hall India., 2003
3. Stephanopolous, G., "Chemical Process Control" Prentice-Hall of India, 1990.
4. Coughaowr, "Process System Analysis and Control"
5. Riggs, J.B., "Chemical Process Control"
6. Marlin, T.E., "Process Control", McGraw Hill, 1995.

Reference Books:

1. Bentley, J.P., "Principles of Measurement Systems", Longmann, 1988
2. Liptak, B., "Instrumentation Engineers Hand Book", Butterworths Heinmann, 1995.
3. Nakra, B.C., and Chaudhury, K.K, "Instrumentation Measurement and Analysis", Tata McGraw Hill, 1985.
4. Considine, "Process/Industrial Instruments and Control Hand Book", McGraw Hill, 1993.

5. Patranabish, D., “Principles of Industrial Instrumentation.” Tata McGraw Hill.

Title: Process Modeling and Simulation **Code: 18B14CL541**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Basic knowledge of numerical techniques, probability and statistics, and programming.

Objective:

This course is designed to provide juniors in chemical engineering the tools necessary to formulate chemical engineering problems using the concepts learned in the core chemical engineering courses. In addition, various techniques for solving algebraic and differential equations are presented in this course. All fundamental concepts are introduced with applications related to chemical engineering using modern software tools. The course aims at making chemical engineering students adequately trained to use modeling techniques in different areas to maximize the operational efficiency and economic gains.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the basic concepts of modelling & simulation.
CO2	Explain fundamental laws for the development of mathematical model.
CO3	Learn numerical methods to solve different types of equations.
CO4	Apply numerical methods to solve problems encountered in chemical engineering.
CO5	Develop the models for some chemical engineering problems.
CO6	Understand scaling of model equations for momentum, heat and mass transfer.

Course Content:

Unit-1:

Introduction to process modeling and simulation, Examples of chemical engineering problems arising in fluid mechanics, thermodynamics, heat and mass transfer, separation processes, reaction engineering, process dynamics, and transport phenomena. Uses of mathematical models: scope of coverage, principles of formulation. Algorithm and flow diagram for development of mathematical model. Development of process model: steady-state and dynamic models, lumped parameter and distributed parameter models, time constants and transients.

Unit-2:

Fundamental Laws: Continuity Equations, Energy Equation, Equations of Motion, Transport Equations, Equations of State, Equilibrium, Chemical Kinetics. Application of principles of conservation and types of boundary conditions: Ideal CSTR, Ideal Batch Reactor, Ideal PFR, tubular reactor axial dispersion model. Multiplicity and Instability in systems. Stability of steady states or control systems.

Unit-3:

State space models: matrix algebra, eigenvalues, eigenvectors, eigenvalue problems, general and physical solution. Properties of eigenvalues and eigenvectors, Cayley-Hamilton theorem, Sylvester's formula, Gram Schmidt Orthogonalization procedure. Numerical solution by power method and polynomial method. Staged-process models: modeling of multiple stages - solution methods for linear finite difference equations, particular solution methods e.g. method of undetermined coefficients, inverse operator method. Numerical solution techniques for solving the initial and boundary value problems; Solution of higher order and system of ordinary differential equations. Numerical solution techniques for solving single and systems of non-

linear algebraic equations. Dynamic and steady state model of a staged gas absorber, distillation column, and extraction column, Multiple Effect Evaporator. Analysis of a non-isothermal CSTR.

Unit-4:
Population balance models, RTD models e.g. Ideal PFR, N-Tanks in series model, models of a real CSTR, Back Flow Cell Model, Deterministic Approach, Expected Value, Moments of Probability density function.
Unit-5:
Scaling of model equations for momentum, heat and mass transfer. Steady state process flowsheeting, macroscopic, microscopic, and economic Analysis.

Teaching Methodology:

This course is introduced to help students understand basic principles of Process Modeling and Simulation. At the conclusion of this course, student should be able to:

1. Model various processes using chemical engineering principles.
2. Use concepts of material and energy balances, thermodynamics, fluid dynamics, and kinetics to develop model equations.
3. Use computer software and programming languages to solve complex Chemical Engineering systems.

The entire course is broken down into following separate units: introduction to modeling & simulation, fundamental laws related to modeling, numerical methods to solve chemical engineering problems, modeling of some important chemical systems, and scaling of model equations. Each section includes multiple topics to help a student gain deeper understanding of the subject. This subject is complementedwith the lab entitled Process Modeling and simulation lab in the same semester.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 to Unit-2
Test-2	25 Marks	Based on Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-3 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.
Text Books:

1. Transport phenomena R.B. Bird, W.E. Stewart and E. Lightfoot John Wiley, 1960
2. Mathematical methods in Chemical Engineering, S. Pushpavanam, Prentice Hall of India 1998.
3. Mathematical methods in Chemical Engineering : Matrices and their Applications, N.R. Amundson Prentice Hall, 1966
4. Computational Methods in Chemical Engineering O.T. Hanna and O.C. Sandall
5. Mathematical Methods in Chemical and Environmental Engineering,, A.K. Ray and S.K. Gupta, Thomson Learning, 2004.
6. Applied Mathematics and Modelling for Chemical Engineers, R.G. Rice and D.D. Do, Wiley 1995.
7. Process Modeling, Simulation, and Control for Chemical Engineers, William L. Luyben, McGraw-Hill, 1996.
8. Fundamentals and Modeling of Separation Processes, C.D. Holland, Prentice Hall Inc. 1975.

Reference Books:

1. Mathematical Methods in Chemical Engineering Vol. 1 and 2. Aris, R. and Amundson, N.R. Prentice Hall, 1973
2. Modeling with differential equations in Chemical Engineering, M. Walas, Butterworth Heinemann, 1991
3. The Mathematical Understanding of Chemical engineering Systems Aris, R and Varma, A. Pergamon, 1980
4. Mathematical Methods in Chemical Engineering, A. Varma and M. Morbidelli, Oxford Univ. Press, 1997.

Title: Transport Phenomena **Code: 18B14CL542**

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Fluid and Fluid Particle Mechanics, Heat Transfer Operations, Mass Transfer Operations.

Objective:

Transport Phenomena is the subject which deals with the movement of different physical quantities such as momentum, energy and mass in any chemical or mechanical process and combines the basic principles (conservation laws) and laws of various types of transport.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the basic concepts of transport phenomena.
CO2	Setup overall balances for conservation of momentum, energy and mass.
CO3	Recognize and apply analogies among momentum, heat and mass transfer.
CO4	Reduce and solve the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration.
CO5	Utilize information obtained from solutions of the balance equations to obtain Engineering quantities of interest.
CO6	Reduce and solve appropriate macroscopic balances for conservation of momentum, energy and mass.

Course Content:

Unit-1:

Introduction to transport phenomenon: classification of transport processes, conservation laws, vector and tensor calculus.

Unit-2:

Principles of momentum transport: concept of viscosity, newton's law of viscosity, shell momentum balance, application of shell momentum balance, flow of falling film, flow through circular pipe, flow through annulus, flow over moving plate, couette viscometer, equation of changes: continuity equation, equation motion, navier-stokes equation in cartesian co-ordinate's and cylindrical co-ordinate, basics of velocity distribution.

Unit-3:

Principles of steady state heat transport: steady state condition and fourier's law, shell energy balance, applications of shell energy balance: heat conduction with electrical source, heat conduction with chemical heat source, temperature distribution in two concentric cylinder's, natural convention heat transfer governing equation, flow over flat plate.

Unit-4:

Principles of mass transport: equation of molecular mass transport, molecular diffusion in gases, equimolar counter diffusion, diffusion of A through non-diffusing B, mass and molar transport by convection: mass and molar concentrations, mass average and molar average velocity, molecular mass and molar fluxes, convective mass and molar fluxes.

Teaching Methodology:

This course is introduced to help students understand in detail transport phenomena. The entire course is broken down into following separate units: introduction to transport phenomenon, principles of momentum transport, principles of steady state heat transport, and principles of mass transport. Each unit includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 to Unit-2
Test-2	25 Marks	Based on Unit-2 to Unit-3, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-3 to Unit-4 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books/Reference Books:

1. R. Byron Bird, "Transprt Phenomena", 2nd Edition, John Wiley & Sons (Asia) pvt.Ltd.
2. Christie John Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, PHI Learning Private Limited., NewDelhi
3. Incropera, "Fundamentals of Heat and Mass Transfer", 6th Edition, John Wiley & Sons (Asia) pvt. Ltd.
4. W.J.Thomson, "Introduction to Transport Phenomena", Pearson Education Asia, New Delhi,2001.

Title: Chemical Reaction Engineering Lab **Code: 18B17CL571**
L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite:NIL

Objective: The objective of this course is the successful design and operation of chemical reactors**.**

Learning Outcomes:

Course Outcome	Description
CO1	Outline the significance of chemical reactors in various process industries.
CO2	Understand different reaction mechanisms along with kinetic expressions for homogeneous reactions.
CO3	Describe different types of reactors for carrying out reactions.
CO4	Develop performance equations for reactors such as batch, PFR and CSTR.
CO5	Apply material and energy balance equations for the design of adiabatic and non-isothermal reactors.
CO6	Demonstrate the complete design of all the reactors.

Course Content:

LIST OF EXPERIMENTS:

1. To study a non-catalytic homogeneous reaction in a plug flow reactor (PFR).
2. To study a non-catalytic homogeneous reaction in a coil type plug flow reactor under ambient conditions.
3. To study a non-catalytic homogeneous reaction in a CSTR under isothermal conditions.
4. To study a second order saponification reaction (between Ethyl acetate and NaOH) in a Semi Batch Reactor under isothermal condition (i.e. at a fixed temperature).
5. To study a non-catalytic homogeneous reaction in an isothermal Batch Reactor.
6. To study a non-catalytic homogeneous second order liquid phase reaction in a CSTR under ambient conditions.
7. To study the performance of a cascade of three equal volumes CSTRs in series for the saponification of Ethyl acetate with NaOH.
8. To study a non-catalytic homogeneous reaction in a series arrangement of PFR and CSTR.

Teaching Methodology:

This course is introduced to help students understand basic principles of different types of reactors along with their design employed in the chemical industries for carrying out homogeneous reactions. The entire course is broken down into following separate units: Intorduction, Reaction kinetics, Analysis of experimental data, Types of reactors and their design, design of single and parallel reactions, Heat effects, introduction to catalytic heterogeneous reactions. Each section includes multiple topics to help a student gain deeper understanding of the subject. This lab course is well complemented by a theory course under the name Chemical Reaction Engineering in the same semester that helps a student learn and discuss the technical details of the underlying technologies.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-5**
P-2		15 Marks	**Based on Lab Exercises: 6-8**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Chemical Reaction Engineering Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Laboratory Manual available in Lab
[2] Study material available in related folder of Server
[3] Levenspiel , O., "Chemical Reaction Engineering", John Wiley and Co. (latest edition)
[4] Smith, J. M., "Chemical Engineering Kinatics", McGraw Hill (Latest edition)
[5] Laidler, K. J., "Chemical Kinetics" Tata McGraw Hill, 1973

Reference Books/Material:

1. Haugen, O. A., and Watson, K. M., "Chemical Process Principles" part-3, "Kinetics and Catalysis", John Wiley, 1964
2. Hill, C. G., "Chemical Reaction Engineering"
3. Walas, "Reaction Kinetics for Chemical Engineers", Tata McGraw Hill, 1959
4. Sharma, M. M., and Daraiswami, L. K., "Heterogeneous Reactions" vol.-1, John Wiley.

Title: Heat Transfer Operations Lab-II **Code:**18B17CL573
L-T-P scheme:0-0-2 **Credit:** 1

Prerequisite: Heat Transfer Operations

Objective:

The laboratory course is aimed to provide the practical exposure to the students about some heat transfer equipments and make them to learn to design some important heat transfer equipments.

Learning Outcomes:

Course Outcome	Description
CO1	Demonstration of working of boiler.
CO2	Understand working and design of single effect evaporator.
CO3	Learn to design multiple effect evaporators.
CO4	Study different types of evaporators, heat exchangers, and types of fin.
CO5	Know the designing method of double pipe heat exchanger.
CO6	Gain knowledge of designing methods of shell & tube heat exchangers.

Course Content:

Unit-1:

Experiments on double pipe heat exchangers, shell & tube heat exchangers, and evaporators.

Unit-2:

Design problems on various types of heat exchangers like double pipe, shell and tube, plate type.

Unit-3:

Design problems on various types of evaporators such as single effect, multiple effect (forward and backward feed).

Unit-4:

Design problems on condensers.

Teaching Methodology:

This lab is introduced to help students to learn designing concepts in detail for heat transfer equipments. The entire course is broken down into following separate sections: experiments on heat exchangers and evaporators, design of heat exchangers, design of evaporators, and design of condensers. Each section includes some relevant experiments/class assignments/lectures/home assignments/seminars to help students to gain deeper understanding of the topic.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on unit-1 & unit-2**
P-2		15 Marks	**Based on unit-3 & unit-4**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Heat Transfer Operations Lab – I (will be added time to time): Digital copy will be available on the JUET server.

Text Book:

1. Holman, J.P., "Heat Transfer", 9th edition, McGraw Hill, 2001
2. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", 6th ed, Tata
McGraw Hill, New Delhi, 2001.

Reference Books:

3. Kern, D.Q., "Process Heat Transfer" McGraw Hill, New delhi, 1965.
4. Kreith, F., Bohn, M.S., "Principles of Heat transfer", 6th edition, Thomson Learning, 2001
5. Sadik K Kakac, Hongton Liu " Heat exchangers selection, Rating, Thermal Design", 2nd Edition CRC
Press 1998.
6. J. E Hesselgreaves , "Compact Heat Exchangers Selection, Design and Operation" Pergamon 2001.
7. Brown, G.G., "Unit Operations", CBS Publishers, New Delhi, 1995.

Title: Instrumentation and Process Control Lab **Code: 18B17CL572**
L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: Students must be studying the course ***"Instrumentation and Process Control"*** simultaneously.

Objective:

The main objective of this lab course is to provide the basic understanding of process dynamics, modes of control, and instrumentation.

Learning Outcomes:

Course Outcome	Description
CO1	Learn about the significance of process dynamics in process control.
CO2	Understand about working and calibration of instruments.
CO3	Describe valve characteristics.
CO4	Study of transient behaviour of closed loops.
CO5	Know about controller parameter tuning.
CO6	Demonstration of control of different process variables.

Course Content:

List of experiments:

1. Two Tank Interacting System
2. Two Tank Non-Interacting System
3. Measurement of Temperature using Thermocouple
4. Measurement of Temperature using RTD
5. Temperature Control Trainer using PID
6. Time Constant of Thermometer
7. Water Level Measuring Tutor
8. Dead Weight Pressure Gauge
9. Level Control Trainer using PID
10. Temperature Measurement using RTD
11. Study of PID Controller
12. Characteristics of Control Valve
13. Armfield Process Control Trainer

Teaching Methodology:

This lab is introduced to help students understand basic principles of Instrumentation and Process Control. The entire course is broken down into following separate sections: process dynamics, modes of control, and instrumentation. Each section includes some relevant experiments to help a student gain deeper understanding of the topic. This lab course is well complemented by a theory course under the name 'Instrumentation and Process Control' in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-6**
P-2		15 Marks	**Based on Lab Exercises: 7-13**
Day-to-Day Work	Viva	20 Marks	**70 Marks**

	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Instrumentation and Process Control Lab (will be added time to time): Digital copy will be available on the JUET server.

Text Books:

1. Luyben, W.L., "Process Modelling, Simulation and Control for Chemical Engineers", McGraw Hill International Edition, 1990.
2. Bequette W., "Process Control: Mathematical Modeling and Simulation and Control", Prentice Hall India., 2003
3. Stephanopolous, G., "Chemical Process Control" Prentice-Hall of India, 1990.
4. Coughaowr, "Process System Analysis and Control"
5. Riggs, J.B., "Chemical Process Control"
6. Marlin, T.E., "Process Control", McGraw Hill, 1995.

Reference Books:

6. Bentley, J.P., "Principles of Measurement Systems", Longmann, 1988
7. Liptak, B., "Instrumentation Engineers Hand Book", Butterworths Heinmann, 1995.
8. Nakra, B.C., and Chaudhury, K.K, "Instrumentation Measurement and Analysis", Tata McGraw Hill, 1985.
9. Considine, "Process/Industrial Instruments and Control Hand Book", McGraw Hill, 1993.
10. Patranabish, D., "Principles of Industrial Instrumentation." Tata McGraw Hill.

Title: Process modeling & simulation lab **Code: 18B17CL574**
L-T-P scheme: 0-0-2 **Credit: 1**
Prerequisite: Students must have some knowledge about*numerical methods*.

Objective:

Use computer software and programming languages to solve complex chemical engineering systems.

Learning Outcomes:

Course Outcome	Description
CO1	Introduction of MATLAB, EXCEL, CHEMCAD, and POLYMATH.
CO2	Use of EXCEL to solve chemical engineering problems.
CO3	Use of MALAB to solve chemical engineering based problems.
CO4	To solve problems based on flow sheets using CHEMCAD
CO5	Solving problems on Flash Calculations, distillation columns, heat exchangers using CHEMCAD
CO6	Using polymath to solve basic chemical engineering problems.

Course Content:

LIST OF EXPERIMENTS

A) SECTION I: EXPERIMENTS ON MATLAB

1. Introduction to MATLAB
2. Problems on Euler's Method
3. Problems on Runge-Kutta Fourth Order Method
4. Problems on Newton-Rapson Method

B) SECTION II: EXPERIMENTS ON CHEMCAD

1. Overview of CHEMCAD and its Uses
2. CHEMCAD Products and Features
3. Introduction to CHEMCAD
4. Problems on Flow sheet
5. Problems on Flash Calculations, distillation columns, heat exchangers.

C) SECTION III: EXPERIMENTS ON POLYMATH

1. Introduction to Polymath
2. Problems on Linear Equations
3. Problems on Non-Linear Equations
4. Problems on Ordinary Differential Equations

Teaching Methodology:

This lab is introduced to help students to learn about process simulation software in case of chemical engineering. The entire course is broken down into following threesections: MATLAB, CHEMCAD, and POLYMATH. Each section gives knowledge about these softwares and how to implement them on chemical engineering problems.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: A-B**
P-2		15 Marks	**Based on Lab Exercises: B-C**
Day-to-Day Work	Viva	20 Marks	**70 Marks**

	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Process modeling & simulation lab (will be added time to time): Digital copy will be available on the JUET server.

Text Books:

1. Mathematical methods in Chemical Engineering, S. Pushpavanam, Prentice Hall of India 1998.
2. Mathematical methods in Chemical Engineering : Matrices and their Applications, N.R. Amundson Prentice Hall, 1966
3. Computational Methods in Chemical Engineering O.T. Hanna and O.C. Sandall
4. Mathematical Methods in Chemical and Environmental Engineering,, A.K. Ray and S.K. Gupta, Thomson Learning, 2004.
5. Applied Mathematics and Modelling for Chemical Engineers, R.G. Rice and D.D. Do, Wiley 1995.
6. Process Modeling, Simulation, and Control for Chemical Engineers, William L. Luyben, McGraw-Hill, 1996.
7. Fundamentals and Modeling of Separation Processes, C.D. Holland, Prentice Hall Inc. 1975.
8. Pratap, R., "Getting started with Matlab" Oxford university press.

Title: Minor Project-1 **Code:18B19CL591**
L-T-P scheme: 0-0-4 **Credit: 2**

Prerequisite: Subjects taught during previous/current semester

Objective:

A topic will be allotted to the student following which relevant literature survey will be done. Based upon the literature survey, it is expected from the student to conduct experiments, collect data, and analyze it to arrive at some concrete conclusion.

Learning Outcomes:

Course Outcome	Description
CO1	Learn to do literature survey.
CO2	Gain knowledge of how to prepare the report.
CO3	Be skilled in data analysing ability.
CO4	Be familiar about referencing style and citation in the report.
CO5	Study data and reach to some conclusion.
CO6	Develop research aptitude in the students.

Teaching Methodology:

Student as individual or in groups (max. of 3 students) will be given projectsin the area of subjects taught during previous/current semester. The students will do a project based on literature review, small experiments where possible and prepare a report. There will be one mid-term evaluation, a presentation at the end followed by a viva voce examination.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	
P-2		15 Marks	
Day-to-Day Work	Viva	20 Marks	70 Marks
	Presentation	20 Marks	
	Report	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

6th Semester

Title: Design of Separation Processes **Code: 18B11CL611**

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite:MASS TRANSFER OPERATIONS

Objective: The objective of this course is to give the students about designing of separation processes such as distillation liquid-liquid extraction, solid-liquid extraction, crystallization, drying etc.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various solid-fluid, fluid-fluid mass transfer operations.
CO2	Understand the importance of operations such as extraction, leaching, drying etc.
CO3	Describe various modes of operations for these operations.
CO4	Develop material and energy balance equations for all separation processes.
CO5	Apply operating line equations to enable the design various mass transfer equipments.
CO6	Demonstrate the working of all the mass transfer equipments.

COURSE CONTENT:

UNIT-1 DISTILLATION
Design of sieve plate columns. Design of packed columns.

UNIT-2 INTRODUCTION TO MULTICOMPONENT DISTILLATION
Fractionation of multicomponent mixtures. Multiple feeds and withdrawals**.**

UNIT – 3 GAS ABSORPTION
Design of trays and sizing of tray towers. Performance evaluation of packed and plate columns

UNIT- 4 COOLING TOWER
Cooling tower process design. Performance evaluation of cooling towers.

UNIT- 5 CRYSTALLIZATION
Process design of crystallizers. Selection and specification of crystallizers such as Oslo, Swenson – Walker, agitated type, etc. Performance evaluation of crystallizers.

UNIT- 6 DRYING
Process design of dryers such as Spray rotary, tunnel, tray, fluid bed and thin film. Performance evaluation of dryers.

UNIT-7 EXTRACTION
Solvent slection. Ternary liquid equilibria and ternary diagrams. Staged calculations. Spray columns. Packed and Plate columns. Muttistage extraction columns. Mixer – settlers. Analysis on Solvent free basis. Performance evaluation of extractors. Solid – liquid equilibria Single and

multi – stage leaching Staged calculations and efficiency. Performance evaluation. Supercritical fluid extraction.

UNIT – 8 ADSORPTION AND ION EXCHANGE

Adsorption and ion exchange process. Adsorption and ion exchange equilibria, Various isotherms. Design of fixed bed adsorber. Introduction to chromatographic separations.

UNIT – 9 MEMBRANE SEPARATION OPERATIONS

Types of membranes and modules for membranes. Transport through membranes. Ultrafiltration. Reverse Osmosis. Electrodialysis. Pervaporatin. Liquid membranes. Equipment and operations.

Teaching Methodology:

This course is introduced to help students understand the design of various separation processes such as distillation, extraction leaching, adsorption, etc. The entire course is broken down into following separate units: Multi-component distillation, Extraction, Drying, Adsorption, membrane separation processes. Each section includes multiple topics to help a student gain deeper understanding of the design aspects of various mass transfer equipment. This theory course is well complemented by a laboratory course under the name Separation processes Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2& Unit-3
Test-2	25 Marks	Based on Unit-4& Unit-6 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C. and Harriott, P., “Unit Operations of Chemical Engineering”, 6thed., McGraw Hill, New Delhi, 2001.

2. Treybol, R.E., “Mass-Transfer Operations”, 3rd ed., McGraw Hill, New Delhi, 1981.
3. Dutta, B. K., “ Principles of Mass Transfer and Separation Processes”, 4th ed., PHI, New Delhi, 2010

REFERENCE BOOKS:

1. Cussler, E.D., “Diffusion Mass Transfer in Fluid Systems”, Cambridge Univ. Press, Cambridge, 1984.
2. Foust, A.S., “Principles of Unit Operations”, 2nd ed., Wiley, New York, 1980.
3. Geankopolis, C.J., “Transport Processes and Unit Operations”, 3rd ed., Prentice Hall India, New Delhi, 1993.
4. Smith, B.D., “Design of Equilibrium Stage Processes”, McGraw Hill, New York, 1980

Title: Chemical Reactor Design **Code: 18B11CL612**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite:CHEMICAL REACTION ENGINEERING

Objective: The objective of this course is to give the students an idea of design of single reactions, behavior of non ideal flow reactors.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of heterogeneous reactions.
CO2	Understand the significance of catalyst along with their properties.
CO3	Describe various types of reactors such as fixed bed, slurry and trickle bed reactor.
CO4	Develop kinetics for two phase and three phase reactions.
CO5	Apply kinetics of the reaction in order to estimate the performance equation.
CO6	Demonstrate the complete design of different types of reactors employed to carry out heterogeneous reactions.

COURSE CONTENT:

UNIT-1 REVIEW OF DIFFERENT TYPES OF REACTORS

UNIT -2 NON-IDEAL FLOW REACTORS

Concept of Residence Time Distribution (RTD).Segregation,micro and macro mixing in reactors. Methods of obtaining RTD-E,F,C curves mathematical and experimental techniques. Models of non-ideal flow-Dispersion model for the case of small or large extent of dispersion. Effect of dispersion on conversion for general irreversible reaction case. Tanks in series model-Effect of number of tanks on conversion for general irreversible reaction case. Recycle model. Multi parameter models. Diagnostic methods of analysis of flow patterns in reactors. Role of micro & micromixing & segregation in ideal (MFR, PFR) and non-ideal reaction cases.

UNIT – 3 NON-CATALYTIC FLUID SOLID REACTION IN FLOW REACTORS

(Excluding the portion covered under Reaction Kinetics) Applications to design of continuous solid flow reactors. Various design considerations. Application of fluid bed reactors and their design consideration. Heat transfer effects.

UNIT- 4 SOLID CATALYZED FLUID PHASE REACTOR

Phenomena observed in operation of packed, fluid bed, slurry and such reactors. Product distribution in multiple and complex reactions. Thermal effects. Phenomenon of stability, unstability. Runaway and its analysis. Strategies for stable operations of reactors.
Design considerations of fluid/solid catalytic reactors. Fluid bed reactors.

UNIT – 5 DESIGN OF GAS/LIQUID AND LIQUID/LIQUID AND GAS/LIQUID/SOLIDREACTORS

Hetrogeneous reactors. Bubble heterogeneous reactors, Cocurrent & Counter-Current flow packed bed reactor

Teaching Methodology:

This course is introduced to help students understand the design of various various reactors for carrying out homogeneous and heterogeneous reactions in process industreis. The entire course is broken down into following separate units: Introduction, non-catalytic heterogeneous reactions and catalytic heterogeneous reactions. Each section includes multiple topics to help a student gain deeper understanding of the design aspects of various chemical reactors.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Levenspiel, O., "Chemical Reaction Engineering", John Wiley and Co. (latest edition).
2. Smith, J. M., "Chemical Engineering Kinetics", McGraw Hill (Latest edition)
3. Laidler, K. J., "Chemical Kinetics" Tata McGraw Hill, 1973
4. Fogler, H. S., "Elements of Chemical Reaction Engineering", Prentice Hall of India, 1972.

REFERENCE BOOKS:

1. Haugen, O. A., and Watson, K. M., "Chemical Process Principles" part-3, "Kinetics and Catalysis", John Wiley, 1964
2. Hill, C. G., "Chemical Reaction Engineering"

3. Walas, “Reaction Kinetics for Chemical Engineers”, Tata McGraw Hill, 1959
4. Sharma, M. M., and Daraiswami, L. K., “Heterogeneous Reactions” vol.-1and vol 2, John Wiley.

Title: Environmental Engineering **Code: 18B11CL613**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite:NIL

Objective: The objective of this course is to give the students a basic idea of the different types of pollution in the environment. This course also gives them the idea about how to handle environmental pollution problems.

Learning Outcomes:

Course Outcome	Description
CO1	Outline different types of pollutants.
CO2	Understand the causes of pollution and their harmful effects.
CO3	Describe various equipments related to air pollution and water pollution control.
CO4	Develop expressions for the estimating the efficiency of various air pollution control equipments.
CO5	Apply appropriate equations for the design of water pollution control equipments.
CO6	Demonstrate the working of various equipments related to pollution control.

COURSE CONTENT:

UNIT -1 INTRODUCTION

Importance of environmental pollution control , Concept of Ecological Balance, Role of hydrological and nutrient cycles of environment, pollution control aspects, Environmental legislation & Regulations, Industrial Pollution Emissions and Indian standards - Environmental legislations – water (prevention and control of pollution) act, Air (prevention and control of pollution) act.

UNIT – 2 WATER POLLUTION

Classification, sources and effect of water pollutant on human being and ecology, eutrophication, dissolved oxygen depletion, natural aeration. Sampling, measurements & standards of water quality – DO, BOD, COD, TOC, nitrogen, phosphorus, alkalinity, suspended solids , MLSS, ML VSS etc.

UNIT -3 WASTE WATER TREATMENT

Pretreatment: Bar Racks, grit chambers, Comminutors, equalization (theory) Primary Treatment: Settling tanks & their sizing. Secondary Treatment: Trickling filters, Rotating biological contactors (design theory), Activated sludge process, (with design problems) Tertiary treatment – Advanced Biological treatments, methods for recovery of value from effluent treatment.

UNIT -4 AIR POLLUTION

Air pollutants, sources & effect in man and environment: acid rain, smog, greenhouse effect, Ozone depletion, global warming. Stability , inversion, atmospheric dispersion, The Gaussian Plume model, Air pollution sampling and measurement – Ambient air sampling, stack sampling, Analysis of air pollutants – SO_2, nitrogen oxides, CO, ozone & hydrocarbons, H_2S.

UNIT – 5 AIR POLLUTION CONTROL

Review of equipment, system , and processes for (a) Particulate pollutants – Gravity settler, Cyclones, bed filters, bag filters , ESP, Scrubbers etc. (b) Gaseous pollutants – Dry & wet

Scrubbing, absorption, adsorption , Catalytic conversion. Source Correction Methods for air pollution control.

UNIT -6 WASTE MANAGEMENT

Solid waste including plastic waste. nuclear waste; Hazardous Waste

UNIT -7 NOISE POLLUTION

Noise- Pollution – measurements & control, effect on man & environment.

Teaching Methodology:

This course is introduced to help students understand basic principles of air and water pollution along with the design of air pollution and water pollution control equipment. The entire course is broken down into following separate units: Introduction, Air pollution, Water pollution and Noise pollution. Each section includes multiple topics to help a student gain deeper understanding of the subject. This theory course is well complemented by a laboratory course under the name Wastewater treatment processes Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5, Unit-6 & Unit-7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS

1. Rao C.S., “Environmental Pollution Control Engineering”, Wiley Eastern.
2. Davis M.L., Cornwell D.A., “Introduction to Environmental Engineering”, 2/e McGraw Hill-1991.
3. Mahajan S.P., “Pollution Control in Process Industries”, Tata McGraw Hill Publishing Company Ltd.

4. Peavy, H.S., Rowe, D.R., Tchobanoglous G., "Environmental Engineering", McGraw Hill 1985.
5. Master, G.M., "Introduction to Environmental Engineering & Science", Prentice Hall of India.

REFERENCE BOOKS

1. Metcalf et. al., "Waste Water Treatment, Disposal & Teuse", 3/e, Tata McGraw Hill.
2. Chandalia S.B., Rajgopal D., "Environmental Perspectives of Chemical Industries"

Title: Design of Separation Processes Lab **Code: 18B17CL671**
L-T-P scheme:0-0-2 **Credit: 1**

Prerequisite:MASS TRANSFER OPERATIONS

Objective: The objective of this course is to give the students about designing of separation processes such as distillation liquid-liquid extraction, solid-liquid extraction, crystallization, drying etc.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various solid-fluid, fluid-fluid mass transfer operations.
CO2	Understand the importance of operations such as extraction, leaching, drying etc.
CO3	Describe various modes of operations for these operations.
CO4	Develop material and energy balance equations for all separation processes.
CO5	Apply operating line equations to enable the design various mass transfer equipments.
CO6	Demonstrate the working of all the mass transfer equipments.

COURSE CONTENT:

1. LIQUID-LIQUID EXTRACTION IN A PACKED BED
2. ADSORPTION IN PACKED BED
3. PERFORMANCE OF WATER COOLING TOWER
4. BATCH CRYSTALLIZATION
5. BINARY DISTILLATION IN A SEIVE PLATECOLUMN
6. FORCED DRAFT TRAY DRYER
7. HUMIDIFICATION-DEHUMIDIFICATION COLUMN
8. LIQUID-LIQUID EXTRACTION IN A SPRAY COLUMN
9. SOLID-LIQUID EXTRACTION UNIT (BONNOTTO TYPE)
10. FLUIDIZED BED DRYER

Teaching Methodology:

This course is introduced to help students understand the design of various separation processes such as distillation, extraction, leaching, adsorption, etc. The entire course is broken down into following separate units: Multi-component distillation, Extraction, Drying, Adsorption, membrane separation processes. Each section includes multiple topics to help a student gain deeper understanding of the design aspects of various mass transfer equipment.This lab course is well complemented by a theory course under the name Design of Separation Processes in the same semester that helps a student learn and discuss the technical details of the underlying technologies.

Evaluation Scheme:

Exams	Marks	Coverage
P-1	15 Marks	**Based on Lab Exercises: 1-7**
P-2	15 Marks	**Based on Lab Exercises: 8-10**

Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Design of Separation Processes Lab (will be added time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1.Laboratory Manual available in Lab
2.Study material available in related folder of Server
3. Treybol, R.E., "Mass-Transfer Operations", 3rd ed., McGraw Hill, New Delhi, 1981.
4. Dutta, B. K., " Principles of Mass Transfer and Separation Processes", 4th ed., PHI, New Delhi, 2010

REFERENCE BOOKS /Material:

1. Cussler, E.D., "Diffusion Mass Transfer in Fluid Systems", Cambridge Univ. Press, Cambridge, 1984.
2. Foust, A.S., "Principles of Unit Operations", 2nd ed., Wiley, New York, 1980.
3. Geankopolis, C.J., "Transport Processes and Unit Operations", 3rd ed., Prentice Hall India, New Delhi, 1993.
4. Smith, B.D., "Design of Equilibrium Stage Processes", McGraw Hill, New York, 1980

Title: Environmental Engineering Lab **Code: 18B11CL673**
L-T-P scheme:0-0-2 **Credit: 1**

Prerequisite:NIL

Objective: The objective of this course is to give the students a basic idea of the different types of pollution in the environment. This course also gives them the idea about how to handle environmental pollution problems.

Learning Outcomes:

Course Outcome	Description
CO1	Outline different types of pollutants.
CO2	Understand the causes of pollution and their harmful effects.
CO3	Describe various equipments related to air pollution and water pollution control.
CO4	Implement expressions for the estimating the efficiency of various air pollution control equipments.
CO5	Apply appropriate equations for the design of water pollution control equipments.
CO6	Demonstrate the working of various equipments related to pollution control.

COURSE CONTENT:

1. pH, Turbidity, Electrical Conductivity
2. Acidity and Alkalinity
3. Total Hardness, Calcium and Magnesium
4. Solids (total, suspended and dissolved)
5. Settleable solids (by Imhoff Cone)
6. Optimum coagulant dose (Jar Test)
7. Dissolved oxygen
8. Biochemical oxygen demand
9. Chemical oxygen demand (COD)
10. Gas liquid mass transfer characteristics (aeration apparatus)
11. Softening or demineralization of water (ion exchange column)

Teaching Methodology:

This course is introduced to help students understand basic principles of air and water pollution along with the design of air pollution and water pollution control equipment. The entire course is broken down into following separate units: Introduction, Air pollution, Water pollution and Noise pollution. Each section includes multiple topics to help a student gain deeper understanding of the subject.This lab course is well complemented by a theory course under the name Environmental Engineering in the same semester that helps a student learn and discuss the technical details of the underlying technologies.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	**Based on Lab Exercises: 1-7**
P-2		15 Marks	**Based on Lab Exercises: 8-11**
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

Learning Resources:

Study material of Environmental Engineering Lab (will be added time to time): Digital copy will be available on the JUET server.

TEXT BOOKS

1.Laboratory Manual available in Lab
2.Study material available in related folder of Server
3.Rao C.S., "Environmental Pollution Control Engineering", Wiley Eastern.
4.Davis M.L., Cornwell D.A., "Introduction to Environmental Engineering", 2/e McGraw Hill-1991.
5.Mahajan S.P., "Pollution Control in Process Industries", Tata McGraw Hill Publishing Company Ltd.
6.Peavy, H.S., Rowe, D.R., Tchobanoglous G., "Environmental Engineering", McGraw Hill 1985.
7.Master, G.M., "Introduction to Environmental Engineering & Science", Prentice Hall of India.

REFERENCE BOOKS / Material:

1. Metcalf et. al., "Waste Water Treatment, Disposal & Teuse", 3/e, Tata McGraw Hill.
2. Chandalia S.B., Rajgopal D., "Environmental Perspectives of Chemical Industries"

Title: Chemical Processes **Code: 18B14CL641**
L-T-P Scheme: 3-0-0 **Credit:** 3
Prerequisite: Nil

Objective:

The main objective of this subject is to give the detailed knowledge about different chemical process and allied industries. It also deals with various process syntheses.

Learning outcomes:

Course outcome	Description
Co1	Outline the status of chemical industry in india and future trends.
Co2	Understand the importance of various chemical processes.
Co3	Describe operations and processes in petroleum refining.
Co4	Demonstrate the process description of important organic compounds.
Co5	Develop the concepts of synthesis of polymers such as polyethylene, polypropylene, polyvinyl chloride and polystyrene.
Co6	Identify with synthesis of other industrially important products such as soaps and detergents, dyes and intermediates, agrochemicals, perfumery and specialty chemicals.

Course content:

Unit-1:

Salient features of manufacture of commodity chemicals. Status of chemical industry in India and future trends

Unit-2:

Nitrogen industries including manufacture of ammonia, urea, nitric acid, and ammonium nitrate. Phosphorus industries including manufacture of phosphorus, phosphoric acid, and superphosphates. Chlor-alkali industries including manufacture of caustic soda, chlorine, hydrochloric acid, and hydrogen

Unit-3:

Manufacture of soda ash. Manufacture of sulfuric acid, oleum, and sulphur trioxide, manufacture of lime and cement. Manufacture of oxygen, nitrogen, argon and helium. Manufacture of synthesis gas. Manufacture of acetylene. Manufacture of aluminum, and sodium and sodium chlorate.

Unit-4:

Outlines of operations and processes in petroleum refining.**Unit-5:**

Engineering aspects of the manufacture with consideration for alternative routes of basic organic chemicals such as ethylene, propylene, and other olefins, butadiene, benzene and alkyl benzenes, vinyl chloride.

Unit-6:

Engineering aspects of the manufacture with consideration for alternative routes of basic organic chemicals such as styrene, phenols, amines, alcohols, aldchydes, ketones, carboxylic, and terephthalicacid. **Unit-7:**

Outlines of synthesis of polymers such as polyethylene, polypropylene, polyvinyl chloride and polystyrene.

Unit-8:

Manufacture of soaps and detergents, dyes and intermediates, agrochemicals, perfumery and specialty chemicals.

Teaching methodology:

This course is introduced to help students to learn about detailed manufacturing processes of different types of chemicals and major engineering problems encountered during manufacturing of these chemicals. The entire course is broken down into following separate units: basic inorganic chemical industries, petroleum refining, basic organic chemical industries, polymers, and other industrially important products. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation scheme:

Exams	Marks	Coverage
Test-1	15 marks	Based on unit-1 & unit-2
Test-2	25 marks	Based on unit-3 to unit-5 and around 30% from coverage of test-1
Test-3	35 marks	Based on unit-6 to unit-8 and around 30% from coverage of test-2
Assignment	10 marks	
Tutorials	5 marks	
Quiz	5 marks	
Attendance	5 marks	
Total	**100 marks**	

Learning resources:

Tutorials and study material (will be added from time to time): digital copy will be available on the juet server.

Text books:

1. Austin, g.t. "shreeve's chemical process industries" 5th edition , mcgraw-hill international
   (latest edition)
2. Rao, b.k. "a text on petrochemicals" , khanna publishers , (latest edition)
3. Rao, g.n. and sittig , m., "drydens outlines of chemical technology for 21st century" east-west press (latest edition)

Reference books:

4. Kirk–othmer's "encyclopedia of chemical technology", john wiley & sons inc., 4th edition, 1990.
5. Ullmann's "encyclopedia of industrial chemistry", vch, 1985.
6. Mcketta's "encyclopedia of chemical processing and design", marcel dekker, 1999.
7. Heaton, c.a., "the chemical industry", leonard hill, 1986.
8. Thompson, r., "moderns inorganic chemical industry", royal society of chemistry, 2nd edition, 1994.
9. Pletchor d. And walsh, f. C., "industrial electrochemistry", chapman's and hill, 1990.
10. Groggins, p.h. , "unit processes of chemical synthesis" , mcgraw hill inc. (latest edition)

Title: Industrial Organic SynthesisCode: 18B14CL642

L-T-P Scheme: 3-0-0 Credit: 3

Prerequisite: The students must be aware of the basic Organic Chemistry 12^{th} level. Students must be aware of organic reaction mechanism for further excel in Industrial Organic Synthesis.

Objective:

The course explains the concepts of natural products their chemistry and synthesis of these natural products.This also emphasizes on the chemical properties of various important natural products e.g. carbohydrates, terpenes, alkaloids, steroid etc.

Course LearningOutcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in still deep interests in learning of industrial organic synthesis. It develops broad and balanced knowledge and understanding of key chemical concepts, principles, and theories related to industrial synthesis.
CO2	Describe the real world industrial synthesis problems, challenges and application of synthesised organic product. It is elective paper for the Chemical Engineering students.
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in industrial organic compound synthesis.
CO4	Identify and use of various synthesis techniques for organic synthesis in project management.
CO5	Apply experimental demonstration and validation by using various analytical techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in industrial organic synthesis and related areas or in multidisciplinary areas that involve organic chemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT:

Unit-01 Process Involved During Organic Synthesis

Nitration: Introduction, nitrating agent, process equipment for technical nitration

Halogenation: Introduction, chlorination in the presence of catalyst, technical halogenation.

Sulphonation: Introduction, industrial equipment and techniques.

Amination: Technical manufacture of primary amino compound.

Unit-02 Synthesis of Natural Products

Introduction to the Chemistry of Natural Products and their synthesis and important chemical reactions;

Carbohydrate : Introduction, classification of carbohydrate; production of sugar .Preparation of Glucose, fructose, starch and cellulose and industrially useful reactions, structure of sucrose.

Terpenes: Introduction and classification of terpenes; Mono terpenes e.g. citral, camphor; Preparation of camphor, detailed study of Lycopene, squalene, B-carotene, lanosterol, vitamin-A, rubber rand gutta –parcha

Alkaloids: Introduction of alkaloids, old structure based classification, detailed study of conine, cocaine, caffeine and nicotine.

Steroids: Introduction and classification of steroids, Chemical structure and properties of Cholesterol, Ergosterol, vitamin-D, stigmasterol. Bile acids, Hormones; Andosterons, oestrogenes and gestogenes**.**

Unit-03 Pigments, and their synthesis

Unit-04 Synthesis for industrially important polymers

Polyethylene, polystyrene, PVC, polyisobutylene, polyester, nylon, bakelite, Teflon

Unit-05 Synthesis of Important materials for Industry Ceramics, Glasses, Zeolites.

Teaching Methodology:

This course planned in 3 lectures each week. The course content divided in two 42 lectures. The lectures will be conducted in both manner white board and PowerPoint presentation. At the end of this course student will be able to: understand the mechanism of synthesis of commercial organic material on industrial scale.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1
Test-2	25 Marks	Based on Unit-2(70 %) and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit 3, Unit-4 to Unit-5 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	

Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Industrial Organic Chemistry, 4rth Ed. by Prof Klaus Weissermel and Prof. Hans Jurgen Arpe. WILEY-VCH Verlag GmbH & Co. KGaA

[2] Organic Chemistry , by IL Finar, Pearson Education, 6th Edition (2002)

Reference Book:

[1] O.P. Agarawal 'Chemistry of Organic Natural Products Vol-1.

[2] O.P. Agarawal 'Chemistry of Organic Natural Products Vol-2.

[3] P. H. Griggins "Unit processes in organic synthesis".

Title: Equipment Design and Drawing **Code: 18B14CL643**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite:NIL

Objective: The objective of this course is to give the students a basic idea of pressure vessel design and storage vessel design.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of mechanical design of equipment and material

	of construction.
CO2	Understand mechanical properties of different materials used in the fabrication of process vessels.
CO3	Describe the accessories of pressure vessels.
CO4	Develop equations for the mechanical design of process vessels used in chemical industries.
CO5	Apply design expressions for evaluation of thickness of different parts.
CO6	Demonstrate the complete mechanical design of process equipments.

COURSE CONTENT:

UNIT -1 INTRODUCTION

Nature of process equipment General design procedure. Standards, codes and their significance. Review of stresses due to compression and tension, bending, torsion, temperature effects. Theories of failure. Materials of construction for chemical process equipment. Review of fabrication techniques. Environmental and economic considerations.

UNIT -2 DESIGN OF UNFIRED PRESSURE VESSELS

Code and standards for pressure vessels (IS:2825:1969). Materials of construction. Selection of corrosion allowance and weld joint efficiency.

A. Pressure Vessel Subjected to Internal Pressure
B. Pressure Vessel subjected to External Pressure
C. Assembly and Detailed Fabrication Drawing of the complete Pressure vessel to a recommended scale.

UNIT – 3 STORAGE VESSELS

Storage vessels for volatile and non volatile liquids, Storage of gases. Various types of roofs. Nozzles and mountings. Design of cylindrical storage vessel as per IS:803 and rectangular tanks as per IS:804, Complete fabrication drawing.

UNIT -4 AGITATORS

Various types of agitators and their applications. Power requirement. Design of shaft, blades, Keys, couplings, seals, stuffing box and gland. Detailed drawing.

UNIT -5 REACTION VESSELS

Introduction, classifications, materials of construction and design of vessel. Design of jackets (IS 2825) and cols. Assembly and detailed drawing of designed reactions vessel and to accessories.

UNIT -6 VESSEL SUPPORTS

Classification of supports. Design of skirt support considering stresses due to dead weight, wind load, seismic load and period of vibration. Design of base plate , Skirt bearing plate, anchor bolts, bolting chairs and skirt shell plates. Design of Lug or bracket supports.

UNIT -7 HEAT EXCHANGERS

Codes and standards for heat exchangers. Baffles, tie-rods, tube joining methods. Design of shell and tube heat exchangers as per IS : 4503 and TEMA standards

UNIT -8 DISTILLATION AND ABSORPTION COLUMNS

Basic features of columns. Stress in columns shell thickness determination at various heights. Elastic stability under compressor stress. Column internals. Tray supports. Complete fabrication drawing

UNIT -9 DESIGN OF OTHER EQUIPMENT

Design and drawing of equipment such as evaporators, crystallizers, filters and high pressure vessels.

Teaching Methodology:

This course is introduced to help students understand basic principles of mechanical design of various process equipment. The entire course is broken down into following separate units: Introduction, Design of pressure vessels, reaction vessels, storage vessels, tall vessels. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2&Unit-3
Test-2	25 Marks	Based on Unit-4, Unit-5 & Unit-6 around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7, Unit-8 & Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Process equipment dsign-vessel design by Lloyd E. Brownell and Edwin Young, John Wiley, NewYork 1963.
2. Introduction to chemical equipment design – Mechanical Aspects by B.C. attacharyya, CBS Publications.

3. Process Equipment Design by M.V. Joshi and V.V. Mahajani Macmillan India
4. Appropriate ISI Specifications and codes for unfired pressure vessels, viz IS: 2825, IS: 803, IS: 804,IS: 1182, IS: 4853, IS: 3658, IS: 3703, IS: 3664, IS: 4260, IS: 4072, IS4503.

REFERENCE BOOKS:

1. Chemical Engineering Volume 6 – Design by J.M. Coulson, J.F. Richardson and R.K. Sinnott, Pergamon press International Edition 1989.
2. Pressure Vessel Hand book by Eugene F. Megyesy, Pressure vessel company USA.
3. Design of machine elements by V.B. Bhandari, McGraw Hill.

Title: Food Process Engineering **Code: 18B14CL644**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite:NIL

Objective: The objective of this course is to give the students about basic idea of food processing and food technology.

Learning Outcomes:

Course Outcome	Description

CO1	Outline the basic idea of food processing and food technology.
CO2	Understand the status of agriculture and food processing industries in India.
CO3	Describe the theory and working of equipment used in food processing.
CO4	Develop the understanding of effect on food by using different techniques for processing.
CO5	Apply the concepts to enable proper food preservation and storage.
CO6	Demonstrate the post processing applications including packaging.

COURSE CONTENT:

UNIT -1 INTRODUCTION

Current status of the Indian a) Agriculture, b) Food Industry, c) Food. Processing Industry. Market opportunities for the Indian Processed Food Industry. Engineering challenges in the Food Processing Industry: Product and Process development. Major challenges in India. R & D opportunities within the Food Industry.

UNIT – 2 BASIC FOOD BIOCHEMISTRY AND MICROBIOLOGY

Food Constituents: Water, Proteins, Carbohydrates, Lipids, Vitamins, Minerals, Flavors, Nutritional & sensory characteristics, Food fortification. Water activity Enzymes: Production from microorganisms and application in food processing Lipid oxidation Growth of microorganisms and food spoilage D & Z values Food safety. Indian laws regulating Foods and Food Processing

UNIT – 3 AMBIENT TEMPERATURE PROCESSING

Raw material preparation Size reduction of solid fibrous foods and in liquid foods. Emulsification and Homogenization. Theory and Equipment. Mixing and Forming. Theory and Equipment. Extraction & expression Membrane concentration Fermentation: Theory, Types, Equipment, Effect on Foods.

UNIT – 4 HEAT PROCESSING USING STEAM OR WATER

Theory, Equipment, Effect on Foods Blanching Extrusion Pasteurization Heat Sterilization In-container Ultra high-temperature (UHT)/aseptic process.

UNIT -5 HEAT PROCESSING USING HOT AIR

Theory, equipment, effect on foods Dehydration Baking& Roasting

UNIT -6 HEAT PROCESSING USING HOT OILS

Theory equipment, effect on foods Frying

UNIT -7 HEAT PROCESSING BY DIRECT AND RADIATED ENERGY

Theory, Equipment, Effect on Foods Dielectric heating Microwave.

UNIT – 8 PROCESSING BY REMOVAL OF HEAT

Theory, Equipment, Effect on FoodsChilling Freezing Freeze drying and freeze concentration.

UNIT -9 FOOD PRESERVATION & STORAGE

Food contamination Modified Atmosphere Storage (MAS) Hurdle Technology.

UNIT -10 POST PROCESSING APPLICATIONS

Packaging. Modified-atmosphere packaging (MAP) Coating and enrobing Filling and sealing of containers.

Teaching Methodology:

This course is introduced to help students understand basic principles of food processing and food technology. The entire course is broken down into following separate units: Basic food chemistry and microbiology, Processing at ambient conditions and by applying heat, heat processing using hot oil, Food preservation and storage. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2&Unit-3
Test-2	25 Marks	Based on Unit-4, Unit-5, Unit-6 & Unit- 7 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-8, Unit-9 & Unit-10 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOK:

1. Fellows, P., Food Processing Technology: Principles and Practice, 2nd ed., Wood head Publishing Ltd., England, 2000.

REFERENCE BOOKS:

1. Toledo, R.., Fundamentals of Food Process Engineering, 2nd ed., CBS Publishers & Distributors, New Delhi, 1997.
2. Sharma, K., et.al., Food Process Engineering, Theory and Laboratory Experiments, John Wiley and Sons Inc., Canada, 2000
3. Pandey and Srivastava, Chemical Process Technology, Vol.2
4. Singh, R.P., & Heldman, D.R., Introduction to Food Engineering, 3rd ed., Academic Press, UK,2001.

5. Lelieveld, H.L.M., et.al., Hygiene in Food Processing, Woodhead Publ. Ltd., England ,2003.
6. Subbulakshmi, G. & Udipi, S.A., Food Processing & Preservation, New Age International Pvt. Ltd., India, 2001.
7. Valentas, K.J. et.al., Food Processing Operations and Scale-up, Marcel Dekker, NY, 1991.
8. Tamb, I.A. and Singh, R.P., Food Storage Stability, CRC Press, 1998.

Title: Solid and Hazardous Waste managementCode: 18B14CL645

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: The students must be aware of the basic Environmental Science upto graduation level. Basic knowledge of Environmental Science helps them to understand the basic concept behind management of solidwaste

OBJECTIVE:

The purpose behind this course is to make the students familiar with the concepts of solid and hazardous waste, their classification, origin and risk management.

Course LearningOutcomes:

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in understanding the significance and importance of solid and Hazardous waste management.
CO2	Describe the real world problems, challenges raised due to industrial and domestic solid waste. It also emphasis the dangerous effect of the Hazardous waste for current and future generation.
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in their surrounding case study.
CO4	Identify and use of various statistical and managerial techniques for solving the problems rise due to hazardous, domestic and industrial waste.
CO5	Apply various statistical and managerial techniques for case study in the surrounding localities.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in the solidwaste and hazardous waste management and related multidisciplinary areas that help to develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT

Unit 1: Introduction:

Environment and development, Solid, liquid and gaseous emissions, Environmental standards and legal framework, Hazardous wastes

Unit 2: Solid Waste Management:

Terminology, Solid waste characteristics, Sources, Collection and transportation, solid waste processing and recovery, Solid waste disposal, Land fill, Environmental issues.

Unit 3: Hazardous Waste Management:

Definition, Types of hazardous wastes, Ignitability, Corrosiveness, Reactivity, Toxicity, Radioactivity, Health Effects, Cradle to grave management. Treatment Methods – Physiochemical processes, Neutralization, Oxidation-reduction, Precipitation, Biological mehods, Solidification and Stabilization, Incineration, Final Disposal, Risk Assessment – Carcinogens, Dose- response assessment, Risk exposure assessment.

Unit 4: Site Remediation:

Quantitative risk assessment, Site and sub surface characterization, Remedial Technologies, Remedial actions and corrective measures.

Unit 5: Solid Waste Utilization Options:

Concept of waste to wealth, Case studies of solid waste utilization, Byproducts, Land fill management, Ash management, Incineration, Biological sludge disposal.

Teaching Methodology:

This course planned in 3 lectures each week. The course content divided in two 42 lectures. The lectures will be conducted in both manner white board and PowerPoint presentation. At the end of this course student will be able to: Understand the significance of the domestic and hazardous solidwaste management. They will demonstrate various case studies for solving the hazardous waste management problems.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 and Unit-2
Test-2	25 Marks	Based on Unit-3(70 %) and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

8. Hazardous Waste Management –Weritz A. - McGraw Hill- 1989.
9. Hazardous Waste Management- 2nd Edition – M.D. Lagrega, P.L. Buckingham, J. C. Evans – McGraw Hill – 2001.

Reference Book:

[1] Environmental Engineering – A design Approach – G.A. Sicero and A.P. Sincero – Prentice Hall India Ltd.-1996.

[2] Handbook of Solid Waste Management - 2nd Edition – G. Tcchobanoglous, F. Kreith – McGraw Hill – 2002.

[3] Loss Prevention in Process Industries – 3rd Edition, Editor Sam Mannan, Elsevier - 2000

Title: Minor Project-2 **Code: 18B19CL692**
L-T-P scheme:0-0-6 **Credit: 3**

Prerequisite:NIL

Objective:A student is expected to select one topic based on which he/she would collect research papers. The student shall prepare a report at the end of the semester after critically analyzing the collected research papers on a particular topic, indicating the work so far done in the area and future scope of work.

Learning Outcomes:

Course Outcome	Description
CO1	Outline of the topic/problem.
CO2	Understand the significance of the topic.
CO3	Describe various methodologies.
CO4	Develop the concept of procedure used in the paper.
CO5	Apply the concepts to reproduce the results.
CO6	Demonstrate the complete paper with its applications.

Teaching Methodology:
Student as individual or in groups (max. of 3 students) will be given projectsin the area of subjects taught during previous/current semester. The students will do a project based on literature review, small experiments where possible and prepare a report. There will be one mid-term evaluation, a presentation at the end followed by a viva voce examination.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	
P-2		15 Marks	
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

7th Semester

Title: Process Engineering and Safety **Code: 18B14CL741**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite:NIL

Objective:

The objective of this course is to give the students a detail idea about process&safety engineering.

Learning Outcomes:

Course Outcome	Description
CO1	Understand the method of process selection, selection of process steps, and development of process flow diagram.
CO2	Learn about control, mass & energy balance, and sizing & costing of major equipments of chemical processes.
CO3	Describe in detail how to prepare techno-economic feasibility report for chemical engineering projects.
CO4	Outline of industrial safety and description about toxicology & industrial hygiene.
CO5	Be familiar with the concepts related to fires & explosions and relief & relief systems in the industry.
CO6	Know about hazard identifications, risk assessment, and accident investigations methods.

Course Content:

A. Process Engineering

Unit-1:

Preliminary process selection: Economic evaluation. Environmental footprint. Safety analysis and controlibity. Flexibility.

Selection of process steps: Identification of individual process steps. Grouping into reactor, separators, reactor and recycle modules, interconnection modules.

Flow sheet synthesis: Development of alternative routes. Selection criterion for modules. Selection of reactor modules. selection of separation modules. Determination of of flow sheet based on heuristics. Batch vs Continuous process.

Unit-2:

Control: Strategy for process Selection of most suitable parameters to be controlled for equipments listed under 7 below. Development of P & ID. Safety instrumentation and multiple redundancy.

Mass & energy balances: Physico-chemical specification of each stream. Detailed Mass &Energy balance around major equipment list in 7 below.

Unit-3:

Sizing & costing of major equipment (short cut methods of sizing only): Reactors, Heat exchangers, multiple effect evaporators, Distillation equipment, Filtration equipment, Selection and sizing of pumps and compressors.

Unit-4:

Utility selection: Process requirement and selection of utility such as refrigerant, chilled water, cooling water, steam, hot oil, Dowtherm boilers, molten salt baths, flue gases. Strategies for heat exchange between process streams.

Unit-5:

Techno-economic feasibility report for chemical engineering projects: Constituents, Capital-Fixed, working. Estimation of capital and cost of product. Factors affecting the estimations-taxes, inflation, uncertainties. Concepts of break even, optimality of design, optimality of operation, cost benefit analysis, marginal rate of return. Profitability, alternative investments and replacement options.

B. Industrial Safety

Unit-6:

Introduction:Concepts. Definitions. Types of Accidents. Causes and direct & indirect effects of accidents, Types of damages. Role of safety considerations in chemical plant Design & operations. Protective & safety equipments. Measure of Risk Liabilities of accidents Laws. Rules, Regulations (concerning safety in chemical process plant) for the prevention of accident. Managerial aspects of safety, General Aspects of Post disaster mitigation and management within an organization & in society at large.

Toxicology and industrial hygiene: Typical toxins and their biological effects. Outline of their ingestion to and elimination from biological systems. Toxicological Parameters -Their definitions and outline of the measurement methods. Evaluation of exposure to toxicants and its impact. Source Models – Release & flow of toxic gases & liquids, flashing liquids, boiling liquids, etc. Dispersion Models – factors affecting dispersion and their modeling. Design & Equipment for prevention of toxic release in chemical plants. Management of toxic release scenario.

Unit-7:

Fires & explosion: The fire triangle and factors contributing to fire & explosions. Definition. Relevant material characteristics & properties. Concepts of Ignition, Ignition Energy. Phenomena and Source of Ignition auto ignition, auto oxidation, adiabatic compression, electrostatic ignition, role of fuel sprays , mists dusts on ignition process. Explosions – various types & conditions for their occurrence. Inerting & Purging of equipment, Ventilation of rooms, Control of static electricity process control systems, Sprinkler systems, Fire fighting systems.

Unit-8:

Relief and relief systems: Definitions. Relief requiring scenarios. Relief types & locations. Relief systems, various options and their sizing and applications for single and multiphase flows. Deflagration venting for dust & vapor explosions**.**

Hazard identifications: HAZOOP, HAZAN and such methods, safety Review & other methods, examples. Safety Audit.

Unit-9:

Risk assessment: Review of probability theory in respect of failures, coincidences etc. leading to unsafe situation. Concepts of event trees & fault trees. Analysis of trees for risk assessment, its advantages & disadvantages for simple examples of application of Risk Assessment technique.

Accident investigations: Learning from accidents Methods of investigating and diagnosing. Aids for recommending case studies of well known accidents such as Flixburough. Bhopal etc.

Teaching Methodology:

After completion of this course the students will be able to do make flow sheet diagram, sizing of major equipments and utility selection. They will also be familiar about the causes of accidents and measures to be taken to avoid these accidents. The entire course is broken down into following separate units: synthesis of flow sheets, sizing & costing of major equipments, techno-

economic feasibility report, introduction to safety, toxicology and industrial hygiene, fire and explosion, relief and relief systems, risk assessment, and accident investigation.Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 to Unit-3
Test-2	25 Marks	Based on Unit-4 to unit-6, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Conceptual Design of Chemical Processes. J.M. Douglas, McGraw Hill International Edition, 1988.
2. Strategy of Process Engineering, John D.F. Rudd & C.C. Watson. Wiley & sons International, 1968.
3. Chemical Engineering Design Project, M.S. Ray & M.G. Sneesby, Gordon & Breach Science publication, 2nd Edition 1998.
4. Chemical Process Control, George Stephanopoulos, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd. (Chapters 23, 24 and 25).
5. Systematic Methods of Chemical Process Design. Loren T Biegler, Grossman E.I., Westerberg, A.W. Prentice Hall International Edition, 1997.
6. Peters, M.S. and Timmerhaus, K.D., Plant design and economics for Chemical Engineers, 4th Edition, McGraw Hill, New York, 1995.
7. Kharbanda, O.P. and Stallworthy, E.A., Capital Cost Estimating for Process Industries, Butterworths, London, 1988.
8. Humphreys, K.K. Jellens, Cost and Optimization Engineering, 3rd Edition, McGraw Hill, 1991.
9. Chaudhary, PROJECT MANAGEMENT, Tata McGraw Hill
10. Joy, TOTAL PROJECT MANAGEMENT, MacMillan
11. Jack Meredith & Samuel, PROJECT MANAGEMENT: A Managerial Approach, John Wiley & sons.

Reference Books:

1. Perry J.H. and Chilton, Perrys Chemical Engineering Handbook, 6th Edition, McGraw Hill, 1984 (or a later edition when available).
2. Walas, S.M. Phase equilibria in Chemical Engineering, Butterworth, Boston 1985.
3. Schweitzer, P.A.,(Ed), Handbook of Separation Techniques for Chemical Engineers, McGraw Hill, New York, 1988.
4. Walas, S. M., Chemical Process Equipment: Selection and design, Butterworth, London, 1989.
5. Sieder, W. D., Seader J. D. and Lewin D. R., Process Design Principles: Synthesis analysis and evaluation, John Wiley and sons, 1998.
6. Young, D., Modern Engineering Economy, John Wiley and sons, New York, 1993.
7. Uhl, V. W. and Hawkins, A. W., Technical Economics for Chemical Engineers, AIChE Continuing Education Series, AIChE, 1971.
8. Peter S. Timmerhouse, PLANT DESIGN & ECONOMICS FOR CHEMICAL ENGINEER, McGraw Hill
9. Jhamb, INVENTARY MANAGEMENT, Everest Publishing house
10. J.K.Sharma, OPERATION RESEARCH, McMillan
11. Gupta, V., and Gupta, S.K., "Fluid Mechanics and Its Applications", 1984.

Title: Energy Sources and Energy Conservation **Code: 18B14CL742**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: No prerequisite is required.

Objective:

The course provides inputs into various energy sources, alternative energy sources, combustion processes and energy conservation approach in various process plants.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the significance of various energy sources and energy conservation.
CO2	Understand about solid, liquid and gaseous fuels.
CO3	Describe various properties of all the fuel types.
CO4	Develop case studies aiming to energy conservation in various industries.
CO5	Apply pinch technology approaches to conserve material and energy.
CO6	Demonstrate the design of solar, wind and bio energy systems.

Course Content:

Unit-1:Introduction:
Classification of Energy sources and resources, present and future energy demand.

Unit-2: Solid fuels:
Principle solid fuels, classification of coal, coal preparation and storage, low and high temperature carbonization, briquetting

Unit-3: Liquid fuels:
Crude petroleum, physical processing of crude, petroleum products, liquid fuels, properties, storage and handling

Unit-4: Gaseous fuels:
Natural Gas, Liquified Petroleum Gas, Producer Gas, Water gas, Storage and distribution of gaseous fuels

Unit-5 : **Combustion of Fuels**:
Combustion of solid, liuid and gaseous fuels, Combuston equipments, Incomplete combustion and excess air, Thermal efficiency and heat recovery, flue gas analysis

Unit-6: Alternative energySources:
Introduction to solar, wind and bio-energy

Unit-7 :Waste Heat Recovery:
Identification and recovery, Steam and condensate handling

Unit-8: Energy Conservation in Process industries:
Energy and material balances, Energy audit, identifying energy loss, insulation, avoiding leakages, optimizing operations, capacity utilization, energy efficient technology and machinery. Introduction to pinch technology, approaches to material and energy conservation. Case studies in energy conservation.

Teaching Methodology:

This course is introduced to help the students to understand various energy sources as Globally energy crisis is being faced. There is lot of hue and cry to develop alternative energy sources to meet future demand of a growing population. Solid, Liquid and Gaseous fuels, their storage and precautions in handling will be covered. Alternative energy sources like solar, wind

and biomass are being covered during the study of the subject. Energy conservation and energy audit will also be covered during the course coverage of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2& Unit-3
Test-2	25 Marks	Based on Unit-4& Unit-5 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 to Unit-8 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Energy Sources and energy conservation (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

[1] Brame J.S. and King J.C., "Fuels – solid, liquid and gases" – McGraw Hill.
[2] S.Rao and B.B. Parulekar, " Energy Technology – Non Conventional, Renewable and Conventional" – Khanna Publishers.
[3] W. Francis, "Fuels and Fuel Technology, Vol I & II" – Pergamon Press.
[4] P.W.O. Collghour, "EnergyManagement" – McGraw Hill (1993).
[5] Samir Sarkar, "Fuels and Combustion" – Universal Press.
[6] Godfrey Boyle, " Renewable Energy"- Oxford Press.

"**Web References:**

[1] Tushar K Ghosh & Mark A Prelas, " Energy Resources and Systems, Volume - 2" - Springer
[2] NPTEL Video lectures

Tite: Polymer Engineering **Code: 18B14CL743**

L-T-P Scheme: 3-0-0 **Credit: 3**

Perquisites:

The students should complete the Chemistry course at under graduate level before considering this course for the study.

Course objectives: This course will be enable students to identify the various mechanisms for the synthesis and characterization of Polymer. This course enables students to understand the

mechanism of Polymer Engineering and develop an ability to learn for enhancing the quality of polymer through various additives.

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help in still deep interests in learning of Polymer Engineering. It develops broad and balanced knowledge and understanding of the Polymer Engineering concepts, principles, and theories.
CO2	Describe the real world problems, challenges in current scenario. It is micro-specialization paper for the Chemical Engineering students.
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems of the world.
CO4	Identify and use of various techniques for resolving the world problem and in project management.
CO5	Apply experimental demonstration and validation by using various techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in the Polymer Engineering and related areas or in multidisciplinary areas that help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT:

Unit1 : INTRODUCTION

Defining polymers; Basic chemistry of polymers; Classification and types; Bonding in polymers, Molecular weight and Molecular Weight Distribution; Thermoplastic Thermosetting polymers, Elastomers, Resins, Adhesives, Coatings, Fiber, Composites; solvents, Solutions, Blend Melt; Additives, Fillers; Examples of industrial and high-performance polymers.

Unit 2: STEP-GROWTH (CONDENSATION) POLYMERIZATION

Features; Definition of functionality; Functionality principle; Derivation of Carothers's Equation; Effect of Stoichemetric imbalance on molecular weight; Mechanism; Kinetics**.**

Unit 3: FREE-RADICAL ADDITION (CHAIN-GROWTH) POLYMERIZATION

Mechanism; Kinetics of homogeneous polymerization; Experimental determination of rate of polymerization; Instantaneous average chain lengths; Temperature dependence of rate and chain length; Gel effect or Autoacceleration; Kinetic chain length; Chain Transfer; Inhibitors and Retarders.

Unit 4: IONIC AND COORDINATION CHAIN (ADDITION) POLYMERIZATION

General Features of ionic-chain addition polymerization; Mechanism and kinetics of cationic polymerization: Mechanism and average degree of polymerization; Kinetics of anionic

polymerization; Mechanism and kinetics of coordination Polymerization.

Unit 5: CO-POLYMERIZATION

Basic concept~ Technical significance~ Steady-state assumptions in free-radical Copolymerization. The co-polymer equation ~ Instantaneous molar composition of copolymer formed; Monomer reactivity ratios; Significance and method of Determination~ Types of copolymers; Variation of composition with conversion; Average copolymer composition; Cumulative composition of copolymer~ Mechanisms; Kinetics~ Block and graft copolymers.

Unit 6: POLYMERIZATION SYSTEMS

Design criteria~ Bulk polymerization (quiescent and stirred)~ Solution polymerization; Suspension polymerization ~ Emulsion polymerization; Smith-Ewart kinetics; Deviations from the Smith-Ewart kinetics; Interfacial poly-condensation; Comparison of the various processes~ Advantages and disadvantages; Heat transfer and mixing in polymerization reactors.

Unit 7: CHARACTERIZATION OF MOLECULAR WEIGHT

Types of average molecular weight; Molecular weight and degree of polymerization; Poly-dispersity and Molecular Weight Distribution in Polymers~ Common techniques for measurement of average molecular weights; Viscometry, End-group analysis, Gel permeation chromatography.

Unit 8: POLYMER RHEOLOGY AND MORPHOLOGY

Definition of rheology; Newtonian and non-Newtonian fluids~ Flow curves; Apparent Viscosity; Power law; Visco-elasticity; Free volume or molecular hole concept; Definition of morphology; Requirements for crystallinity; Effects on mechanical and optical properties.

Unit 9: POLYMER PROCESSING

Blow molding~ Injection molding~ Compression molding; Extrusion; Calendering~ sheet forming or Thermoforming; Casting; Coating; Powder-coating technique; Fluidized-bed coating technique~ Laminating; Fiber spinning; Bi-axial orientation; Reinforced reaction injection molding; Filament winding; Pultrusion~ Design considerations with polymers~ processing characteristics~ Engineering challenges in processing.

Teaching Methodology:

This course planned in 3 lectures each week. The course content divided in two 42 lectures. The lectures will be conducted in both manner white board and Power Point presentation. At the end of this course student will be able to understand the concept of Polymer Engineering and able to apply in further study and research.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit1, Unit 2 and Unit 3

Test-2	25 Marks	Based on Unit 4, Unit 5 and Unit 6 (70 %) and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit 7, Unit 8 and Unit 9 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Gowarikar, V.R. et. al "Polymer Science" , Wiley Eastern, 1984.
2. Rodriguez, F., "Principles of Polymer Systems." 2 / e, Hemisphere (McGraw Hill), 1982
3. Ghosh, P, "Polymer Science & Technology of Plastics & Rubbers." Tata McGraw Hill, 1990.
4. Crawford R.J. "Plastic Engineering ," Paragaman (Maxwell Machmillan International), 1987.

REFERENCE BOOKS:

1. Encyclopedia of Polymer Science & Engineering , Wiley, 1988.
2. Rosen, S.L. Fundamental Principles of Polymer Engineering, 2nd ed. John Wiley & Sons, Inc., 1993.
3. McCrum, N.G. et. al. Principles of Polymer Engineering, 2nd ed. , Oxford Sciences; 1997.
4. Rodrigues, F. Principles of Polymer Systems, McGraw-Hill Book Co., 1970
5. Bhatnagar, M.S., A Textbook of Polymers, Vol. 1, S. Chand & Co. Ltd., New Delhi, 2004.
6. Bhatnagar, M.S. A Textbook of Polymers, Vol. II, S. Chand & Co. Ltd. , New Delhi, 2004.

Title: Petroleum Refining **Code: 18B14CL744**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Chemical Processes

Objective: The objective of this course is to trend the student about the origin and formation petroleum and petroleum products.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of petroleum refining.
CO2	Understand the origin and composition of petroleum.

CO3	Describe the applications of various refinery products along with their feedstock.
CO4	Develop various techniques employed in the refining operations.
CO5	Apply various technologies such as catalytic cracking, coking, and other treatment processes to meet the specifications of the end product.
CO6	Demonstrate the complete working of a petroleum refinery.

Course Content:

UNIT – 1: ORIGIN FORMATION & COMPOSITION OF PETROLEUM

Origin & Formation of Petroleum , Reserves & Deposits Of World. Types Of Crude & Indian Crude Types. Exploration

UNIT – 2: REFINERY PRODUCTS AND FEED STOCKS:

Overall Refinery Flow. Low Boiling Products, Gasoline specifications. Fuels:- Distillate Fuels: Jet Fuels, Automotive Diesel Fuels. Oils: Heating Oils, Residual Fuel Oils. Crude Oil Properties. Composition Of Petroleum Crude suitable For Asphalt Manufacture. Crude Oil Properties. Composition Of Petroleum Crude suitable For Asphalt Manufacture. Crude Distillation Curves. Petrochemical feedstocks.

UNIT – 3: FRACTIONATION OF PETROLEUM. DEHYDRATION & DESALTING OF CRUDES

Heating of Crudes – Pipe Still Heaters. Blending Of Gasoline.

UNIT – 4: TREATMENT TECHNIQUES & PRODUCTS SPECIFICATIONS

Fraction Impurities. Treatment of Gasoline Treatment of Kerosene Treatment of Lubes. Wax & Purification.

UNIT – 5: CATALYTIC CRACKING & THERMAL PROCESS. FLUIDISED

Bed Catalytic Cracking, Catalytic Reforming. Coking Hydrogen Process Hydrocracking Hydrosulpherization, Hydro treatment. Alkylation process Isomerisation Process Polymer Gasoline.

UNIT – 6: ASPHALT TECHNOLOGY

Source of Asphalt. Air Blowing Of Bitumen Upgradation Of Heavy Crudes.

UNIT – 7: FEED STOCK FOR PETROCHEMICALS

Making feedstocks suitable for petrochemical industry.

Teaching Methodology:

This course is introduced to help students understand the basic structure of any petroleum refinery along with the various processes used in the refining of petroleum. The entire course is broken down into following separate units: Origin formation and composition of

petroleum, Refinery products, Fractionation of petroleum, Treatment techniques, Petrochemicals feedstock. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:.

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1& Unit -2.
Test-2	25 Marks	Based on Unit-3 , Unit-4 & Unit -5 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 & Unit -7 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOK:

1. Bhaskara Rao, B. K., "Modern Petroleum Refining Process"

REFERENCE BOOKS:

1. Nelson, W. L., **"** Petroleum Refinery Engineering" 4^{Th} ed., McGraw – Hill
2. .Speight James G, Taylor, Francies, " Petroleum Chmistry And Refining **"**
3. Austin G.T., **"**Shreeve's Chmical Process Industries."
4. McKetta , John J., & Marcel Dekker, Inc, "Encyclopedia of Chemical Processing & Design"
5. Chemical Weekly for supply & Demand figures and current prices and price trends**.**
6. Gianetta and Silverton, Multiphase Chemical Reactor- Theory, Designand Scale-up, Hemisphere Publishing Corporation, 1986.
7. Sharma and Doraiswamy, Hetrogeneous reactions Vol 1 and 2, John Wiley, 1984.

Title: Project Engineering **Code: 18B14CL745**
L-T-P scheme: 3-0-0 **Credit:**3

Prerequisite:NIL

Objective:

The objective of this course is to give the students a detailedknowledge about project life cycle.

Learning Outcomes:

Course Outcome	Description
CO1	Outline about project engineering and techno-economic feasibility reports.

CO2	Learn how a project is initiated on the basis of various feasibility reports.
CO3	Describe in detail about various project clearances required to start a project.
CO4	Explain strategies about project organization and planning in detail.
CO5	Detailed study of project scheduling & execution.
CO6	Know concepts about project monitoring & control, project management system, and project termination.

Course Content:

Unit-1:

Introduction: Definition of project. Project Management. Project Life cycle. Project types. Project over runs. The Project Manager (PM): Role & Responsibilities Demands on PM.

Techno-economic feasibility report for chemical engineering projects: Constituents, Capital-Fixed, working. Estimation of capital and cost of product. Factors affecting the estimations-taxes, inflation, uncertainties.

Unit-2:

Project initiation: Feasibility reports of various types. Project selection criteria & Numeric models of the project section like: ROR, NPV, IRR, Profitability index. Technology selection criteria, site selection criteria. Project Licensing. Basic & Detailed Engineering. Guarantees. Liabilities. Risk, insurance. Project budgeting.

Unit-3:

Project clearances: Various Laws & Regulations. List of various clearances, intellectual property rights. Patents need for clearances & its influence on project management, LOI.

Project organization: Various forms like pure project, matrix and mixed type. Project team, responsibilities of various members.

Project planning: WBS & responsibility charts, Contracts of various types, role of contractor, sub-contractor, consultant, selection criteria & appointment procedure.

Unit-4:

Project scheduling & execution: CPM.PERT.GANTT charts, LOB, resource allocation, material management, ABC analysis, VED analysis, EOQ, CAT & RAT (numerical problems included).

Unit-5:

Project monitoring & control: Time & cost control tools & techniques, fund flow control various types of estimates. Project quality control-Importance of environmental & safety aspects, role of communication in monitoring & control.

Project management systems:

Project termination: Commissioning, Start-up. Stabilization, Close out.

Teaching Methodology:

This course is introduced to help students understand basic principles of Project Engineering. Students will get deep knowledge about project life cycle i.e., from project initiation to termination. The entire course is broken down into following separate sections: Techno-economic feasibility report, project initiation, project clearances, project organization, project planning, project scheduling & execution, and project termination. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 to Unit-2
Test-2	25 Marks	Based on Unit-3, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Peters, M.S. and Timmerhaus, K.D., Plant design and economics for Chemical Engineers, 4th Edition,
McGraw Hill, New York, 1995.
2. Kharbanda, O.P. and Stallworthy, E.A., Capital Cost Estimating for Process Industries, Butterworths,
London, 1988.
3. Humphreys, K.K. Jellens, Cost and Optimization Engineering, 3rd Edition, McGraw Hill, 1991.
4. Chaudhary, PROJECT MANAGEMENT, Tata McGraw Hill
5. Joy, TOTAL PROJECT MANAGEMENT, MacMillan
6. Jack Meredith & Samuel, PROJECT MANAGEMENT: A Managerial Approach, John Wiley & sons.
7. Mahajani, V.V. and Mokashi, S.D., Chemical Project Economics, 1st edition, Macmillan India, New Delhi, 2005.

Reference Books:

8. Young, D., Modern Engineering Economy, John Wiley and sons, New York, 1993.
9. Uhl, V. W. and Hawkins, A. W., Technical Economics for Chemical Engineers, AIChE Continuing
Education Series, AIChE, 1971.
10. Peter S. Timmerhouse, PLANT DESIGN & ECONOMICS FOR CHEMICAL ENGINEER, McGraw
Hill
11. Jhamb, INVENTARY MANAGEMENT, Everest Publishing house
12. J.K.Sharma, OPERATION RESEARCH, McMillan.

Title: Pharmaceutical Technology **Code: 18B14CL746**

L-T-P Scheme: 3-0-0 **Credit: 3**

Perquisites:

The students should complete the Industrial Organic Synthesis and Chemistry course at under graduate level before considering this course for the study.

Course objectives: This course will be enable students to identify the various mechanisms for the synthesis and characterization of drugs. This course enables students to understand the mechanism of Pharmaceutical Technology and develop an ability to learn for enhancing the quality of drugs through various methods.

Course Outcome	Description
CO1	The outline, outcomes and attributes provide students with learning experiences that help

	in still deep interests in learning of Pharmaceutical Technology. It develops broad and balanced knowledge and understanding of the drug synthesis concepts, principles, and theories.
CO2	Describe the real world problems, challenges in current scenario. It is important cours for the Chemical Engineering students.
CO3	Develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems of the world.
CO4	Identify and use of various techniques for resolving the world problem and in project management.
CO5	Apply experimental demonstration and validation by using various analytical techniques given in theorem, principles as explained in lectures.
CO6	Demonstrate students with the knowledge and skill base that would enable them to undertake further studies in the Pharmaceutical Technology and related areas or in multidisciplinary areas that help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

COURSE CONTENT:

Unit 1

Introduction: Development of drugs and pharmaceutical industry- Therapeutic agents and their uses.

Unit 2

Pharmaceutical Products And Their Control: Therapeutic categories such as vitamins, contraceptives, laxatives, analgesics, antibiotics and antibacterials.

Unit 3

Important Unit Processes And Their Applications: Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes.

Unit 4

Manufacturing Principles: Compressed tablets, wet granulation, dry granulation or slogging, direct compression, tablet presses, coating of tablets, capsules, preservation, analytical methods and tests for various drugs and pharmaceuticals, packing techniques, quality management, GMP.

Unit 5

Quality Control: Identity, content of active drug, size, physical appearance, friability (mechanical stability of tablets), variability in weight.

Teaching Methodology:

This course planned in 3 lectures each week. The course content divided in two 42 lectures. The lectures will be conducted in both manner white board and Power Point presentation. At the end of this course student will be able to understand the concept of Polymer Engineering and able to apply in further study and research.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit1, Unit 2 and Unit 3
Test-2	25 Marks	Based on Unit 3 and Unit 4 (70 %) and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit 4 and Unit 5 and around 30% from coverage of Test-1 and Text-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

[1] Aulton M.E. Pharmaceutics- The Science of Dosage Form Design, Churchill Livingstone, Edinburgh 1988.

[2] Leon Lachman Tetal 'Theory and Practice of Industrial Pharmacy', 3rd Edition, Lea and Febiger, 1986.

[3] Remington's 'Pharmaceutical Science', Mark Publishing & Co.

REFERENCE BOOKS:

[1] Modern Pharmaceutics, G.S. Banker New Year, Marcel Dekker 1990.

[2] Pharmaceutics: The Science of Dosage Form Design, Aulton, New Delhi, B.I. Haverly Pvt. Ltd., 1995

[3] Kent, J.A. Riegel's Handbook of Industrial Chemistry, Van Nostrand Reinhold, New York, 987, 1992.

[4] Zanowiak P., Pharmaceutical, Encyclopedia of Chemical Technology.

Title: Multiphase reactor design **Code: 18B14CL747**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Chemical Reaction Engineering

Objective: The objective of this course to give the students basic idea of design and model development multiphase reactors.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of multiphase reactors in chemical industries for carrying out heterogeneous reactions.
CO2	Understand the kinetics involved in multiphase reactions.

CO3	Describe the working of various multiphase reactors along with their applications.
CO4	Develop design equations for various industrial reactors such as trickle bed reactor, slurry reactor etc.
CO5	Apply performance equations to design different types of multiphase reactors employed in process industries.
CO6	Demonstrate the complete design of a two phase and three phase reactor.

Course Content:

UNIT – 1: INTRODUCTION

Reaction Kinetics for multiphase reactions, brief idea about multiphase reactors and design considerations. Catalyst deactivation and regeneration.Review of reaction kinetics and reactor design.

UNIT- 2: INDUSTRIAL REACTORS

Trickle bed, bubble column, segmented bed, agitated slurry, fluidized bed and slurry reactors. Constructional features and operation (batch and continuous).

Models for analysis of gas-liquid and gas-liquid-solid reactions. Flim and penetration theories, transport resistances and heat effects.

Residence time distributions (RTD and macro mixing models. Review of methods for obtaining RTD, Problems in Scale-up.

UNIT – 3: MODELS FOR GAS-LIQUID SOLID REACTORS

Contact effectiveness, models for Trickel bed reactors, RTD based modles, models for three phase slurry reactors, models for packed buuble column, models for three phase slurry reactors, models for packed bubble column, models for gas liquid reactors (only model formulations with assumptions and final design equations wherever available. Numerical solutions of model equations are excluded).

Brief description of laboratory reactors and significance of laboratory data for reactor design and scale-up.

UNIT – 4: INTRINSIC KINETICS

Catalysis, Langmuir-Hinshelwood models. Catalysts pellets, Effective diffusivity, Tortuosity, effectiveness factors, Falsified kinetics, mass transfer and reaction in packed beds. Determination of limiting steps from reaction data. Introduction to Chemical Vapor Deposition reactors.

Teaching Methodology:

This course is introduced to help students understand the design of different types of multiphase reactors employed in the process industries. The entire course is broken down into following separate units: Intorduction, Industrial reactors, Models for gas-liquid reactions, intrinsic kinetics. Each section includes multiple topics to help a student gain deeper understanding of the subject..

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1
Test-2	25 Marks	Based on Unit-2 & Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Y.T. Shah, "Gas-Liquid-Solid Reactor Design", McGraw Hill, 1979.
2. Foggler, "Elements of Chemical Reaction Engineering", Prentice Hall India.

REFERENCE BOOKS:

2. Westererp, K.R., Van Swaaij and Beevackers, "Chemical Reactor Design and Operation", John Wiley and Sons 1978.
3. Carberry, Verma, "Chemical Reactions and Reaction Engineering", Marcell Decker, 1987.
4. Gianetta and Silverton, Multiphase Chemical Reactor- Theory, Designand Scale-up, Hemisphere Publishing Corporation, 1986.
5. Sharma and Doraiswamy, Hetrogeneous reactions Vol 1 and 2, John Wiley, 1984.

Title: Membrane process design **Code: 18B14CL748**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: NIL

Objective: The objective of this course is to give the students a basic idea of types of membranes and membrane separation processes.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the importance of membrane separation processes employed in chemical industries.
CO2	Understand the types of process along with their applications.
CO3	Describe various membrane process utilized in different separation

	operations.
CO4	Develop various techniques for characterization of membranes.
CO5	Apply appropriate expressions that describes the complete transport process through membranes.
CO6	Demonstrate the preparation of various synthetic membranes used in process industries.

Course Content:

UNIT- 1: INTRODUCTION

Introduction to membrane processes, history, definition of membrane, importance of processes.

UNIT – 2: MEMBRANES AND THEIR APPLICATIONS

Types of membranes, membrane processes and their applications porous and solid membranes, Osmosis, Micro-filtration, Ultra-filtration, Nano-filtration, Reverse Osmosis, piezodialysis, electrodialysis, dialysis, membranes for gas separation, pervaporation. Application of these processes

Liquid membranes supported and unsupported liquid membranes, application and mathematical modeling.

Materials and material properties polymers and effect of various properties of polymers such as Tg, thermal, chemical and mechanical stability, elastomers and their properties, inorganic membranes, biological membranes.

UNIT - 3: CHARACTERIZATION OF MEMBRANES

Characterization of porous membranes, characterization of ionic membranes, characterization of non-ionic membranes **UNIT – 4: PREPARATION OF SYNTHETIC MEMBRANES**

preparation of phase inversion membranes, preparation techniques for immersion precipitation, preparation techniques for composite membranes, influence of various parameters on membrane morphology, preparation of inorganic membranes.

Transport processes in membranes driving force, transport through porous membranes, transport through nonporous membranes, transport in ion-exchange membranes.

Polymerization phenomena and fouling concentration polarization, characteristic flux behavior in pressure driven membrane operation, various models, temperature polarization, membranes fouling, methods to reduce fouling.

Modules and process design plate and frame, spiral wound, tubular, capillary, hollow fiber modules and their comparison, system design

Membrane reactors, application of membrane reactors in biotechnology

Economics and feasibility of membrane technology, comparison of membrane technology with other separation techniques, scope in the future, current and existing industrial application.

Teaching Methodology:

This course is introduced to help students understand the design and applications of various membranes employed in various separation processes. The entire course is

broken down into following separate units: Intorduction, membranes and their applications, characterization of membranes, preparation of synthetic membranes. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1& Unit -2
Test-2	25 Marks	Based on Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Marcel Mulder, Kluwer, "Basic Principles of Membrane Technology" , Academic Publishers, 1997.
2. Hoffma E.J., "Membrane Separation Technology", Gulf Prefession Publishing.

REFERENCE BOOK:

1. Membrane Handbook- Editors W.S. Winston Ho, K.K. Sirkar, Van Nostrand Reinhold Publication.

Title: Industrial Catalysis **Code: 18B14CL749**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Chemical Reaction Engineering

Objective: The course aims to provide students with:

1. An understanding of the importance of catalysis in the chemical process industries;
2. Understanding of the associated phenomena happening in catalysts.
3. Learning how to apply chemical engineering principles to the design of modern catalytic reactors.

Learning Outcomes:

Course Outcome	Description

CO1	Outline the importance of catalytic reactions.
CO2	Understand homogeneous and heterogeneous catalysis.
CO3	Describe the working of various catalytic reactors along with their applications.
CO4	Develop design equations for various industrial reactors such as trickle bed reactors, slurry reactor etc.
CO5	Apply performance equations to design different types of catalytic reactors.
CO6	Demonstrate the complete design of a two phase and three phase reactor.

Course Content:

UNIT – 1: CATALYTIC REACTIONS
Nature of catalytic reactions and classification of catalytic reactors

UNIT – 2: HOMOGENEOUS CATALYSIS
Homogeneous catalysis; examples of single phase and multiphase reactions; Acid-base catalysis, transition metal catalysis, bio-catalysis, phase-transfer catalysis, micellar catalysis, micro emulsion catalysis, electron transfer catalysis, heteropoly acid catalysis, homogeneous polymer catalysis. Heterogenization of homogeneous catalysts; Catalyst recovery and reuse

UNIT – 3: HETEROGENEOUS CATALYSIS
General characteristics; Adsorption on solid surfaces; Dynamics of selective and polyfunctional catalysis; Physical properties of catalysts; Classification and preparation of catalysts; Chemisorption rates and equilibrium; Rates of solid-fluid catalytic reactions

UNIT – 4: ANALYSIS OF EXTERNAL AND INTERNAL TRANSPORT PROCESSES
External transport processes in heterogeneous reactions for fixed bed, fluidized bed and slurry reactors. Intrapellet mass transfer, heat transfer, mass transfer with chemical reaction and simultaneous heat & mass transfer with reaction; Effect of internal resistances on catalyst effectiveness, selectivity and poisoning, deactivation and promoting

UNIT -5: DESIGN OF HETEROGENEOUS CATALYTIC REACTORS
Global rates and experimental reactors; Design calculations for ideal reactors operating at isothermal, adiabatic and non-adiabatic conditions; Deviations from ideal reactor performance; Design of industrial fixed bed, fluidized bed and slurry reactors; Examples from petro-refinery, pharmaceutical and fine chemical industry; DeNOx and DeSOx technologies; Catalytic Green Technology; Thermal stability of packed bed and fluidized bed reactors; Introduction to optimum design of catalytic reactors

Teaching Methodology:

This course is introduced to help students understand the importance of catalyst in carrying out the reactions along with the design of catalytic reactors. The entire course is broken down into following separate units: Catalytic reactions, homogeneous catalysis,

heterogeneous catalysis, design of catalytic reactors. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit -2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. C.N. Satterfield, Heterogeneous Catalysis in Industrial Practice, 2nd ed, Krieger.
2. C.G. Hill, An introduction to chemical engineering kinetics and reactor design, John Wiley 1977.
3. Y.T. Shah, “Gas-Liquid-Solid Reactor Design”, McGraw Hill, 1979.

REFERENCE BOOKS:

1. J. Szekely, J.W. Evans and H.Y. Sohn, Gas-solid reactions, Academic Press 1976.
2. P.W.N.M. van Leeuwen, Homogeneous catalysis: understanding the art, Kluwer Academic Publishers, 2004.

Title: Advanced Process Control **Code: 18B14CL750**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite:INSTRUMENTATION AND PROCESS CONTROL

Objective:

The objective this course is to introduce to some advanced control strategies used for control of different processes in chemical industries.

Learning Outcomes:

Course Outcome	Description
CO1	Describe advanced control strategies.
CO2	Learn about the design of multivariable process control.
CO3	Describe method of decoupling control systems and model predictive control.
CO4	Outline of sampled data control system.

CO5	Apply z-transform for stability analysis of sampled data systems.
CO6	Study state-space methods.

Course content:

Unit-1:

Advanced Control Systems: Introduction to multiple loop control systems, Cascade control, Feed Forward control; Inferential control; Adaptive and Ratio control.

Unit-2:

Multivariable Process Control: Introduction, Design of controllers for Multivariable processes:Selection of manipulated and controlled variables, Pairing controlled and manipulated variables, BLT Tuning, Load rejection performance, Decoupling Control Systems, Introduction to Model Predictive Control.

Unit-3:

Sampled Data Control Systems: Introduction;Sampling, Z Transforms and stability; Stability analysis of sampled data systems; Process Identification

Unit-4:

State Space Methods: State Space representation of Physical Systems, Transfer function Matrix.

Teaching Methodology:

This course is introduced to help students to learn about advanced control strategies, design control system for multivariable processes, and digital control system. The entire course is broken down into following separate sections:Advanced Control Systems, Multivariable Process Control, Sampled Data Control Systems, and State Space Methods. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1
Test-2	25 Marks	Based on Unit-2 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-3 to Unit-4 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books and Reference Books:

1. D.R.Coughanowr, “Process System Analysis and Control” McGraw-Hill, 1991.
2. George Stephanopolous, "Chemical Process Control ", Prentice-Hall of India Pvt-Ltd., New Delhi, 1990.
3. Luyben and Luyben ,”Essentials of Process Control”, McGraw-Hill,1996
4. Luyben, W.L., “Process Modelling, Simulation and Control for Chemical Engineers”, McGraw Hill International Edition, 1990.
5. F.G.Shinskey, “Process Control Systems”, McGraw-Hill,1996
6. B.G.Liptak, “Instrument Engineer’s Handbok”-Volume 1&2, CRC Press.

Title: Fluidization Engineering **Code: 18B14CL751**

L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: Fluid & Fluid Particle Mechanics

Objective:

The course aims to provide an insight into fluidization phenomena and its use in industrial applications.

Learning Outcomes:

Course Outcome	Description
CO1	Outline about fluidization phenomena, fluidized beds, and their industrial applications.
CO2	Study laws and equations associated with packed bed.
CO3	Understand the fluidization in detail.
CO4	Explain bubble formation, heat & mass transfer in fluidized bed, and

	introduction to the design aspects of fluidized beds.
CO5	Application of fluidization in conveying.
CO6	Discuss about advanced fluidization.

Course Content:

Unit-1:

Introduction: Fluidization phenomena, behavior of fluidized beds, industrial applications.

Packed Beds: Flow of fluids, Darcy's law and permeability, specific surface and voidage; general expressions for flow through packed beds; Carman-Kozeny equation.

Unit-2:

Fluidized Beds: Properties of gas fluid and liquid-solid systems, onset of fluidization, minimum fluidizing velocity, terminal velocity, slugging, channeling, bed expansion, distributors, voidage, entrainment and elutriation.

Unit-3:

Bubbles In Dense Phase – Bubble formation, bubbling bed model, emulsion phase, RTD of solids, flow patterns of gas.

Unit-4:

Application and Design Aspects: Heat and mass transfer in fluidized beds, reactions in fluidized beds, introduction to design aspects of fluidized beds.

Unit-5:

Pneumatic and Hydraulic conveying: Pneumatic and hydraulic conveying of solids in horizontal and vertical pipelines, choking and saltation velocity, hydraulic conveying of solids.

Unit-6:

Other Topics – Fluidization in Tapered Vessels, Semi fluidized beds; Three phase fluidization, Multistage fluidization

Teaching Methodology:

Students will be able to understand how to design fluidized bed applications in the chemical process industry. The entire course is broken down into following separate sections: packed beds, fluidized beds, bubbles in dense phase, application and design aspects, pneumatic and hydraulic conveying, three phase fluidization, and multistage fluidization. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 to Unit-2
Test-2	25 Marks	Based on Unit-3 to Unit-4, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	

Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Fluidization Engineering: Kunii, D., and Levenspiel, O., John Wiley & Sons.
2. Chemical Engineering Vol-2: Coulson, J. M., and Richardson, J.F., Pergamon Press.

Reference Books:

3. Fundamental of Fluidized Bed Chemical Processes: Yates, Y.G., Butterworth.
4. Fluidization: Davidson, J.F., and Harrison, D., Academic Press.
5. Fluidization: Leva, M., Mc-Graw Hill Book Co.
6. M. Kwauk, Fluidization: Idealized and bubbleless with applications Ellis Horwood, 1992
7. L.S. Fan, "Gas-Liquid-Solid Fluidization Engineering," Butterworth, 1989.

Title: Major Project Part -1 **Code:18B19CL791**
L-T-P scheme: 0-0-8 **Credit: 4**

Prerequisite: Subjects taught during previous/current semester

Objective:

A topic will be allotted to the student following which relevant literature survey will be done. Based upon the literature survey, it is expected from the student to select a suitable process along with the production capacity.

Learning Outcomes:

Course Outcome	Description
CO1	Literature survey with respect to the topic allotted.
CO2	Understand the importance of the product and its applications.
CO3	To perform market survey to fix the production capacity of the plant.
CO4	Development of of process flow sheet.
CO5	To perform material balance for the overall flow sheet.
CO6	To perform energy balance for the overall flow sheet.

Teaching Methodology:
Student as individual or in groups (max. of 3 students) will be given design projects. The students will choose the plant capacity, process flow sheet followed by material balance and energy balance calculations. There will be two mid-term evaluations, a presentation at the end followed by a viva voce examination.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	
P-2		15 Marks	
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Presentation	20 Marks	
	Report	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	

8th Semester

Title: Fertilizer Technology **Code: 18B14CL841**
L-T-P scheme: 3-0-0 **Credit:** 3
Prerequisite: Chemical Processes

Objective:
The objective of this course is to give the students a basic idea about fertilizers and fertilizer technology.

Learning Outcomes:

Course Outcome	Description
CO1	Outline about need for use of fertilizers and micronutrients.
CO2	Understanding of different types of fertilizers i.e., nitrogen fertilizers, phosphate fertilizers, potash fertilizers, and mixed fertilizers.
CO3	Describe production processes of nitrogen fertilizers, phosphate fertilizers, andpotash fertilizers with special reference to engineering aspects.

CO4	Demonstrate the production processes of mixed fertilizers.
CO5	Identify with secondary and micronutrients used in fertilizers, by products from fertilizer industry, and value added products.
CO6	Develop the concepts of bio fertilizers.

Course content:

Unit-1:

Need for use of fertilizers and micronutrients. Nutrient requirements of plants; Nature of chemical fertilizers.

Unit-2:

Ammonia, Urea, ammonium nitrate, ammonium sulfate and other nitrogen based fertilizers. Production process with special reference to engineering aspects

Unit-3:

Ordinary (Single) Super-phosphate, triple super-phosphate , di-ammonium phosphate and other phophorus based fertilizers; Production process with special reference to engineering aspects.

Unit-4:

Potassium chloride, potassium sulfate and potassium nitrate and other potassium based fertilizers. Production processes.

Unit-5:

Manufacture of mixed fertilizers by various process

Unit-6:

Secondary and micronutrients used in fertilizers.

Unit-7:

Use of by products from fertilizer industry; Value added products.

Unit-8

Bio-fertilizers.

Teaching Methodology:

This course is introduced to help students to know about different types of fertilizers and their production processes. The entire course is broken down into following separate units: nitrogen fertilizers,phosphate fertilizers, potash fertilizers,mixed fertilizers, secondary and micronutrients in fertilizers, by products from fertilizer industry, and bio-fertilizers. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-8 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	

Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Textbooks:

1. Strelizoff, "Technology and Manufacture of Ammonia", 2nd.' Edn.,Wiley,1981.
2. L. J. Carpentire, "New Developments in Phosphate Fertilizer Technology", Elsevier, 1971.
3. M. E. Pozin, "Fertilizer Manufacture", MIR Publishers, Moscow, 1986.

Reference books:

1. "Handbook on Fertilizer Technology", Fertilizer Association of India ,near JNU, New Delhi 1992.
2. A. V. Slack, "Phosphoric Acid", 2" Bin., Marcell Dekkar, 1968.

Title: Petrochemical Technology **Code: 18B14CL842**
L-T-P scheme: 3-0-0 **Credit: 3**
Prerequisite: Chemical Processes

Objective:

The objective of this course is to give the students a basic idea of petrochemicals and their uses.

Learning Outcomes:

Course Outcome	Description
CO1	Outline about Indian and world scenarios of petrochemicals, petroleum refining, and bulk petrochemicals.
CO2	Identify with feedstock of petrochemicals.
CO3	Understanding of chemicals from c_1 and c_2 compounds.
CO4	Develop the understanding of chemicals from c_3 and c_4 compounds.
CO5	Explain chemicals from aromatic compounds.
CO6	Demonstrate manufacturing of petrochemicals using unit process.

Course content:

Unit-1:
Introduction to petroleum refining and bulk petrochemicals. Indian and World scenarios.
Unit-2:
Petrochemical feedstock and production of olefins and aromatics.
Unit-3:
Chemicals from c_1 compounds (methane and synthesis gas) -
Methanol, formaldehyde, chloromethane, Trichloroethylene, and pechloroeflyence.
Unit-4:
Chemicals from c_2 compounds (ethylene and acetylene) -
Thanal, Polyethylene, ethylene dichloride, vinyl chloride, ethylene oxide, ethanolamine, vinyl acetate, and acetic acid.
Unit-5:
Chemical from C_3 compounds (PROPYLENE): Isopropanals acetone, cumene, acyloritrile, isoprene, polypropylene, epichcrohydrin, propylene oxide, and oxo processes.
Unit-6: Chemicals from c_4 compounds (butanes and butenes) -
Butadiene and polybutenes and other chemicals from C4 feedstock.
Unit-7:
Chemicals from aromatics -
BTX raw materials, hydrodealkylation to produce toluene, phenol, chlorobenzens, styrene, phthalic anhydride.
Unit-8:
Chemicals from aromatics -
Malefic anhydride, fumaric acid, ferephthalic acid, diethyl terephthalate, nitrobenzene, and amiline. Other important aromatic chemicals.
Unit-9:
Manufacturing using unit process -
Alkydation, halogenations, hydrolysis, hydrogenation and dehydrogenation, animation, nitration oxidation, carbonization and other process.

Teaching Methodology:

This course is introduced to help students to know about different types of petrochemicals, their uses, and manufacturing processes. The entire course is broken down into following separate units: introduction and raw materials, chemicals from c_1& c_2 compounds, chemicals from c_3& c_4 compounds, chemicals from aromatics, and manufacturing using unit process. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 to Unit-4
Test-2	25 Marks	Based on Unit-5to Unit-7and around 30% from coverage of Test-1

Test-3	35 Marks	Based on Unit-8 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books / Reference Books:

1. Austin, G.T. "Shreves" Chemicals Process Industries, 5th ed. McGraw Hill Institution Edition, 1984.
2. Gopal Rao, M. Sittig, M., "Drydcees" Outlines of Chemical Technology.
3. Kirk and Othmer's Encyclopedia of Chemical Technology.
4. Ullmann's Encyclopedia of Chemical Technology.
5. McKetta's Encyclopedia of Chemical Technology.

Title: Mixing Technology **Code: 18B14CL843**
L-T-P scheme: 3-0-0 **Credit: 3**
Prerequisite: Fluid Mechanics and Solid-Fluid Mechanical Operations

Objective:

The objective of this course is to provide a detail study of mixing effects and mixing equipments.

Learning Outcomes:

Course Outcome	Description
CO1	Outline of mixing technology.
CO2	Identify with classification and power consumption of impellers.
CO3	Understanding of Liquid, solid and gas dispersions in liquid. Three phase dispersions.
CO4	Describe the concept of heat transfer in mixing.
CO5	Develop the concept of mass transfer in mixing.
CO6	Demonstrate process design and scale-up of mixing equipments.

Course Content:

Unit-1:
Examples mixing of industrial importance. Need for proper mixing system, selection and design. Mixer, impeller and auxiliary equipments.

Unit-2:
Types of impellers and their characteristics, critical dimensions, flow characteristics. **Unit-3:**
Power consumption for different impellers and correlations.

Unit-4:
Blending of miscible liquids of low and high viscosity.

Unit-5:
Suspension of solid particles

Unit-6:
Liquid, solid and gas dispersions in liquid. Three phase dispersions.

Unit-7:
Heat transfer in mixing. Jacket and Coil in agitated vessels

Unit-8:
Mass Transfer in gas-liquid, liquid-liquid and solid-liquid system

Unit-9:
Design and scale-up of mixing equipments

Teaching Methodology:

This course is introduced to help students understand basic principles of MIXING along with the design of MIXING equipmentS. The entire course is broken down into following separate units: introduction to mixing and classification of impellers, power consumption and mechanism of mixing, suspension of solid particles and three phase dispersion, heat & mass transfer in mixing, and design and scale-up of mixing equipments. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 to Unit-3
Test-2	25 Marks	Based on Unit-4 to Unit-6 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books / Reference Books:

1. Nagata, S., "Mixing", John Wiley, N. Y.
2. Uhl, V.W. and Gray, J.B., "Mixing: Theory and Practice", Vol. I, II, and III, Academic Press.
3. Sterbacek, Z. and Tausk, P., "Mixing in the Chemical Industry", Pergamon Press.
4. Holland, F.A. and Chapman, F.S.,"Liquid Mixing and Processing in Stirred Tanks", Reinhold.
5. Oldshue, "Mixing".

Title: Piping Engineering **Code: 18B14CL844**
L-T-P scheme: 3-0-0 **Credit:** 3
Prerequisite: Fluid Mechanics

Objective:

The objective of this course is to tell the students about role of piping, standard pipe fittings pipe flanges and gaskets their selection and specifications.

Learning Outcomes:

Course Outcome	Description
CO1	Outline of piping engineering.
CO2	Understanding material of construction and fabrication of pipes, codes/standards/statutory regulations.
CO3	Describe pipe, pipe fittings, valves, and other piping components.
CO4	Demonstrate design of piping system along with piping layout and drawing.
CO5	Identify with computer aided piping design/ drafting and documentation.
CO6	Apply principles of piping engineering on different types of pipe arrangements.

Course Content:

Unit-1:

Role of piping, scope of piping engineering, responsibilities of piping engineer; Inputs received by a piping engineer and output given by him. Interactions of piping engineers with other disciplines such as process engineering, instrumentation etc. introduction to engineering line diagram, process flow diagram and piping and instrumentation diagram for process plant and utilities including various symbols.

Unit-2:

Selection of various piping materials such as ferrous, non-ferrous and non-metallic. Piping; Fabrication; Precautions; Welder's qualification; Preparation of pipe edges, Designation of coated electrodes. Requirements of weld test, hot bending and cold bending operations; fabrication specifications.

Unit-3:

Statutory rules and regulations such as, C.C.E, S.M.P.V rules, petroleum rules, gas cylinder rules, Factories act, I.B.R. and N.F.P.A rules. Codes and standards such as, A.N.S.I. codes for pressure piping 31.1 and 31.3 international standards, D.I.N and A.P.I.

Unit-4:

Introduction to various standard pipe fittings pipe flanges and gaskets their selection and specifications-

1) Schedule number and pipe thickness
2) I.D. sizing for liquids and gases
3) Branch pipe and its drawing details
4) Miter bend and its drawing details for single cut and multiple cuts
5) Stress intensification factor and flexibility factor for various bends specialty piping system such as traced piping, jacketed piping, hoses, and flexible metallic piping etc. [6]

Unit-5:

Functions of valves and their selection valve materials and methods of constructions of the following types. Gate, glove, needle, piston, butterflies. Plug, diapharagm, pinch, foot and float valves. Applications of various valves and their operational characteristics relevant to piping engineering.

Special piping components: Construction, Working and Selection of various components such as Steam Traps, Strainers, Sight glass, Level gages, Expansion bellows, Flame arresters, Inline mixers and Static mixtures.

Unit-6:

Mechanical and Thermal stress analysis in piping, loop calculations, types and design of pipe supports and their selections and design of pipe racks. Protection of pipe system such as Cathodic protection, painting and insulation etc.

Unit-7:

Factors considered in piping layout. Recommended practices/statutory requirements in equipment spacing and piping layout in process, utility and offsite area. Various drawings and their preparation e.g. general arrangements, Master plot plan, unit plot plan, piping plan and piping isometrics. Drawings for approval, fabrication and records, specification sheets, Bill of material and line designation lists.

Unit-8:

Computer aided piping design/ drafting and documentation. **Unit-9:**

Application of piping engineering -
Piping arrangements and factors considered in
a) Tank farm piping
b) Heat exchanger piping
c) Reactor piping
d) Furnace piping
e) Process and storage vessel piping
f) Piping of compressor and pumps
g) Reboiler piping and
h) Utility piping.

Teaching Methodology:

This course gives a detailed knowledge about piping engineering i.e., role of piping engineer, design, drawing and application of piping engineering. The entire course is broken down into following separate units: introduction, material of construction and fabrication, codes/standards/statutory regulations, pipes and pipe fitting, valves and other piping components, piping system design, piping layout and drawing, computer aided piping design/ drafting and documentation, and application of piping engineering. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 to Unit-3
Test-2	25 Marks	Based on Unit-4 to Unit-6 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 to Unit-9 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	100 Marks	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Kellogg, M. W., Design of Piping System, 2/e. M.W. Kellogg Co., 1976
2. Weaver R., Process Piping Design Vol.1 and 2, gulf Publishing, 1981
3. Zappe R. W., Valve Selection Handbook, Gulf Publishing, 1981
4. Sam Kannappan, P.E., Pipe Stress Analysis, A Wiley-Interscience publications.

5. G.K. Sahu., Handbook of Piping Design, New Age International publisher.
6. Evans, F.L., Equipment Design Handbook of Refineries and Chemical Plant Vol. 1 and 2. Gulf Publishing, 1980

Reference Books:

7. Mcketta, J.J., Piping Design Handbook, Gulf Publishing, 1992.
8. McAllister, E.W., Pipeline Rules of Thumb Handbook, Gulf Publishing, 1988
9. Wasp, E.J., Solid Liquid Flow: Slurry Pipeline Transportation, Gulf Publishing, Houston, 1979
10. Watters, G.Z., Analysis and Control of Unsteady Flow in Pipelines, 2/e. Butterworths, 1986.

Title: Cement Manufacturing **Code: 18B14CL845**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite: No prerequisite.
Objective: The purpose is to familiarize the students with basics of cement raw materials , raw mix design, clinker manufacturing technologies, cement types, energy trends and waste utilization in cement .

Learning Outcomes: After completion of this course, a student will be familiar with the cement raw materials, cement manufacturing technologies, energy trends related to cement manufacture and quality aspects of different cement varieties.

Course Outcome	Description
CO1	Outline of cement manufacturing.
CO2	Understand the processes of cement manufacture.
CO3	Describe production process of wet, semi wet, dry with pre-heater and dry with pre-calciner.

CO4	Develop the understanding of conversion of raw materials to cement.
CO5	Identify the quality control aspects in cement.
CO6	Demonstrate the principles of heat and mass transfer in cement manufacture.

Course Content:

Unit 1:INTRODUCTION

What is cement, importance of cement in construction, usage of lime in construction. Ancient constructions around the world.

Unit 2: CEMENT MANUFACTURE

History of development of cement, all the processes of cement manufacture, wet, semi-wet, semi-dry and dry process, various unit operations in cement manufacture.

Behive kilns, vertical shaft kilns, long wet process kilns, long dry process kilns, LEPOL Kilns, pre-heater kilns and pre-heater- pre-calcinator dry process kilns. Their developments and transformation into modern kilns.

Unit 3:DIMENTIONS OF CEMENT INDUSTRY

Indian cement industry, benchmarks with respect to thermal and electrical energy consumption, various groups and cement companies in India, world scenario. Future prospects of cement industry.

Unit 4: RAW MATERIALS & RAW MIX DESIGN

Raw materials for cement manufacture and their quality requirements, calcareous and argillaceous materials. Corrective raw materials, sweetner and mineralizers. Quality requirements of industrial and agricultural wastes for utilization in cement manufacture.

Different types of limestone: limestone, aragonite, marl and dolomite, classification of limestone, different types of clay: Kaolinite, montmorrilonite, shale and illite, other corrective materials: laterite, iron ore, pyrite cinder and bauxite. Utilization of calcareous, argillaceous and siliceous industrial wastes for cement manufacture.

Unit 5: MINING OF LIMESTONE

Geological assessment of limestone deposits and various methodologies used for limestone mining and haulage of limestone. Safety in mining operations, mines rehabilitation.

Mining techniques: Blasting, ripping and surface mining and different methods used for limestone haulage: usage of dumpers, belt conveyors and rope ways.

Unit 6: SIZE REDUCTION

Size reduction machinery: crushers such as Jaw crusher, gyratory crushers, impact crushers, roll crushers and cone crushers; Grinders such as hammer mills, ball mills, roll presses & vertical roller mills.

Unit 7: MATERIAL HANDLING

Various material handling equipments used in cement plants. Mechanical and pneumatic equipments and their energy requirements. Logistic arrangements for cement transportation and storage of cement, precautions during transportation and storage of cement.

Unit 8:BLENDING AND HOMOGENIZATION

Pre-blending of limestone, various types of stackers and reclaimers. Homogenization of raw meal in silo: batch blending and continuous homogenization.

Unit 9: CEMENT CLINKER

Clinker minerals, absorption of various constituents in phases. Bouge's calculation, phase diagrams. Polymorphs of alite and belite.

Unit 10: FORMATION OF CLINKER MINERALS

Chemical reactions during clinkerization, role of minor constituents in clinkerization, thermochemistry of clinker formation. Microscopic examination of cement minerals.

Unit 11: TYPES OF CEMENTS

Varieties of cement being manufactured in the country and their classification. Physical and chemical properties of cement.

Unit 12: QUALITY CONTROL IN CEMENT

Sample collection, Quality control procedure, requirements of scheme of testing and inspection .

Sample collection techniques: auto samplers and robotic control in cement plants, sample preparation. Quality control points and quality norms at various stages. Quality control norms mentioned in scheme of testing and inspection defined by Bureau of Indian Standards.

Unit 13: ENERGY TRENDS AND WASTE UTILIZATION IN CEMENT

Basic concerns, energy economy, energy audit, conservation of natural resources, usage of industrial wastes for cement manufacture. Usage of alternative fuels and technological advancements.

Teaching Methodology:

This course is introduced to help the students to understand raw material collection procedures, Quality control norms to be followed during cement manufacture.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1to Unit-4
Test-2	25 Marks	Based on Unit-5 to Unit-8 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-9 to Unit-13 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on raw material collection, specification requirements, physical tests, quality control norms (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

1. Cement Engineers' Handbook, Labahn and Kohlhaas, Bauverlag GMBH, Berlin.
2. The Rotary Cement Kiln, K. Perey, Edward Arnold.
3. Cement Data Book, All volumes, W. H. Duda, Verlag GmBH, Berlin.
4. Reports of VDZ Congress, 1993, 2002.
5. Cement International, No. 3/2003, No. 6/2003, VDZ, Germany
6. BIS Specifications on Cement.
7. NCB Guide Norms for Cement Plant Operations, Fifth Edition, 2005, National Council for Cement and Building Materials, New Delhi.
8. Quality Control in Cement Manufacture, NCB publication, 1995.
9. The Chemistry of Cement and Concrete, F M Lea, Edward Arnold (Publishers) Ltd.,Great Britain.

Reference books:

[1] Proceedings of Selected International Seminars on Cement

[2] Innovation in Portland Cement Manufacturing, J I Bhatty, F M Miller and S H Kosmatka, Portland Cement Association, USA.

[3] Advances in Cement Technology, S N Ghosh,Tech Books International, New Delhi

Web References:

[1] Cement Data Book, Vol - 1 – Walter H Duda

[2] Cement Engineers' Handbook, Labahn and Kohlhaas, Bauverlag GMBH, Berlin

Title: Plant Utilities and Energy system **Code: 18B14CL846**

L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite: HEAT TRANSFER OPERATIONS

Objective: The objective of this course is to tell the students about the basic requirements of any plant such as water, steam and air supply.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various utilities employed in chemical plants.
CO2	Understand the importance of utilities in different processes.
CO3	Describe various types of refrigeration systems and boilers.
CO4	Develop efficiency expressions for the absorption and compression refrigeration system.
CO5	Apply the basic concepts to design heat exchange networks.
CO6	Demonstrate the heat integration of different process units.

COURSE CONTENT:

UNIT -1 INTRODUCTION

Identification of common plant utilities. Importance of utilities in India.

WATER

Raw water storage and treatment. Soft water and demineralized water. Cooling water system. Fire water system.

STEAM

Properties of steam. Steam generation by boilers. Type of boilers and their operations. Waste heat and thermic fluid boilers. Regenerators. Distribution of steam in a plant. Effectiveness of steam.

AIR

Compressed air from blowers and compressors. Air drying systems. Humidification and dehumidification.

UNIT – 2 REFRIGERATION

Refrigeration systems such as compression and absorption refrigeration.

VACUUM SYSTEMS

Selection of vacuum system and maintenance.

FLARING AND VENTING

UNIT – 3 ENERGY AUDIT

INTRODUCTION

Methodology and steps taken; Target setting. Reduction in losses. Improvements in operation. Operating equipment near its best efficiency. More efficient equipment ; preventive maintenance for energy efficiency ; high frequency equipments .Energy Efficient Process Technologies.

UNIT – 4 ENGINEERING INTEGRATION IN THE PROCESS INDUSTRIES

a) DESIGN OF HEAT EXCHANGER NETWORKS (HENS): Minimizing utilities in heat integration Temperature interval method Using graphical display Linear programming method Stream matching at the pinch concepts of Optimum approach temperature, Superstructures for minimization of annualized cost.

b)HEAT INTEGRATION IN PROCESS UNITS

(i) Multiple Effect Evaporators: with and without vapor recompression.

(ii) Distillation Column: Effect of pressure on heat integration, Multiple effect distillation, Heat pumping,

Vapor recompression and reboilers, flashing, Superstructures for minimization of annualized cost.

UNIT -5 CO-GENERATION OF ENERGY

INTRODUCTION

Advantages of co generation, waste heat boilers, different type of co-generation power plants, steams, turbine systems, gas turbine systems, combined gas steam turbine systems, diesel engine systems.

RENEWABLE SOURCES OF ENERGY

solar energy—Photo-volumetric cells, solar boilers, solar refrigerators , wind energy; fuel cells; biogas; bio-diesel, bio mass gasification etc.

INTRODUCTION TO TIDAL GEOTHERMAL SOURCE OF ENERGY

Comparison with nuclear energy.

Teaching Methodology:

This course is introduced to help students understand basic principles of application of various utilities such as air, water and steam in process industries. The entire course is broken down into following separate units: Water, steam, air, refrigeration, vacuum systems, energy audit, co-generation, use of renewable energy. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3& Unit-4, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Seider, W.D., and Seader, J.D. and Lewine D. R., "Process Design Principles",John Wiley and Sons. Inc, 1988
2. Douglas J. M., "Conceptual Design of Chemical Process", McGraw Hill Books Co. 1988
3. Biegler, L.T., Grossman, E. I. and Westerberg A. W., "Syatematic Method of Chemical Process Design", Prentice Hall Intl Ltd. 1997

REFERENCE BOOKS:

4. Larmine James., "Fuel Cells Explained", John Wiley and Sons 2000.

5. Kreith, F., “Principles of Solar Energy”, McGraw Hill Book Co1978.
6. Freris, L.L., “Wind Energy Conversion System”, Prentic Hall, 1990.
7. Turner, (Ed) “Energy Management Hand Book”, John Wiley and Sons 2000.
8. Thilkeld, J.L., “Thermal Environmental Engineering”, Prentice Hall, 1970
9. lyle, o, “Efficient of steam”,
10. Wagham, D. A. , “Theory and Practical of Heat Engine”, ‘ELBS’. Cambridge University Press , 1970

Title: Co-generation **Code: 18B14CL847**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite:HEAT TRANSFER OPERATIONS

Objective: Process industry uses both thermal and electrical energy making cogeneration possible. The course provides a thermodynamics background to power cycle with inputs on cogeneration.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various energy sources utilized in the chemical industries.
CO2	Understand thermodynamic properties of pure substances, steam table, Mollier diagram.
CO3	Describe various power cycles such as vapour power cycle and gas power cycle.
CO4	Develop the expressions for efficiency related to various cycles.
CO5	Apply the energy balance equations for determining the performance of steam turbines.

CO6	Demonstrate the case studies for the cogeneration in process plants.

COURSE CONTENT:

UNIT -1

Introduction: Energy sources, Available energy referred to a cycle, Maximum work in a reversible process, Useful work, Availability in chemical reactions, Concepts of co-generation.

UNIT -2

Properties of pure substances: PVT surfaces, Mollier diagram, Steam tables, Thermodynamic properties, Measurement of steam quality.

UNIT – 3

Vapour power cycle: Simple steam power cycle, Rankine cycle, Actual power cycle process, Reheat cycles, Thermodynamics of coupled cycles, Process heat and by product power, Efficiency in steam power plant.

UNIT -4

Gas power cycle: Carnot cycle, Stirling cycle, Ericsson cycle, Air standard cycles, Ottocycle, Diesel cycle, Dual and Brayton cycle.

UNIT – 5

Steam generation: Boilers, Construction, Working of different types of boilers, Boiler mountings, Draught, Combustion of fuels, Performance of steam generators.

UNIT -6

Steam turbines: Types, Classification, Velocity diagram, Compounding, Steam turbine performance. Reheat factor, Steam nozzles, Condensers.

UNIT -7

Co-generation: Characteristics of cogeneration plant, Cogeneration economics.

UNIT -8

Case studies of cogeneration in process plants.

Teaching Methodology:

This course is introduced to help students understand basic principles of application of various energy sources utilized in process industries. The entire course is broken down into following separate units: Vapor power cycle, gas power cycle, steam generation, steam turbines, co-generation. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2&Unit-3
Test-2	25 Marks	Based on Unit-4& Unit-5, and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-6 , Unit-7 & Unit -8 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	

Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Cogeneration- S.David. Hu, Reston publishing Co., (1985).
2. Cogeneration of steam and electrical power – Editor- Robert Noyes, Noyes Data corp. (1978).
3. Engineering thermodynamics - P.K. Nag, Tata McGraw Hill Book Co.(1995).
4. Power plant technology – M.M.Elwakil, Mcgraw Hill Book Co, (1985).

REFERENCE BOOKS:

1. Energy cogeneration Hand Book- George Polimeros; Indutrial Press Inc (1981)
2. Engineering thermodynamics- Glen Meyers, Prentice Hall inc, (1989).

Title: Thermal Energy generation Systems **Code: 18B14CL848**
L-T-P scheme:3-0-0 **Credit: 3**

Prerequisite:HEAT TRANSFER OPERATIONS

Objective: The course provides an insight into fuels and combustion and steam systems. It provides basic knowledge on thermal energy system in process plants.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the need of energy in Indian scenario especially thermal energy.
CO2	Understand different types of fuels and their combustion characteristics.
CO3	Describe the working of different types of steam generators and steam cycles.
CO4	Develop the expressions related to kinetics of combustion.
CO5	Apply the appropriate equations for the design of different equipment

	such as cooling tower.
CO6	Demonstrate the applications of thermal energy system in process plants.

COURSE CONTENT:

UNIT-1
Introduction: Energy needs in Indian scenario, Thermal energy and power.

UNIT – 2
Fuels and combustion: Coal, Fuel oil, Natural gas, Industrial fuels, Biomass, Combustion reactions, Mass and energy balance, Draught systems, Heat of combustion , Theoretical flame temperature.

UNIT – 3
Combustion Mechanism and Equipments: Kinetics of combustion reaction, Solid fuel combustion , Combustion equipment for burning Coal, Fuel bed combustion, Mechanical stoker, Pulverised coal firing, Cyclone furnace, Fluidized bed combustion, Coal gasifier, Combustion of fuel oil, combustion of gas.

UNIT – 4
Steam Generators: Basic type, Fire tube and water tube boiler, Economisers, Super heaters, Reheaters, Steam generation control, Air preheaters, ESP, Fabric filters, Baghouses, Ash handling system, Feed water treatment, Deaeration, Evaporation, Boiler Blowdown, Steam purity, Thermal Efficiency.

UNIT – 5
Analysis of steam cycles- Steam power plant, Rankine and Carnot Cycle, Effect of steam condition on thermal efficiency of a steam power plant, Reheating of steam, Regeneration, Supercritical pressure cycle, Steam power plant appraisal, cogeneration of power and process heat.

UNIT -6
Steam turbines: Introduction, Flow through nozzles, Turbine blading

UNIT – 7
Condenser- Need for condenser, Direct contact condenser, Surface condenser, Feed water heater, Circulating water system, Cooling tower.

UNIT – 8
Steam and condensate handling: Steam quality, Steam distribution, Steam nozzles, Condensate handling, Steam traps.
Introduction to diesel engines and gas turbines, energy storage.

Teaching Methodology:

This course is introduced to help students understand basic principles of systems involving generation of thermal energy. The entire course is broken down into following

separate units: Fuels and combustion, combustion mechanism, Steam generators, steam cycle analysis. Each section includes multiple topics to help a student gain deeper understanding of the subject.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2&Unit-3
Test-2	25 Marks	Based on Unit-4, Unit-5 & Unit-6 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-7 & Unit-8 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and study material (will be added from time to time): Digital copy will be available on the JUET server.

TEXT BOOKS:

1. Power plant Engineering- 2nd Edition, P.K. Nag; Tat McGraw Hill Book Co. Ltd. (2001)
2. Power plant technology – M.M.Elwakil, Mcgraw Hill Book Co, (1985).

REFERENCE BOOKS:

1. Engineering thermodynamics- Glen Meyers, Prentice Hall inc, (1989).

Title: Major Project Part-2 **Code:18B19CL891**
L-T-P scheme: 0-0-16 **Credit: 8**

Prerequisite: Major Project Part -1

Objective:

The objective is to make students understand the design of various chemical equipments used in the industry along with their cost estimation.

Learning Outcomes:

Course Outcome	Description
CO1	Understand the various unit operations used in the flow-sheet.
CO2	Development to design equations for all the equipments.
CO3	Application of design equations to find out the size of the equipment.
CO4	Development of cost estimation techniques.
CO5	Evaluation of profitability parameters.
CO6	Perform HAZOP analysis.

Teaching Methodology:
In continuation to Major Project Part – 1, the students perform the detailed process as well as mechanical design of all the equipment followed by costing of all the equipments and evaluation of profitability parameters. There will be two mid-term evaluations, a presentation at the end followed by a viva voce examination.

Evaluation Scheme:

Exams		Marks	Coverage
P-1		15 Marks	
P-2		15 Marks	
Day-to-Day Work	Viva	20 Marks	**70 Marks**
	Presentation	20 Marks	
	Report	15 Marks	
	Attendance & Discipline	15 Marks	
Total		**100 Marks**	