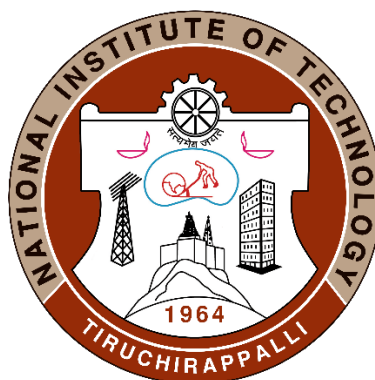


B.Tech. SYLLABUS (I YEAR)
2019-20 Onwards

NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620015
TAMILNADU, INDIA





B.Tech. Curriculum Structure – Students admitted in 2019 – 20 (CL, CE, M Semester I (July Session)

Sl. No.	COURSE	Credits
1	English for Communication (Theory)	2
2	English for Communication (Lab)	2
3	Matrices and Calculus	3
4	Chemistry	3
5	Chemistry Lab	2
6	Branch Specific Course	2
7	Basics of Electrical and Electronics Engineering (For CL, CE, ME, MT, PR)	2
8	Engineering Graphics	3
	Total	19

Semester II (January Session)

Sl. No.	COURSE	Credits
1	Complex Analysis and Differential Equations	3
2	Physics	3
3	Physics Lab	2

4	Introduction to Computer Programming (Theory & lab)	3
5	Basics of Civil Engineering (for CL, ME, MT, PR)	2
6	Energy and Environmental Engineering	2
7	Engineering Practice	2
8	Programme Core – I	4
	Total	21

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Page 1 of 23





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B.Tech. Curriculum Structure – Students admitted in 2019 – 20 (CS, EE, E
Semester I (July Session)

Sl. No.	COURSE	Credits
1	Energy and Environmental Engineering	2
2	Linear Algebra and Calculus	3
3	Physics	3
4	Physics Lab	2
5	Introduction to Computer Programming (Theory & lab)	3
6	Basics of Mechanical Engineering (For CE, EE, EC, IC & CS)	2
7	Engineering Practice	2
8	Basics of Civil Engineering (For EE, EC, IC & CS)	2
	Total	19

Semester II (January Session)

Sl. No.	COURSE	Credits
1	English for Communication (Theory)	2
2	English for Communication (Lab)	2
3	Complex Analysis and Differential Equations	3
4	Chemistry	3
5	Chemistry Lab	2
6	Branch Specific Course	2
7	Engineering Graphics	3
8	Programme Core – I	4
	Total	21

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CHIR11 CHEMISTRY

Course Code:	CHIR11	No. of Credits:
Course Name:	Chemistry	Prerequisite:

OBJECTIVES

To introduce the student's basic principles of Electrochemistry and Corrosion. They will be phase rule & its applications. Students will know about the essential requirements of water and its day-to-day life. To provide students with a brief outline of the types and applications of polymer students will be equipped with the usage of spectroscopy in industrial applications.

COURSE CONTENT

Electrochemistry and Corrosion

Cell EMF- its measurement and applications - concentration cell - electrode electrolyte concentration cell with and without transference - Dry corrosion and wet corrosion, mechanisms, corrosion, Differential metal corrosion, differential aeration corrosion, intergranular, Passivity Polarization - Chemical conversion coatings and organic coatings- Paints, enamels.

Phase rule

Definition of terms – phase- components- degree of freedom- derivation of Gibbs phase rule – one component systems – H_2O , CO_2 , Sulfur – Two-component system – Eutectic systems – reduced phase rule - Pb-Ag system – Compound with congruent melting – Zn- Mg Alloy system- Copper-nickel alloy system - systems with incongruent melting – $Na_2SO_4 - H_2O$ simple three-component systems.

Water

Sources, Hard & soft water, Estimation of hardness by EDTA method, Scale & Sludge- Caustic softening of water, zeolite process & demineralization by ion exchangers, boiler feed water, international methods-specifications for drinking water, BIS & WHO standards, treatment of water for domestic desalination - Reverse osmosis & Electrodialysis.

Spectroscopy

Interaction of electromagnetic radiation with matter, Electronic spectroscopy - Theory of electronic transitions, instrumentation, Beers Lambert law, Woodward FIESER rule, applications. Infrared spectroscopy - Fundamentals, Instrumentation, and applications, Raman spectroscopy – Fundamental applications.

Polymers and Composites

Concept of macromolecules- Tacticity- Classification of Polymers- Types of Polymerization- Mech Ziegler Natta Polymerization - Effect of Polymer structure on properties - Important addition condensation polymers –synthesis and properties – Molecular mass determination of polymers and dynamic methods, Light scattering- Rubbers – Vulcanization – Synthetic rubbers – Copolymers- Composite materials

COURSE OUTCOME

- Students will learn about the Electrochemistry and phase rule.
- They will be familiarized with the importance of polymer and its application in industries.
- Additionally, a brief introduction in the area of water, spectroscopy will be very useful for the student's future endeavour

References & Text Books

1. P.C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Company, New Delhi, 200
2. P. Atkins, J.D. Paula, *Physical Chemistry*, Oxford University Press, 2002.
3. B.R. Puri, L.R. Sharma, M.S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing C
4. F.W. Billmeyer, *Textbook of Polymer Science*, 3rd Edition, Wiley. N.Y. 1991.
5. S.S. Darer, S.S. Umare, *A Text Book of Engineering Chemistry*, S. Chand Publishing, 2011.

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CHIR12 CHEMISTRY LAB

Course Code:	CHIR12	No. of Credits:
Course Name:	Chemistry Lab	Prerequisite:

LIST OF EXPERIMENTS

1. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
2. Estimation of dissolved oxygen in the given water sample.
3. Determination of the percentage of Fe in the given steel sample.
4. Estimation of Fe^{3+} by spectrophotometer.
5. Corrosion rate by polarization technique
6. Conductometric titration
7. Potentiometric titration
8. pH-metric titration
9. Percentage purity of bleaching powder
10. Determination of molecular weight of the polymer by Viscometry
11. Study of three component system.
12. Demonstration experiments using Advanced Spectroscopic Techniques, (UV-Vis, FTIR, Ra

COURSE OUTCOME

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry to the study of science and engineering.
- The students will learn how to estimate various components from the corresponding bulk mixture.

Reference Books

1. *Laboratory Manual*, Department of Chemistry, National Institute of Technology, Tiruchirappalli.
2. S.K. Bhasin, S. Rani, *Laboratory Manual on Engineering Chemistry*, Dhanpat Rai Publications, New Delhi, 2011.

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ENIR 11 ENERGY AND ENVIRONMENTAL ENGINEERING

Course Code:	ENIR11	No. of Credits:
Course Name:	Energy and Environmental Engineering	Prerequisite:

OBJECTIVES

- To teach the principal renewable energy systems.
- To explore the environmental impact of various energy sources and also the effects of different pollutants.

COURSE CONTENT

Present Energy resources in India and its sustainability - Different type of conventional Power Plant Demand Scenario in India-Advantage and Disadvantage of conventional Power Plants – Conventional conventional power generation.

Basics of Solar Energy- Solar Thermal Energy- Solar Photovoltaic- Advantages and Disadvantages and Environmental impacts and safety.

Power and energy from wind turbines- India's wind energy potential- Types of wind turbines- Offshore energy- Environmental benefits and impacts.

Biomass Resources-Biomass conversion Technologies- Feedstock preprocessing and treatment methods Bioenergy program in India-Environmental benefits and impacts.

Geothermal Energy resources –Ocean Thermal Energy Conversion – Tidal.

Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution control Water Pollution-Sources and impacts, Soil Pollution-Sources and impacts, disposal of solid waste Greenhouse gases – effect, acid rain. Noise pollution. Pollution aspects of various power plants. Fuel impacts, Industrial and transport emissions- impacts.

COURSE OUTCOME

Students will be introduced to the Principal renewable energy systems and explore the environmental impact of various energy sources and also the effects of different types of pollutants.

References

1. Boyle G, *Renewable energy: Power for a sustainable future* . Oxford University press, 2004.
2. B H Khan, *Nonconventional Energy Resources*, The McGraw –Hill Second edition.
3. G. D. Rai, *Nonconventional energy sources* , Khanna Publishers, New Delhi, 2006.
4. Gilbert M. Masters, *Introduction to Environmental Engineering and Science* , 2nd Edition, Prentice Hall, 2003.
5. G Sargsyam, M Bhatia, S G Banerjee, K Raghunathan and R Soni, *Unleashing the Potential of Energy in India*, World bank report, Washington D.C, 2011.
6. Godfrey Boyle, Bob Everett and Janet Ramage, *Energy Systems and Sustainability: Power for a sustainable future*. Oxford University press, 2010.

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HSIR11 ENGLISH FOR COMMUNICATION

Course Code:	HSIR11	No. of Credits:
Course Name:	English for Communication	Prerequisite:

OBJECTIVES

The primary objective is to develop in the under-graduate students of engineering a level of competent English required for independent and effective communication for academic and social needs.

COURSE CONTENT

Theory: Language and communication-reading strategies: skimming, scanning, inferring, predicting, responding to content – Guessing from context – Note making – Vocabulary extension - speaking practice – use of extensive reading texts.

Analytical and critical reading practice- critical, creative and lateral thinking- language and thinking process and language development.

Effective writing practice – Vocabulary expansion - Effective sentences: role of acceptability, appropriateness & clarity in writing – Cohesion & coherence in writing –Writing of definitions, descriptive Paragraph writing.

Reciprocal relationship between reading and writing –thinking and writing - Argument Writing practice Perspectives in writing –professional writing - Narrative writing.

Lab: Listening process & practice – Exposure to recorded & structured talks, class room lectures – Problems in comprehension & retention – Note-taking practice – Listening tests- Importance of listening in corporate world.

Barriers to listening: Physical & psychological – Steps to overcome them – Purposive listening practice listening and anticipating the speaker – Use of technology to improve the skill.

Fluency & accuracy in speech –Improving self-expression – Tonal variations – Listener oriented speaking Group discussion practice – Interpersonal Conversation -Developing persuasive speaking skill

Barriers to speaking – Building self-confidence & fluency – Conversation practice- Improving respiratory capacity - Extempore speech practice – Speech assessment.

COURSE OUTCOME

The students will be able to express themselves in a meaningful manner to different levels of people in academic and social domains.

Reference Books

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw-Hill, New Delhi, 2005.
2. Strunk, William, and E B. White, *The Elements of Style*. Boston: Allyn and Bacon, Pearson Education, 2000.
3. Garner, Bryan A, *HBR Guide to Better Business Writing*, Harvard Business Review Press, Boston, Massachusetts, 2013.

MAIR11 MATRICES AND CALCULUS

(Common to Chemical, Civil, Mechanical, Metallurgy and Production Engineering)

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Course Code:	MAIR 11	No. of Credits:
Course Name:	Matrices and Calculus	Prerequisite:

OBJECTIVES

- Introduce eigen value and eigen vectors and its properties.
- Determine canonical form of given quadratic form.
- Discuss the convergence of infinite series.
- Analyze and discuss the extrema of the functions of several variables.
- Evaluate the multiple integrals and apply in solving problems.
- Introduce vector differential operator for vector function and important theorems on vector function engineering problems

COURSE CONTENT

Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem. Q form.

Sequence and series: Convergence of sequence. Infinite Series-Tests for Convergence-Integral test, Ratio test, Root test, Raabe's test, Logarithmic test, and Leibnitz's test; Power series.

Functions of two variables: Limit, continuity and partial derivatives; Total derivative, Jacobian, Taylor's Maxima, minima and saddle points; Method of Lagrange multipliers; Double and triple integrals, cylindrical coordinates, multiple integral in cylindrical and spherical coordinates.

Gradient, divergence and curl; Line and surface integrals; Green's theorem, Stokes theorem and Gauss divergence theorem (without proofs).

COURSE OUTCOME

1. Compute eigenvalues and eigenvectors of the given matrix.
2. Transform given quadratic form into canonical form.
3. Discuss the convergence of infinite series by applying various test.
4. Compute partial derivatives of function of several variables
5. Write Taylor's series for functions with two variables.
6. Evaluate multiple integral and its applications in finding area, volume.
7. Compute the dot product of vectors, lengths of vectors, and angles between vectors.
8. Perform gradient, div, curl operator on vector functions and give physical interpretations.
9. Use Green's, Gauss divergence and Stokes's theorems to solve engineering problems.

References

1. Dennis Zill, Warren S. Wright, Michael R. Cullen, *Advanced Engineering Mathematics*, Jones Learning, 2011
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2019.
3. Jerrold E. Marsden, Anthony Tromba, *Vector Calculus*, W. H. Freeman, 2003
4. Strauss M.J, G.L. Bradley and K.J. Smith, *Multivariable calculus*, Prentice Hall, 2002.
5. Ward Cheney, David Kincaid, *Linear Algebra: Theory and Applications*, Jones & Bartlett Pub

MAIR12 LINEAR ALGEBRA AND CALCULUS
(Common to CSE, EEE, ECE and ICE)

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Course Code:	MAIR12	No. of Credits:
Course Name:	Linear Algebra and Calculus	Prerequisite:

OBJECTIVES

1. Introduce vector space and inner product space and its properties.
2. Introduce eigen value and eigen vectors and its properties.
3. Determine canonical form of given quadratic form.
4. Discuss the convergence of infinite series.
5. Analyze and discuss the extrema of the functions of several variables.
6. Evaluate the multiple integrals and apply in solving problems.

COURSE CONTENT

Vector space – Subspaces – Linear dependence and independence – Spanning of a subspace– Basis Dimension. Inner product – Inner product spaces – Orthogonal and orthonormal basis – GramSchmidt orthogonalization process. Linear transformation. Eigenvalues and eigenvectors. Diagonalization of matrices; Cayley-Hamilton Theorem. Quadratic form
 Sequence and series: Convergence of sequence. Infinite Series-Tests for Convergence-Integral test, Ratio test, Root test, Raabe’s test, Logarithmic test and Leibnitz’s test; Power series;
 Functions of two variables: Limit, continuity and partial derivatives; Total derivative, Jacobian, Taylor’s series; Maxima, minima and saddle points; Method of Lagrange multipliers; Double and triple integrals, change of variables, multiple integral in cylindrical and spherical coordinates.

COURSE OUTCOME

1. Compute eigenvalues and eigenvectors of the given matrix.
2. Identify vector space and its basis.
3. Construct orthonormal basis for a given vector space.
4. Transform given quadratic form into canonical form.
5. Discuss the convergence of infinite series by applying various test.
6. Compute partial derivatives of function of several variables
7. Write Taylor’s series for functions with two variables.
8. Evaluate multiple integral and its applications in finding area, volume.

References

1. Dennis Zill, Warren S. Wright, Michael R. Cullen, *Advanced Engineering Mathematics*, Jones Learning, 2011
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2019.
3. Strauss M.J, G.L. Bradley and K.J. Smith, *Multivariable Calculus*, Prentice Hall, 2002.
4. Ward Cheney, David Kincaid, *Linear Algebra: Theory and Applications*, Jones & Bartlett Pub

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MAIR21 COMPLEX ANALYSIS AND DIFFERENTIAL EQUATIONS

(Common to CL, CE, ME, MME and PR)

Course Code:	MAIR21	No. of Credits:
Course Name:	Complex Analysis and Differential Equations	Prerequisite:

OBJECTIVES

The course presents

1. an introduction to analytic functions and power series.
2. various Cauchy's theorems and its applications in evaluation of integral.
3. various approach to find general solution of the ordinary differential equations
4. Laplace transform techniques to find solution of differential equations Partial differential equations methods to find solution.

COURSE CONTENT

Analytic functions; Cauchy-Riemann equations; Line integral, Cauchy's integral theorem and integrals (without proof); Taylor's series and Laurent series; Residue theorem (without proof) and its applications; Higher order linear differential equations with constant coefficients; Second order linear differential equations with variable coefficients; Method of variation of parameters; Cauchy- Euler equation; Powerseries solutions; Legendre polynomials, Bessel functions of the first kind and their properties; Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem – Periodic functions – Application to ordinary differential equation. Formation of partial differential equations by eliminating arbitrary constants and functions – solution of partial differential equations – four standard types – Lagrange's equation. Method of separation of variables

COURSE OUTCOME

Completion of the course, student will be able to

1. understand analytic functions discuss its properties
2. obtain series representation of analytic functions
3. evaluate various integrals by using Cauchy's residue theorem
4. classify singularities and derive Laurent series expansion
5. find the solutions of first and some higher order ordinary differential equations
6. apply properties of special functions in discussion the solution of ODE.
7. Find Laplace transform of a given function and its inverse Laplace transform.
8. Find solution of first order partial differential equations.

References

1. James Ward Brown, Ruel Vance Churchill, *Complex Variables and Applications*, McGraw-Hi Education, 2004
2. Dennis Zill, Warren S. Wright, Michael R. Cullen, *Advanced Engineering Mathematics*, Jones Learning, 2011
3. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2019.
4. William E. Boyce, Richard C. DiPrima, Douglas B. Meade, *Elementary Differential Equations Boundary Value Problems*, Wiley, 2017.
5. Ian N. Sneddon, *Elements of Partial Differential Equations*, Courier Corporation, 2013

MAIR22 COMPLEX ANALYSIS AND DIFFERENTIAL EQUATIONS (Common to CSE, EEE, ECE and ICE)

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Course Code:	MAIR22	No. of Credits:
Course Name:	Complex analysis and Differential Equations	Prerequisite:

OBJECTIVES

The course presents

1. an introduction to analytic functions and power series.
2. various Cauchy' theorems and its applications in evaluation of integral.
3. various approach to find general solution of the ordinary differential equations
4. Laplace transform techniques to find solution of differential equations
5. Partial differential equations and methods to find solution of it.

COURSE CONTENT

Analytic functions; Cauchy-Riemann equations; Line integral, Cauchy's integral theorem and integ (without proof); Taylor's series and Laurent series; Residue theorem (without proof) and its applica Higher order linear differential equations with constant coefficients; Second order linear diff equations with variable coefficients; Method of variation of parameters; Cauchy- Euler equation.

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem – Periodic functions – solution of ordinary differential equation and simult equations with constant coefficients and integral equations by Laplace Transform.

Formation of partial differential equations by eliminating arbitrary constants and functions – sc first order equations – four standard types – Lagrange's equation. Method of separation of v

COURSE OUTCOME

Completion of the course, student will be able to

1. understand analytic functions discuss its properties
2. obtain series representation of analytic functions
3. evaluate various integrals by using Cauchy's residue theorem
4. classify singularities and derive Laurent series expansion
5. find the solutions of first and some higher order ordinary differential equations
6. apply properties of special functions in discussion the solution of ODE.
7. Find Laplace transform of a given function and its inverse Laplace transform.
8. Find solution of first order partial differential equations.

References

1. James Ward Brown, Ruel Vance Churchill, *Complex Variables and Applications*, McGraw-Hi Education, 2004
2. Dennis Zill, Warren S. Wright, Michael R. Cullen, *Advanced Engineering Mathematics*, Jones Learning, 2011
3. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2019.
4. William E. Boyce, Richard C. DiPrima, Douglas B. Meade, *Elementary Differential Equations Boundary Value Problems*, Wiley, 2017.
5. Ian N. Sneddon, *Elements of Partial Differential Equations*, Courier Corporation, 2013

PHIR11 PHYSICS

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Course Code:	PHIR11	No. of Credits:
Course Name:	Physics	Prerequisite:

OBJECTIVES

- To introduce the notions of light matter interaction, fabrication of lasers, light pro waveguides, applications of lasers and optical fibers to engineering students.
- To comprehend and explain the concepts of matter waves, wave functions and its interq understand the matter at atomic scale.
- To teach the fundamentals of nuclear forces, models and classification of matter.
- To impart knowledge about the basics of conductors, superconductors, nanomaterials and their in science, engineering and technology.

COURSE CONTENT

Lasers: Introduction to Laser-characteristics of Lasers-spontaneous and stimulated emissions – Eii coefficients – population inversion and lasing action – laser systems: He-Ne Laser, semiconductor applications.

Fiber Optics: Snell’s law-optical fiber – principle and construction – acceptance cone - numerical –types of fibers - fiber optic communication principle – fiber optic sensors.

Quantum Mechanics: Inadequacy of classical mechanics-black body radiation, photoelectric effect particle duality of radiation – de Broglie concept of matter waves – electron diffraction – Heisenbe uncertainty principle – Schrodinger’s wave equation – eigen values and eigen functions – superpos principle – interpretation of wave function – particle confined in one dimensional infinite square w

Nuclear and Particle Physics: Nuclear properties and forces - Nuclear models - Shell model - Nu Radioactivity - types and half-life. Fundamental forces - Particle physics - classification of matter -

Physics of Advanced Materials: Conductors: classical free electron theory (Lorentz –Drude the electrical conductivity. Superconductors: definition – Meissner effect – type I & II superconductor theory (qualitative). Nanomaterials: introduction and properties – synthesis – top-down and bot approach – applications.

COURSE OUTCOME

1. On completion of this course, the students will be able to,
2. know principle, construction and working of lasers and their applications in various science an
3. explain light propagation in optical fibers, types and their applications.
4. experience and appreciate the behaviour of matter at atomic scale, and to impart knowledge in problems in modern science and engineering.
5. understand the role of nuclear and particle physics in applications like radioactivity and nuclea
6. recognize, choose and apply knowledge to develop materials for specific applications for comm

References

1. William T. Silfvast, *Laser Fundamentals* , 2nd Edition, Cambridge University press, New York
2. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics* , 6th Edition, John Wiley and York, 2001.
3. Arthur Beiser, *Concepts of Modern Physics* , Tata McGraw-Hill, New Delhi, 2010.
4. R. Shankar, *Fundamentals of Physics* , Yale University Press, New Haven and London, 2014.
5. R. Shankar, *Fundamentals of Physics II* , Yale University Press, New Haven and London, 2016
6. C.P. Poole and F.J. Owens, *Introduction to Nanotechnology* , Wiley, New Delhi, 2007.
7. Charles Kittel, *Introduction to Solid State Physics* , 8th Edition, John Wiley & Sons, NJ, USA,

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PHIR12 PHYSICS LAB

Course Code:	PHIR12	No. of Credits:
Course Name:	Physics Lab	Prerequisite:

OBJECTIVES

- To introduce the spirit of experiments to verify physics concepts such as reflection, refraction, and interference on light matter interaction.
- To perform experiments to estimate the materials properties and to check their suitability in sci engineering.
- To familiarize physics concepts and to design instruments and experimental set up for better ar measurements.
- To teach and apply knowledge to measure and verify the values of certain constants in physics.

LIST OF EXPERIMENTS

1. Determination of rigidity modulus of a metallic wire
2. Conversion of galvanometer into ammeter and voltmeter
3. Wavelength of laser using diffraction grating
4. Dispersive power of a prism – Spectrometer
5. Radius of curvature of lens-Newton's Rings
6. Numerical aperture of an optical fiber
7. Field along the axis of a Circular coil
8. Wavelength of white light – Spectrometer
9. Calibration of Voltmeter – Potentiometer
10. Thickness of a thin wire – Air Wedge
11. Specific rotation of a liquid – Half Shade Polarimeter
12. Photoelectric effect – Planck's constant

COURSE OUTCOME

On completion of this course, the students will be able to

1. Know how to calibrate a galvanometer and convert it into a current and voltmeters.
2. To make experimental setup to verify certain physics concepts of wave and particle nature of li
3. Understand the light propagation in fibers, light matter interaction and use of lasers in science ; engineering.
4. Acquire knowledge, estimate and suggest materials for engineering applications.

References

1. *Physics Laboratory Manual*, Department of Physics, National Institute of Technology Tiruchir
2. R.K. Shukla, Anchal Srivastava, *Practical Physics*, New age international, 2011.
3. C.L Arora, *B.Sc. Practical Physics*, S. Chand & Co., 2012.

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CSIR12 INTRODUCTION TO COMPUTER PROGRAMMING

(Common to CL, CE, ME, MME, PR)

Course Code:	CSIR12	No. of Credits:
Course Name:	Introduction to Computer Programming	Prerequisite:

OBJECTIVES

- To learn the fundamentals of computers.
- To learn the problem solving techniques using algorithms and procedures
- To read, write and execute simple Python Programs
- To learn and use Python data structures – lists, tuples and dictionaries

COURSE CONTENT

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program. Algorithms – Characteristics – Flowcharts.

Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Cc statements: if-else, loops (for, while); short-circuit (lazy) evaluation

Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab- s String manipulations: subscript operator, indexing, slicing a string; strings and number syste converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; search sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversi dictionaries.

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs act arguments, named arguments- Program structure and design- Recursive functions – Introduct and OOP.

List of Programs

1. Programs using sequential constructs
2. Programs using selection constructs
3. Programs using Iterative constructs
4. Programs using nested for loops
5. Programs using lists
6. Programs using tuples and dictionaries
7. Simple Python functions
8. File input and output
9. Sorting and searching programs
10. Recursion

COURSE OUTCOME

- Write algorithms for problems
- Use syntax and semantics of Python programming language for problem solving
- Code a given logic in Python language
- Appreciate and apply appropriate Data structures available in Python language for solving prob

References

1. Kenneth A. Lambert, *Fundamentals of Python: First Programs* , CENGAGE Learning, 2012.
2. Guido van Rossum and Fred L. Drake Jr, *An Introduction to Python – Revised and updated for* Network Theory Ltd., 2011.
3. Reema Thareja, *Python Programming using Problem Solving Approach* , Oxford University Pr
4. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist* , 2nd edition, Update 3, Shroff/O'Reilly Publishers, 2016. (<http://greenteapress.com/wp/thinkpython/>)
5. John V Guttag, *Introduction to Computation and Programming Using Python* , Revised and ex Edition, MIT Press, 2013.

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CSIR11 INTRODUCTION TO COMPUTER PROGRAMMING

(Common to CS, EE, EC, IC)

Course Code:	CSIR11	No. of Credits:
Course Name:	Introduction to Computer Programming	Prerequisite:

OBJECTIVES

- To learn the fundamentals of computers.
- To learn the problem solving techniques writing algorithms & procedures.
- To learn the syntax and semantics for C programming language.
- To develop the C code for simple logic.
- To understand the construct of structure program including conditionals and iterations

COURSE CONTENT

Introduction to computers - Types of programming languages- Developing a program - Algorithm Characteristics- Flow Charts- Principles of structured programming- Sequential selecting structures Repetitive Structures-Bounded, Unbounded and Infinite iterations.

Introduction to C- C character set- Identifiers and Keywords- Data types- Constants- Variables- Declarations Expressions- Statements- Symbolic Constants- Operators- Library Functions- Data input and output character input and output- Entering input data- Writing output data- gets and puts functions - Control Branching: if-else-looping: while- do-while- for; Nested control Structures- switch statements- If statements- Continue Statements- Comma operator- goto statements.

Modular Programming- Functions and Procedures - Examples- Parameters passing methods - Array: array- Processing an array- Multi dimensional arrays- Pointers- Variables definitions and initialization operators- Pointer expressions and arithmetic- Pointers and one dimensional arrays - String operations Functions- Defining function- Accessing a function- Function prototypes- Passing arguments to a function Passing arrays to a function- Passing Pointers to function- Recursion – Dynamic memory allocation malloc, realloc – Structures – Declaration – Structures and Functions

– Arrays of Structures – Pointers to structures – Typedef - Unions – Bit-fields.

Files – Input / Output using files – fread, fwrite, fprintf, fscanf – Formatted input – File access - argc

COURSE OUTCOME

- Ability to write algorithms for problems
- Knowledge of the syntax and semantics of C programming language
- Ability to code a given logic in C language
- Knowledge in using C language for solving problems

References

1. Byron Gottfried, *Programming with C*, 3rd Edition, Tata McGraw Hill Education, 2010.
2. R.G. Dromey, *How to solve it by Computers?* Prentice Hall, 2011.
3. Brian W Kernighan and Dennis Ritchie, *The C Programming language*, 2nd Edition, Prentice Hall
4. J.D. Henk and E.P. Koffmann, *Problem Solving and Program design in C*, 6th Edition, Pearson

4. J.K.Pamny and E.D. Kohnmann, *Problem Solving and Program Design in C*, 6th Edition, Pearson 2009.
5. Paul Deitel and Harvey Deitel, *C How to Program ?* 7th Edition, Prentice Hall, 2012.
6. Yashvant Kanetkar, *Let Us C*, 12th Edition, BPB Publications, 2012.

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MEIR11 BASICS OF MECHANICAL ENGINEERING

(Common to all branches except ME)

Course Code:	MEIR11	No. of Credits:
Course Name:	Basic of Mechanical Engineering	Prerequisite:

OBJECTIVES

1. To introduce and define the basics concept of mechanical engineering.
2. To familiarize the working principles of IC engines and automobile systems.
3. To enable the students to understand the details about the energy systems and its components.
4. To demonstrate the various machine elements, materials and its function.
5. To help the students acquire knowledge about the various manufacturing process.

COURSE CONTENT

Introduction to Mechanical Engineering, Thermal Engineering, Design, manufacturing Engineering,

IC Engines – 2 Stroke and 4 stroke systems in IC Engines. Automobiles - Transmission systems, S system, E-Vehicles.

Energy Systems - Power plants, Types, Gas Turbines, Steam Turbines, Utility boilers, R & A/C sy Energy production and Devices.

Engineering materials, Machine elements, Transmission, Fasteners, Support systems.

Manufacturing, Classification, Metal forming, Casting, Lathe, Drilling machines, Milling machine joining.

COURSE OUTCOME

At the end of the course, students will be able

1. To identify the basic concept and fundamentals of mechanical engineering.
2. To understand the working principle of IC engines and Energy systems.
3. To appreciate the process and materials involved in the manufacture of various machine elements components.

References

1. Basant Agarwal and C.M. Agarwal, *Basic Mechanical Engineering*, Wiley India Pvt. Ltd., 2008.
2. Sadhu Singh, *Basic Mechanical Engineering*, S. Chand & Company Limited, 2009.
3. P.K. Nag, Karthikeya Tripathi, C.S. Pawar, *Basic Mechanical Engineering*, Tata McGraw Hill Pvt Company, 2009.
4. Lecture notes prepared by Department of Mechanical Engineering, NITT, 2018.

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MEIR12 ENGINEERING GRAPHICS

Course Code:	MEIR12	No. of Credits:
Course Name:	Engineering Graphics	Prerequisite:

OBJECTIVES

1. Irrespective of engineering discipline, it has become mandatory to know the basics of Engineering. The student is expected to possess the efficient drafting skill depending on the operational function in order to perform day to day activity.
2. Provide neat structure of industrial drawing.
3. Enables the knowledge about position of the component and its forms. Interpretation of technical assemblies.
4. Preparation of machine components and related parts.

COURSE CONTENT

Fundamentals Drawing standard - BIS, dimensioning, lettering, type of lines, scaling-

Orthographic projection Introduction to orthographic projection, drawing orthographic views of objects and their isometric views - Orthographic projections of points lying in four quadrants.

Orthographic projection of lines parallel and inclined to one or both planes Orthographic projections of planes inclined to one or both planes. Projections of simple solids - axis perpendicular to HP and axis perpendicular to VP and axis inclined to one and both planes.

Sectioning of solids Section planes perpendicular to one plane and parallel or inclined to other planes

Intersection of surfaces Intersection of cylinder & cylinder, intersection of cylinder & cone, and intersection of prisms.

Development of surfaces Development of prisms, pyramids and cylindrical & conical surfaces. Isometric projection Isometric projection and isometric views of different planes and simple solids introduction to perspective projection.

COURSE OUTCOME

At the end of the course student will be able to visualize the engineering components. A number of problems will be solved to illustrate the concepts clearly.

References

1. Bhatt, N. D. and Panchal, V.M, *Engineering Drawing* , Charotar Publishing House, 2010.
2. Ken Morling, *Geometric and Engineering Drawing* , 3rd Edition, Elsevier, 2010
3. Jolhe, D. A., *Engineering drawing* , Tata McGraw Hill, 2008
4. Shah, M. B. and Rana, B. C., *Engineering Drawing* , Pearson Education, 2009
5. K.V. Natarajan, *A text book of Engineering Graphics* , Dhanalakshmi Publishers, Chennai, 2008

CEIR11 BASICS OF CIVIL ENGINEERING

(All Branches except CE)

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Nil

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Course Code:	CEIR11	No. of Credits:
Course Name:	Basics of Civil Engineering	Prerequisite:

OBJECTIVES

- To give an overview of the fundamentals of the Civil Engineering fields to the students of all b Engineering.
- To realize the importance of the Civil Engineering Profession in fulfilling societal needs.

COURSE CONTENT

Properties and uses of construction materials - stones, bricks, cement, concrete and steel.

Site selection for buildings - Component of building - Foundation- Shallow and deep foundations

- Brick and stone masonry - Plastering - Lintels, beams and columns - Roofs.

Roads-Classification of Rural and urban Roads- Pavement Materials-Traffic signs and road Markin Signals.

Surveying - Classification-Chain Survey-Ranging-Compass Survey-exhibition of different survey

Sources of Water - Dams- Water Supply-Quality of Water-Wastewater Treatment – Sea Water Int Recharge of Ground Water.

COURSE OUTCOME

1. The students will gain knowledge on site selection, construction materials, components of b roads and water resources
2. A basic appreciation of multidisciplinary approach when involved in Civil Related Projects.

References

1. Punmia, B.C, Ashok Kumar Jain, Arun Kumar Jain, *Basic Civil Engineering* , Lakshmi Pub
2. Satheesh Gopi, *Basic Civil Engineering* , Pearson Publishers, 2009.
3. Rangwala, S.C, *Building materials* , Charotar Publishing House, Pvt. Limited, Edition 27, 2
4. Palanichamy,M.S, *Basic Civil Engineering* , Tata McGraw Hill, 2000.
5. Lecture notes prepared by Department of Civil Engineering, NITT.

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Nil

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EEIR11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING
(For CL, CE, ME, MME, PR)

Course Code:	EEIR11	No. of Credits:
Course Name:	Basics of Electrical and Electronics Engineering	Prerequisite:

OBJECTIVES

- This course aims to equip the students with a basic understanding of Electrical circuits and more specific types of applications.
- The course gives a comprehensive exposure to house wiring.
- This course also equips students with an ability to understand basics of analog and digital elect

COURSE CONTENT

DC & AC Circuits: Current, voltage, power, Kirchhoff's Laws - circuit elements R, L and C, phase impedance, real and reactive power in single phase circuits.

DC & AC Machines: DC Motor, Induction motor, Synchronous motor, Synchronous generator and Transformers- construction, principle of operation, types and applications.

House wiring & safety: Single phase and three phase system – phase, neutral and earth, basic house and components, different types of wiring – staircase, florescent lamp and ceiling fan, basic safety home and industry.

Analog Electronics: semiconductor devices – p-n junction diode, Zener diode, BJT, operational amplifier principle of operation and applications – Introduction to UPS.

Digital Electronics: Introduction to number systems, basic Boolean laws, reduction of Boolean expressions implementation with logic gates.

COURSE OUTCOME

The students shall develop an intuitive understanding of the circuit analysis, basic concepts of electrical machines, house wiring and basics of electronics and be able to apply them in practical situation.

References

1. Hughes revised by McKenzie Smith with John Hilcy and Keith Brown, *Electrical and Electronic Technology*, 8th Edition, Pearson, 2012.
2. R.J. Smith, R.C. Dorf, *Circuits Devices and Systems*, 5th Edition, John Wiley and sons, 2001.
3. P. S. Dhogal, *Basic Electrical Engineering – Vol. I & II*, 42nd Reprint, McGraw Hill, 2012.
4. Malvino, A. P., Leach D. P. and Gowtham Sha, *Digital Principles and Applications*, 6th Edition McGraw Hill, 2007.
5. Vincent Del Toro, *Electrical Engineering Fundamental*, Prentice Hall India, 2002.

PRIR11 ENGINEERING PRACTICE

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Course Code:	PRIR11	No. of Credits:
Course Name:	Engineering Practice	Prerequisite:

OBJECTIVES

- To use hand tools and machinery in Carpentry, welding shop, Foundry, Fitting shop and Sheet
- To manufacture engineering products or prototypes.

COURSE CONTENT

Foundry: Mould preparation for Flange and Hand Wheel, Plastic moulding / Wax moulding.

Welding: Fabrication of Butt Joint and Fabrication of Lap Joint.

Carpentry: Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make; Halving Joint and Dovetail Scarf Joint.

Fitting: Preparation of joints, markings, cutting and filling for making; Semi-circle part with the g piece, Dovetail part with the given work piece.

Sheet metal: Fabrication of Dust Pan and Fabrication of Corner Tray.

COURSE OUTCOME

1. Know to utilize hand tools and machineries in Carpentry, Welding shop, Foundry, Fitting shop Metal work.
2. Produce simple engineering products or prototypes

References

1. R.K. Rajput, *Workshop Practice*, Laxmi Publications (P) Limited, 2009.
2. Shashi Kant Yadav, *Workshop Practice*, Discovery Publishing House, New Delhi, 2006.

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B. Tech.
IN
CHEMICAL ENGINEERING

FLEXIBLE CURRICULUM
(Effective from 2020-2021)

DEPARTMENT OF CHEMICAL ENGINEERING NATIONAL
TECHNOLOGY TIRUCHIRAPPALLI – 620
TAMIL NADU, INDIA





Vision of the Department

To be a global leader in Chemical Engineering

Mission of the Department

- (i) To produce competent graduates through effective Teaching-Learning, State of th
- (ii) To foster community by providing leadership in solving societal problems for sustainal
- (iii) To serve organization and society as adaptable engineers, entrepreneurs or leaders.

Programme Educational Objectives (PEOs)

After 4 years of graduation, our graduates will:

- Choose their careers as practicing chemical engineers in traditional chemical industries of materials, environmental and energy-related industries.
- Engage in post-baccalaureate study and are making timely progress toward an advance engineering or a related technical discipline or business.
- Function effectively in the complex modern work environment with the ability to assure professional leadership roles.

Programme Outcomes (POs) : Chemical Engineering

- (1) The Chemical Engineering graduates are capable to apply knowledge of mathematics, sci
- (2) The Chemical Engineering graduates are capable to design and conduct experiments, as w data.
- (3) The Chemical Engineering graduates are capable to design a system, a component, or a pr within realistic constraints such as economic, environmental, social, ethical, health and safe sustainability.
- (4) The Chemical Engineering graduates are capable to function on multi-disciplinary teams.
- (5) The Chemical Engineering graduates are capable to identify, formulate and solve enginee
- (6) The Chemical Engineering graduates have the understanding of professional and etl
- (7) The Chemical Engineering graduates are capable to communicate effectively.
- (8) The Chemical Engineering graduates have the broad education necessary to understand th solutions in a global, economic and societal context.
- (9) The Chemical Engineering graduates are capable to engage themselves in life-long learni
- (10)The Chemical Engineering graduates have knowledge of contemporary /current issues.
- (11)The Chemical Engineering graduates are capable to use the techniques, skills, and mode for engineering practice.
- (12) Chemical engineering graduates are capable to apply fundamental and practical knowled processes, principles of management and economics for providing better services to chemical process industries.

CURRICULUM

The total minimum credits for completing the B.Tech. programme in **Chemical Engineeri** 163 (160±3).

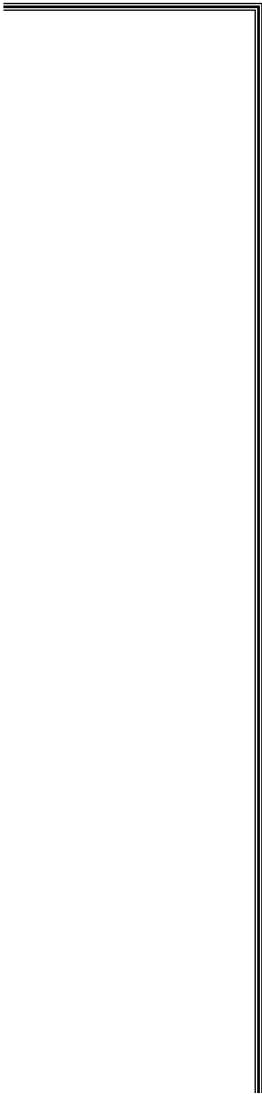
MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGOR

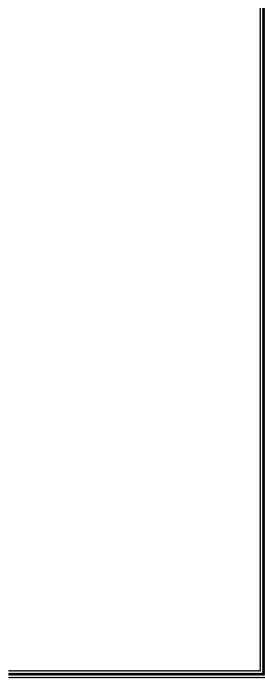
The structure of B.Tech. programmes shall have General Institute Requirement Programme Core (PC), Elective Courses (PE, OE and MI) and Essential Programme Labor as follows:

Sl.No.	COURSE CATEGORY	Number of Courses
1.	General Institute Requirement (GIR)	22
2.	Programme Core (PC)	15
3.	Essential Programme Laboratory Requirement (ELR)	2 per session

4.	Elective courses a. Programme Electives (PE) b. Open Electives (OE) **The students should study at least eight programme elective courses (PE)	14
Total		
5.	Minor Course (Optional)	Courses for 15 credits
6.	Honours Course (Optional)	Courses for 15 credits
TOTAL		

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Number of Credits
56
49
16

42
163
15
15
193

(I) GENERAL INSTITUTE REQUIREMENTS

Sl. No.	Name of the course	Number of courses
1.	Mathematics	3
2.	Physics	1 Theory
		1 Lab
3.	Chemistry	1 Theory
		1 Lab
4.	Industrial Economics and Foreign Trade	1
5.	English for Communication	1 Theory
		1 Lab
6.	Energy and Environmental Engineering	1
7.	Professional Ethics	1
8.	Engineering Graphics	1
9.	Engineering Practice	1
10.	Basic Engineering	2
11.	Introduction to computer Programming	1
12.	Branch Specific Course (Introduction to the Branch of study)	1
13.	Summer Internship	1
14.	Project work	--
15.	Comprehensive viva	1
16.	Industrial Lecture	1
17.	NSS/NCC/NSO	1
Total		22

I. GENERAL INSTITUTE REQUIREMENTS**1. MATHEMATICS**

Sl.No.	Course Code	Course Title	
1.	MAIR11	Mathematics I	
2.	MAIR21	Mathematics II	
3.	MAIR41	Mathematics III	
			Total

2. PHYSICS

Sl.No.	Course Code	Course Title	
1.	PHIR11	Physics I (Theory)	
2.	PHIR12	Physics II (Lab)	

	Total
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Max. Credits
10
3
2
3
2
3
2
2
2
3
3
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4
3
2
2
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1
1
Compulsory participation
50

Credits
3
3
4
10

Credits
3
2

3. CHEMISTRY

Sl.No.	Course Code	Course Title
1.	CHIR11	Chemistry I (Theory)
2.	CHIR12	Chemistry II (Lab)
		Total

4. COMMUNICATION

Sl.No.	Course Code	Course Title
1.	HSIR11	English for Communication (Theory)
		English for Communication Lab
		Total

5. PROFESSIONAL ETHICS

Sl.No.	Course Code	Course Title
1.	HSIR14	Professional Ethics
		Total

6. ENERGY AND ENVIRONMENTAL ENGINEERING

Sl.No.	Course Code	Course Title
1.	ENIR11	Energy and Environmental Engineering
		Total

7. HUMANITIES

Sl.No.	Course Code	Course Title
1.	HSIR13	Industrial Economics & Foreign Trade
		Total

8. ENGINEERING GRAPHICS

Sl.No.	Course Code	Course Title
1.	MEIR12	Engineering Graphics
		Total

9. ENGINEERING PRACTICE

Sl.No.	Course Code	Course Title
1.	PRIR11	Engineering Practice
		Total

10. BASIC ENGINEERING

Sl.No.	Course Code	Course Title
1.	CEIR11	Basics of Civil Engineering

2.	EEIR11	Basics of Electrical and Electronics Engineering
		Total

Credits
3
2
5

Credits
2
2
4

Credits
3
3

Credits
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2

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11. INTRODUCTION TO COMPUTER PROGRAMMING

Sl.No.	Course Code	Course Title
1.	CSIR12	Introduction to Computer Programming
		Total

12. BRANCH SPECIFIC COURSE

Sl.No.	Course Code	Course Title
1.	CLIR15	Introduction to Chemical Engineering
		Total

13. INDUSTRIAL LECTURE

Sl.No.	Course Code	Course Title
1.	CLIR16	Industrial Lectures
		Total

A course based on industrial lectures shall be offered for 1 credit. A minimum of five lect industry experts will be arranged by the Department. The evaluation methodology, w at the end of each lecture.

14. SUMMER INTERNSHIP

Sl.No.	Course Code	Course Title
1.	CLIR17	INTERNSHIP / INDUSTRIAL TRAINING / ACADEMIC ATTACHMENT (2 to 3 months duration during summer vacation) #
		Total

The student should undergo industrial training/internship for a minimum period of two mo 3rd year. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs is also permitted instead of industrial training.

To be evaluated at the beginning of VII semester by assessing the report and seminar pres

15. COMPREHENSIVE VIVA

Sl.No.	Course Code	Course Title
1.	CLIR18	Comprehensive Viva-Voce
		Total

16. PROJECT WORK

Sl.No.	Course Code	Course Title
1.	CLIR19	Project Work
		Total

17. NSS/NCC/NSO

Sl.No.	Course Code	Course Title
1.	SWIR11	NSS/NCC/NSO
		Total

Credits
3
3

Credits
2
2

Credits
1
1

ures of two hours duration by
will in general, be based on quizzes

Credits
2
2

onths during the summer vacation of
and CFTIs) or university abroad

sentations.

Credits
1
1

Credits
6
6

Credits
0
0

(II) PROGRAMME CORE (PC)

Sl.No.	Course Code	Course Title	Prerequisites
1.	CLPC11	Process Calculations	NONE
2.	CLPC12	Chemistry-III	NONE
3.	CLPC13	Momentum Transfer	NONE
4.	CLPC14	Chemical Engineering Thermodynamics	CLPC11
5.	CLPC15	Chemical Technology	NONE
6.	CLPC16	Heat Transfer	CLPC13
7.	CLPC17	Particulate Science and Technology	NONE
8.	CLPC18	Mass Transfer - I	CLPC11, CLPC14
9.	CLPC19	Transport Phenomena	CLPC13,CLPC16, CLPC18
10.	CLPC20	Mass Transfer - II	CLPC18
11.	CLPC21	Chemical Reaction Engineering	CLPC14,CLPC16
12.	CLPC22	Chemical Process Equipment Design	CLPC13, CLPC16 CLPC18,CLPC20
13.	CLPC23	Process Modeling and Simulation	CLPC13, CLPC16 CLPC18,CLPC20
14.	CLPC24	Process Dynamics and Control	MAIR21
15.	CLPC25	Project Engineering and Economics	CLPC17
Total			

(III) ESSENTIAL PROGRAMME LABORATORY REQUIREMENTS (ELR)

Sl.No.	Course Code	Course Title	Co requisites
1.	CLLR11	Momentum Transfer Lab	CLPC13
2.	CLLR12	Instrumental Analysis and Thermodynamics Lab	CLPC14
3.	CLLR13	Particulate Science & Technology Lab	CLPC17
4.	CLLR14	Heat Transfer Lab	CLPC16
5.	CLLR15	Mass Transfer Lab	CLPC18, CLPC20
6.	CLLR16	Chemical Reaction Engineering Lab	CLPC21
7.	CLLR17	Process Dynamics and Control Lab	CLPC24
8.	CLLR18	Process Modeling Simulation Lab	CLPC23
Total			

NOTE: Students can register for 2 laboratory courses during one session along with reg courses (PC / PE / OE / MI).

Credits
3
3
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3
4
3
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49

Credits
2
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16

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(IV) PROGRAMME ELECTIVES**(PE)**

Sl.No.	Course Code	Course Title	Prerequisites
1.	CLPE11	Petroleum and Petrochemical Engineering	NONE
2.	CLPE12	Computer Applications in Chemical Engineering	NONE
3.	CLPE13	Polymer Science and Technology	NONE
4.	CLPE14	Modern Separation Processes	CLPC18, CLPC20
5.	CLPE15	Safety in Chemical Process Industries	CLPC17
6.	CLPE16	Material Science & Technology	NONE
7.	CLPE17	Industrial Process Biotechnology	NONE
8.	CLPE18	Fluidization Engineering	CLPC13, CLPC17
9.	CLPE19	Pharmaceutical Technology	NONE
10.	CLPE20	Process Intensification	CLPC16, CLPC18, CLPC21
11.	CLPE21	Electro-chemical Reaction Engineering	NONE
12.	CLPE22	Food Processing Technology	NONE
13.	CLPE23	Biorefinery Engineering	NONE
14.	CLPE24	Water Treatment Technology	NONE
15.	CLPE25	Biochemical Engineering	NONE
16.	CLPE26	Air Pollution Control Engineering	NONE
17.	CLPE27	Industrial Wastewater Treatment	NONE
18.	CLPE28	Fuel Cells and Batteries	NONE
19.	CLPE29	Heterogeneous Chemical Reaction Engineering	CLPC21

(V)**OPEN ELECTIVES (OE)**

Sl.No.	Course Code	Course Title	Prerequisites
1.	CLOE11	Environmental Engineering	NONE
2.	CLOE12	Optimization Techniques	NONE
3.	CLOE13	Energy Engineering	NONE
4.	CLOE14	Process Instrumentation	NONE
5.	CLOE15	Nano Technology	NONE
6.	CLOE16	Bioenergy	NONE
7.	CLOE17	Design and Analysis of Experiments	NONE

8.	CLOE18	Introduction to Data Analysis	NONE
9.	CLOE19	Soft Computing Techniques	NONE

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ONLINE COURSES – Open Electives**Course offered by NPTEL/SWAYAM/MOOC**

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1	CLOE 51	BioInformatics:Algorithms and Applications	NONE	
2	CLOE 52	Introduction to Machine Learning	NONE	
3	CLOE 53	System Identification	NONE	
4	CLOE 54	Computer Aided Drug Design	NONE	

Course offered by NPTEL/SWAYAM/MOOC

* The students should register online courses after obtaining prior approval from the competent authorities. The BoS recommended absolute grading policy for online courses.

MINORS (MI)

Students who have registered for B.Tech. Minor in Chemical Engineering

[Note: Number of Minor courses: 5 courses (Minimum)]

(VI)

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	CLMI 11	Chemical Process Calculations	NONE	3
2.	CLMI 12	Transfer Operations – I	NONE	3
3.	CLMI 13	Transfer Operations – II	CLMI 12	3
4.	CLMI 14	Chemical Reaction Engineering	CLMI 11, CLMI 13	3
5.	CLMI 15	Chemical Technology	NONE	3
Total				15

VII. HONOURS

A student can obtain B.Tech. (Honours) degree provided the student has to

- i. Register at least for 12 theory courses and 2 ELRs in the second year.
- ii. Consistently obtain a minimum GPA of 8.5 in the first four sessions and continue to maintain the same in the subsequent sessions (including the Honours courses)
- iii. Complete 3 additional theory courses specified for the Honors degree of the programme.
- iv. Complete all the courses registered, in the first attempt and in four years of study.

Sl.No.	Course Code	Course Title	Co requisites	Credits
1.	CLHO11	Advanced Process control	CLPC24	3
2.	CLHO12	Pinch Analysis and Heat Exchange Network Design	CLPC14, CLPC16	3

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: same GPA of 8.5

3.	CLHO13	Applied Mathematics in Chemical Engineering	CLPC16, CLPC18, CLPC21
4.	CLHO14	Advances in Heat Transfer	CLPC16
5.	CLHO15	Computational Fluid Dynamics	CLPC13
6.	CLHO16	Process Safety Management	NONE

3
3
3
3

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To understand the fundamental operations.
2. To impart knowledgeable on ma

COURSE CONTENT

Stoichiometry: Introduction - Unit specific gravity.

Ideal Gases and Vapor Pressure: Be mixtures - volume changes with cha - effect of Temperature on vapour p

Humidity and Solubility: Humidity and Crystallisation - Dissolution - s
Material Balance: Material Balance
Recycling operations - bypassing st
problems

Energy Balance: Thermo chemisti
mixing - mean specific heat - Theor

REFERENCE BOOKS

1. *Richard M. Felder, Ronald W. F*
edition, wiley, 2016.
2. *O. A .Hougen, K. M. Watson an*
Distributors, New Delhi, 1995.
3. *V.Venkataramani, N.Ananthara*
Hall of India Ltd, New Delhi. 2013
4. *B. I. Bhatt, "Stoichiometry", 5th*
5. *Himmelblau, "Basic Principles*
India 2012.

COURSE OUTCOMES

CLPC11
PROCESS CALCULATIONS
3
NONE
PC

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knowledge in units and conversions and also the basic laws governing chemical material and energy balance with and without reactions.

ts and Dimensions - Stoichiometric principles –composition relations, density and

behaviour of Ideal gases - kinetic theory of gases - application of ideal gas law - gaseous change in composition. Vapour pressure pressure - vapour pressure plots - vapour pressure of immiscible liquids - solutions.

- saturation - vaporization - condensation - wet and dry bulb thermometry Solubility solubility of gases.

- Processes involving chemical reaction - Combustion of coal, fuel gases and sulphur - streams - Degree of conversion – excess reactant - limiting reactant. Unsteady state

ry - Hess's law of summation - heat of formation, reaction, combustion and chemical flame Temperature

Rousseau, Lisa G. Bullard, “Elementary Principles of Chemical Processes”, 4th

and R. A. Ragatz, “Chemical Process Principles”, Vol- I, CBS Publishers and

Man and K.M. Meera Sheriffa Begum, 2nd Edn., 'Process Calculations' Prentice

Edn., Tata McGraw Hill Publishers Ltd., New Delhi, 2010.

and Calculations in Chemical Engineering", 8th Edn., Prentice Hall of India Ltd,

At the end of the course, student will have

CO1	the capability to convert units and dimensions and also modify equations from system to another.
CO2	the capability to apply the laws of physics and chemistry in solving process industry related applications.
CO3	the proficiency to integrate the data and formulate the mass and energy balance problems.
CO4	the capability to use mathematical knowledge for solving mass and energy balance problems with and without chemical reactions.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓		✓	✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓
CO4	✓	✓	✓		✓			✓	✓		✓

PO12
✓
✓
✓
✓

Course Code	:	CLPC12
Course Title	:	CHEMISTRY-III
Number of Credits	:	3
Prerequisites	:	NONE
Course Type	:	PC

COURSE LEARNING OBJECTIVES

1. To learn the principles of photochemical and pericyclic reactions in order to apply them in org
2. To acquire knowledge on the advanced characterization techniques in identification of
3. To learn about the industrially relevant catalytic processes, technologies for various chemical preparation of fine chemicals.
4. To learn the applications of electrochemistry in energy and environmental studies

COURSE CONTENT

Photochemistry and Pericyclic Reactions: Fundamentals of photochemistry, Norrish type I and reduction of ketones, photochemistry of arenes. Pericyclic reactions, classification, Woodward-FMO theory.

Identification of organic compounds: Basics of IR spectroscopy, applications. Mass Methods of desorption and ionization (EI, CI, MALDI, ESI), study of fragmentation principles of ^1H and ^{13}C NMR, applications of ^1H and ^{13}C NMR (DEPT) to organic chemistry, case studies and combined problems.

Catalysis and Kinetics: Catalysis- Homogeneous & heterogeneous catalysis, Langmuir – Hinshelwood of a bimolecular surface reaction, Eley – Rideal mechanism of a surface reaction, enzyme catalysis assembled monolayers and Langmuir-Blodgett films- determination of surface area of catalysts.

Process development for fine chemicals: Preparation of acid chlorides from carboxylic acids, Friedel-Crafts acylation, Grignard reagents, Wittig reaction, ozonolysis, Sharpless epoxidation. Hydroformylation synthesis, Monsanto acetic acid and carbonylation processes.

Electrochemistry Principles: Electrode processes, thermodynamics and potential, electron and proton electrochemical measurement methods and instruments; principles of electrochemical devices, batteries, super capacitors, fuel cells and electrochemical sensors.

REFERENCE BOOKS

1. K. Jagadamba Singh, Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Edn, New Age publications, 2009
2. R. M. Silverstein and F. X. Webster: *Spectrometric Identification of Organic Compounds*, 7th
3. Gopala Rao M. and Marshall S., "*Dryden's Outlines of Chemical Technology- for the 21st C East-West Press.*
4. V. S. Bagotsky, *Fundamentals of electrochemistry*, 2nd Edition, John Wiley and Sons, 2005.
5. Bard and Faulkner, *Electrochemical Methods: Fundamentals and Applications*, 2nd edition, 471-04372-9)
6. C. Someswara Rao "*The Chemistry of Process Development in Fine Chemical and Pharmaceutical Industry*" John Wiley and Sons. 2007.

rganic synthesis.
compounds.
processes and

d II reactions, photo
Hoffmann rules and

is spectroscopy:
1 pattern. Basic

nshelwood mechanism
and kinetics, self-

Friedel-Crafts
ion, Wacker-smidt

nass transfer;
evices including

ge International

: Edn, 2007

Century”, Affiliated

Wiley 2001, (ISBN 0-

COURSE OUTCOMES

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

CO1	apply the concepts of photochemistry and catalysts in optimizing the conditions of organic sy
CO2	use advanced spectroscopic tools in characterization of the reaction products to assess purity yield.
CO3	determine the best reaction conditions to maximize the products by applying the principles of homogeneous and heterogeneous catalysis.
CO4	understand the concepts of electrochemistry principles and applications

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓			✓
CO2	✓	✓	✓		✓			✓			✓
CO3	✓	✓	✓		✓			✓			✓
CO4	✓	✓	✓		✓			✓			✓

nthesis.
and

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJ

1. To impart the fundament
2. To nurture the students to :
3. To enable students to comp
4. To impart the knowledge c

COURSE CONTENT

Properties of fluids and concej
 fluids. Fluid statics: Pressure
 Dimensional analysis. Simila

Momentum Balance and their
 Newtonian and non-Newtoni
 Momentum balance - Forces
 Potential flow - Bernoulli's eq

Flow of Incompressible Fluids
 through closed conduits - velo
 fitting etc. Introduction to cor
 flow through convergent and c

Flow of Fluids through Solids:
 factor for packed beds. Ergun's
 - Motion under gravitational
 Mechanism, types, general pro

Transportation and Metering:]
 notches Wet gas meter and dry
 machinery performance. Selec
 Rotary and Reciprocating pu
 Centrifugal pumps and charac

CLPC13
MOMENTUM TRANSFER
3
NONE
PC

OBJECTIVES

Understand the basic concepts of fluid statics, pressure distribution and dimensional analysis
 Solve fluid dynamics problems using Newton's laws of motion.
 Compute velocity profile, friction factor and head loss in pipes and fittings
 Understand the importance of metering and transportation of fluids and fluid moving machinery performance

Point of pressure: Introduction - Nature of fluids - physical properties of fluids - types of fluids - density - height relationships. Pressure Measurement. Units and Dimensions - Fluid statics - forces arising out of physical similarity - dimensionless numbers.

Applications: Kinematics of fluid flow: Stream line -stream tube - velocity potential. Flow of fluids - Time dependent fluids - Reynolds number - experiment and significance - Drag - acting on stream tubes - Drag coefficient - Correction for fluid friction - Correction for pump work.

Flow Through Ducts: Flow of incompressible fluids in pipes - laminar and turbulent flow velocity profile & friction factor for smooth and rough pipes - Head loss due to friction in pipes, compressible flow. Isentropic flow. Convergent and divergent nozzles and sonic velocity

Drag: Form drag - skin drag - Drag coefficient. Flow around solids and packed beds. Friction coefficient Equation - Motion of particles through fluids. Fluidization - Drag in centrifugal fields - Terminal settling velocity. Fluidisation - Properties – applications

Measurement of fluid flow: Orifice meter, venturi meter, pitot tube, rotameter, weirs and flow gas meter. Hot wire and hot film anemometers. Transportation of fluids: Fluid moving machinery and specification. Air lift and diaphragm pump. Positive displacement pumps: Characteristics.

REFERENCE BOOKS

1. Yunus Cengel "Fluid Mechanics: Fundamentals and Applications" McGraw-Hill Higher Education, 2017.
2. Noel. D. Nevers, "Fluid Mechanics for Chemical Engineers", McGraw Hill, 3rd International Edition, 2001.
3. W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", 7th International Edn., 2004.
4. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol 1, 6th Edn. Butterworth-Heinemann, 1999.

COURSE OUTCOMES

On completion of the course, the students would have

CO1	the knowledge of fundamental concepts in fluids statics and to use dimensional analysis for scaling experimental results.
CO2	the ability to solve hydrostatic and fluid flow problems using Newton's laws of motion.
CO3	the ability to analyze frictional flow in pipes and piping networks and to compute the head loss and power requirements for chemical process equipments.
CO4	the ability to select the metering equipments and fluid moving machinery for an appropriate chemical engineering operations.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓
CO4	✓	✓	✓		✓			✓	✓		✓

er Education; 4 edition,

1 Edition, 2005.

Edn., McGraw Hill,

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites(Course code)	:
Course Type	:

COURSE LEARNING OBJECT

1. To understand and appreciate th
2. To introduce the behavior of cc
3. To impart fundamental concept

COURSE CONTENT

Introduction to Basic laws and Ter
Heat effects accompanying chemi
of Second law-Third Law of Thern
pipes, Flow through nozzles,
Compression- Refrigeration.

Thermodynamic Properties of Pure
energy-Fundamental Property relat
Differential equations of Entropy
Gibb's Helmholtz Equation-
Properties of Jacobians-Thermodyn

Thermodynamic Properties of s
molar properties-Chemical potentia
Duhem Equation-Phase Equilibria
stability, Phase equilibria in single
Calculation of activity
coefficients.

Reaction stoichiometry-Equilibriu
pressure, volume and other factors-

REFERENCE BOOKS

CLPC14
CHEMICAL ENGINEERING THERMODYNAMICS
4
CLPC11
PC

OBJECTIVES

Thermodynamics as applied to various Chemical Engineering Processes.
 Components in a mixture or solution.
 Aspects of solution thermodynamics involving ideal and non-ideal systems.

Terminologies in Thermodynamics- Statement of First law, P-V-T behavior of pure fluids -
 Chemical Reactions - Statements of second law- Clausius Inequality-Mathematical Statement
 of Thermodynamics. Applications to Laws of Thermodynamics - Flow processes: Flow in

1. Fluids- Classification of Thermodynamic properties -Work function and Gibb's Free
 Energy-Maxwell's equations- Clapeyron equation- Entropy Heat capacity relationship-
 2. Relationship between C_p and C_v -Effect of pressure and volume on C_p and C_v -

Thermodynamic Relations through method of jacobians.

Solutions - Introduction to fugacity and activity, Activity coefficients-Partial
 molar property-Lewis-Randall rule-Roult's and Henry's law-Gibbs
 free energy and Chemical Reaction Equilibria - Criteria for phase equilibrium, Criterion of
 stability and multiple component systems, Duhem's theorem, VLE for Ideal solutions,

3. Equilibrium constant- Feasibility of reaction- Effect of temperature,
 - Simultaneous Reactions

1. J.M. Smith, H.C.Van Ness, Michael M. Abbott, *Introduction to Engineering* McGraw Hill, New York, 2005.
2. M.D. Koretsky, *Engineering and Chemical Thermodynamics*, 2nd edition, Wiley; 2'
3. Y. V. C. Rao, *Chemical Engineering Thermodynamics*, Universities Press, 1997.
4. K.V.Narayanan, *A Textbook of Chemical Engineering Thermodynamics*, PHI Learning, .

COURSE OUTCOMES

On completion of the course, the students will be familiar with

CO1	Fundamentals of thermodynamics as applied to various processes
CO2	Correlating the property changes for real fluids in terms of easily measurable macroscopic properties
CO3	Applying the fundamentals of solution thermodynamics to gas and liquid mixtures and correlate phase equilibrium of binary/multi component systems using various models
CO4	Calculating the equilibrium conversion and composition for reactions for chemical reaction

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓		✓	✓	✓		✓				✓
CO2	✓		✓	✓				✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓		✓	✓				✓	✓	✓

3 *Thermodynamics,*

nd *edition , 2012.*

2004.

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To impart the basic concepts of
2. To develop understanding about
3. To learn manufacturing processes and problems encountered in the process
4. To learn the process flow sheet of

COURSE CONTENT

Natural Products Processing: Production and starch derivatives, Gasification

Industrial Microbial Processes and Products and antibiotics, Refining of edible

Alkalies and Acids: Chlor - alkali process, Soda and chlorine - common salt. Synthesis and Manufacture of hydrochloric acid.

Cement Gases, Water and Paints: Treatment of Nitrogen, Hydrogen, Oxygen and

Fertilisers: Nitrogen Fertilisers; Synthesis of Phosphate rock, phosphoric acid, su

CLPC15
CHEMICAL TECHNOLOGY
3
NONE
PC

[VES

chemical technology.

: unit process and unit operations in various industries.

es of organic and Inorganic Chemicals and its applications and major engineering

s

drawing for the manufacturing chemical processes.

ction of pulp, paper and rayon, Manufacture of sugar, starch
of coal and chemicals from coal.

Edible Oils: Fermentation processes for the production of ethyl alcohol, citric acid
e oils and fats, fatty acids, Soaps and detergents.

industries: Manufacture of Soda ash, Manufacture of caustic

sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid.

Types and Manufacture of Portland cement, Glass: Industrial gases: Carbon dioxide,
Acetylene - Manufacture of paints - Pigments

ynthetic ammonia, nitric acid, Urea, Phosphorous Fertilisers:

per phosphate and Triple Super phosphate.

REFERENCE BOOKS

1. G.T. Austin, N. Shreve's *Chemical Process Industries*", 5th Edn., McGraw Hill, New York
2. W.V. Mark, S.C. Bhatia "Chemical Process Industries volume I and II", 2nd Edition 2007.
3. R. Gopal and M. Sittig "Dryden's Outlines of Chemical Technology: For The 21st Century" 1st Edition, Affiliated East-West Publishers, 1997.
4. S.D. Shukla and G.N. Pandey, "Text book of Chemical Technology" Vol 2, Vikash Publishing Company, 1984.

COURSE OUTCOMES

On completion of the course, the students can

CO1	understand the various unit operations and processes with their symbols
CO2	understand the manufacturing process of natural products processing and industrial Microbial Processes and Edible Oils.
CO3	understand the various chemical reactions involved in the process
CO4	understand the manufacturing process of inorganic chemicals
CO5	draw the process Flowsheet and understand the major engineering problems encountered in the processes.

Mapping of Course Outcomes with Programme Outcomes

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

ork, 1984.

Third Edition,

PO12
✓
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites (Course code)	:
Course Type	:

COURSE LEARNING OBJECTIVE

1. To study the fundamental concept condensation.
2. To use these fundamentals in Evaporator) and current research.

COURSE CONTENT

Basic modes of heat transfer and the law general heat conduction equation, co thermal conductivity, Radial Heat cond extended surfaces, Transient heat conduction

Convection – Dimensional analysis a spherical surfaces, Hydrodynamic a groups. Boiling and condensation.

Heat Exchangers – classification and de LMTD correction factor for multiple pa

Evaporation, single and multiple effec boiling point elevation, Duhring’s rule, Thermal Radiation laws, spectrum of – typical examples. Radiation exchar without participating medium. Radiatic

CLPC16
HEAT TRANSFER
3
CLPC13
PC

LS

ts of heat transfer viz., conduction, convection, radiation, boiling and

typical engineering applications (Heat exchanger and

ws governing them. Steady state conduction through plane and composite walls
 ncepts of thermal diffusivity and equivalent thermal conductivity. Variable
 luction through thick cylindrical and spherical vessels, concept of critical thickness,

nd empirical correlations, critical insulation thickness for cylindrical and
 nd thermal Boundary layers, physical significance of the dimensionless

esign, overall and individual film coefficients, mean temperature difference,
 ass exchanger, NTU and efficiency of Heat exchangers, use of efficiency charts.

st operation, material and Energy balance in evaporators,
 effect of liquid head, illustrative examples.

f electromagnetic radiation, Black and Gray bodies, and configuration factor
 age between black surfaces with and
 on exchange between non-black surfaces.

td.

ensation.

PO12
✓
✓
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. Understand the philosophy of cl
particulates materials
2. Enable to apply Population Bala
3. Understand the basic principles
Size Reduction, Filtration, Sedime

COURSE CONTENT

Characteristics of Particulate Mat
methods for size and surface area di

Synthesis Methods: Introduction to
generation, Introduction to size redu
simulation techniques for mill perf

Particulate Processes: Gas-liquid se
and mixing of solids, Fluidization, e

Handling of Particulate Material:
selection of feeders and elevators

REFERENCE BOOKS

1. *Martin Rhodes (Ed.), "Introduct*
2. *W.L.McCabe and J.C .Smith," U
Hill., New York, 2004.*
3. *M. Coulson and J.F .Richard*
4. *Raymond A. Kulweic, "Mate*
5. *Badger and Banchero, "Introca
NewYork, 1955*

CLPC17
PARTICULATE SCIENCE AND TECHNOLOGY
3
NONE
PC

YES

Characterization of particulate materials and its application to various functionalities of

Balance Equations (PBE) to study the dynamic behavior of various particulate processes and design/ analysis of various process applications such as separation, Mixing and Agitation, material handling and metering etc.

Material: Properties and characterisation of particulate solids, analysis and technical distribution of powder; Flow properties of particulates. Population Balance Equations

Synthesis of composite material by spray technique, aerosol production equipment, energy and power requirement in milling operations, computer performance.

Separation methods, Classification by size, agitation of liquids encapsulation etc., process performance simulations

Conveying methods, Storage methods and design of silo,

Introduction to Particle Technology", 2nd Edn, Wiley- Interscience Publications, 2002
Unit Operation of Chemical Engineering", 7th Edn., McGraw

son, "Chemical Engineering", Vol. II, 5th Edn., Butterworth - Heinemann, 2002
Materials Handling Handbook", 2nd Edn, Wiley- Interscience Publications, 1985.
Introduction to Chemical Engineering", 1st Edn., McGraw Hill,

COURSE OUTCOMES

On completion of the course, students are expected to

CO1	understand the philosophy of characterization of particulate material
CO2	use Population Balance Equations to study the dynamics of various processes
CO3	design a process or analyze the performance of a process associated with particulate material
CO4	have sufficient knowledge to address the current challenges of particulate processes in industries including safety, environmental and ethical considerations

Mapping of Course Outcomes with Programme Outcomes

	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓
CO4	✓	✓	✓		✓			✓	✓		✓

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To learn the concept of diffusion
2. To understand the basics of inter
3. To learn application of gas-lic

COURSE CONTENT

Definition, Ficks law, Molecular
Types of solid diffusion, Pseudo s
diffusion in multicomponent gase
state Diffusion.

Equilibria, Mass transfer coefficient
between momentum, heat and m

Absorption – Solubility, theory o
operating lines. Mass Transfer Equi
Concept of HTU and NTU, Tower p
characteristics, Non-isothermal abs

Humidification Theory, Psychometr
Humidification and dehumidificatio
conditioning process, Recirculating

Drying Theory and Mechanism, Dry
Driers, Through circulation driers d
and Application of Driers, Analysis

Crystallization Theory, Solubility
Theory, Factors governing nucle
crystallizers and their applications.]
MSMPR model. Industrial crystalli

REFERENCE BOOKS

CLPC18
MASS TRANSFER - 1
3
CLPC11, CLPC14
PC

IVES

1 in gas, liquid & solid.

mp phase mass transfer.

iquid operation and simultaneous heat and mass transfer operations.

and eddy diffusion, Diffusion in gaseous mixtures, liquid mixtures and solids, steady state diffusion, measurement and calculation of diffusivities. Ordinary ous mixtures. Unsteady

nts - Individual and overall with relations, Theories of mass transfer, Analogies ass transfer to predict mass transfer coefficients.

f gas absorption, Design of absorption towers, Concept of Equilibrium and pments- Batch and continuous Stage wise contactors and Differential contactors, ackings and packing rbers, Case studies in absorption with chemical reactions.

ic Chart, Adiabatic Saturator, Wet Bulb Theory, Methods of n, Cooling tower theory, Design of cooling towers, Industrial cooling towers, Air water gas humidification system.

/ing Characteristics, Estimation of Drying time, drying rate curve, Classification of esign, Design of driers, Description of continuous driers.

r curve, Types of crystals, Principles of Crystallization, Supersaturation eation and crystal growth. Theory of crystallization, Classification of Product size distribution by zers, Crystallizer Design.

1. E. L. Cussler, "Diffusion: Mass Transfer in Fluid Systems", Cambridge University Press; 3rd Edition, 1996.
2. R. E. Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1980.
3. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice", PVT. Ltd., New Delhi, 2013.
4. A.S.Foust, "Principles of Unit Operations", 2nd Edition, Wiley & Sons, New York, 1980.
5. J. M. Coulson and J. F. Richardson, "Chemical Engineering", 5th Edition Vol. II, P Butterworths, London, 2002.
6. C.J.Geankoplis, "Transport Processes and Separation Process Principles," IV edition, Prentice Hall, New Delhi, 2004.
7. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 7th Edn., McGraw Hill Book Co., New York, 2004.

COURSE OUTCOMES

On completion of the course, the students will be

CO1	familiar with the basic phenomenon of mass transfer involving phases.
CO2	applying the mathematical and design concepts of mass transfer in gas-liquid systems like absorption, humidification, drying and crystallization.
CO3	gaining good knowledge of required optimum condition for a gas-liquid system

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		✓	✓		✓						✓
CO2		✓	✓		✓						✓
CO3		✓	✓		✓						✓

edition, 2009.

081.

Printice Hall of India

orth Heinemann, New,

tice Hall of India Pvt.

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To find the velocity distribution
2. To obtain the temperature distribution

COURSE CONTENT

Mechanism of fluid transport
 momentum balances - Flow
 Equation of Motion: Equations of
 motion and continuity - Euler's

Turbulent Flow: Velocity distribution
 stress. Interphase transport in

Heat Transfer analysis: Mechanisms
 in laminar flow - Equations

Mass Transfer analysis: Mechanisms
 fluids laminar flow - Equations

REFERENCE BOOKS

1. James Welty, Charles W. Eckert, and John A. Gortler, "Fundamentals of Heat and Mass Transfer", 5th ed.
2. Bird R.B., Stewart W.E., and Lightfoot E.N., "Transport Phenomena", 2nd ed.
3. Geankoplis C.J., "Transport Processes and Separation Process Principles", 4th ed.
4. J.L. Stuart, "Transport Phenomena", 2nd ed.
5. W. J. Thomson, "Introduction to the Study of Fluid Mechanics", 2nd ed.

COURSE OUTCOMES

CLPC19
TRANSPORT PHENOMENA
3
CLPC13, CLPC16, CLPC18
PC

OBJECTIVES

istribution in laminar and turbulent flow of Newtonian and non-Newtonian fluid
 re and concentration profiles in solids and in fluids respectively.

ort: Laminar Flow - Velocity distribution in Laminar flow - Shell
 through tubes, surfaces. Flow of non-Newtonian fluids

on of change for isothermal process – One dimensional equation of
 er and Navier – Stokes equation. Dimensional analysis of equation of change

istribution in turbulent flow - Semi empirical expressions for Reynolds
 n isothermal system - Ergun's equation.

hanism of heat transport - Temperature distribution in solids and fluids
 of change for multi component systems.

hanism of mass transport - Concentration distribution in solids and in
 ons of change for multi component systems.

*E. Wicks, Gregory L. Rorrer, Robert E. Wilson, "Fundamentals of Momentum, Heat
 'tion, Wiley; 2007*

and Light Foot E.N. Transport Phenomena, 2nd Edition, John Wiley and Sons., 2007.

ort Processes and Separation Process Principles, 4th Edition, Prentice Hall Inc., 2009.

Phenomena", John Wiley, New York, 1982.

uction to Transport Phenomena", Prentice Hall, 2000.

On completion of the course, the students can

CO1	understand the analogy among momentum, heat and mass transport
CO2	develop differential momentum, heat, and mass balances for 1-D steady state problems using conservation principles
CO3	formulate a mathematical representation of velocity, temperature and concentration profiles in momentum, heat and mass transfer respectively in laminar flow.
CO4	identify the similarity among the correlations for flow, heat and mass transfer at interface
CO5	solve the flow, heat and mass transfer problems

Mapping of Course Outcomes with Programme Outcomes

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

PO12
✓
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

1. To impart the basic concept of c
2. To learn the equilibrium charact
3. To understand the hydrodynam
4. To develop the skill in the desig

COURSE CONTENT

Distillation-Principle, theory, Vap
 Methods of distillations- flash,
 distillation - Design of single stage
 steam distillation columns.

Design of Distillation -Stage-wise
 Ponchon-Savarit and Mc-Cabe
 overall efficiency interrelations- Rel
 towers-HTU and NTU calculations.
 aspects of distillation
 tower.

Extraction- Theory, LLE for diffe
 Design of Batch and continuous ext
 systems- Industrial Applications: C
 Leaching-Theory, Mechanism, Type
 continuous extractors- Equipments
 Adsorption-Types of adsorption,
 of adsorption columns- Design of

CLPC20
Mass Transfer II
4
CLPC18
PC

IVES

onventional mass transfer operations.
 eristics of two phase mass transfer processes.
 es and modes of operations in mass transfer equipment.
 n and analysis of mass transfer equipment in process industries.

or- Liquid Equilibria calculations- Effect of Pressure and temperature on VLE-
 steam, simple, vacuum, molecular distillations- Azeotropic and Extractive
 flash , simple and

: and continuous Differential contact operations- Design calculations using
 Thiele Methods- Separation efficiency- Murphree Plate Efficiency, Point and
 boilers and condensers- Open steam Distillation – Design of Packed bed distillation
 – Case Study: Multicomponent distillation of Petroleum crude and design

arent systems, Effect of Pressure and Temperature on LLE- Solubility criteria-
 raction towers for miscible and immiscible
 ase Study- Description of Extractors with reflux.

es of leaching, Solid - Liquid equilibria- Design of Batch and
 and industrial applications.

nature of adsorbents-Adsorption hysteresis- Adsorption isotherms- Operation
 f Batch and continuous adsorbers- Mechanism of Break through plot and its effect.

REFERENCE BOOKS

1. R.E. Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 19
2. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice Pvt. Ltd., New Delhi, 2013.
3. A.S. Foust, "Principles of Unit Operations", 2nd Edn., Wiley & Sons, New York, 1980.
4. M. Coulson and J.F. Richardson, "Chemical Engineering", Vol - II, 5th Edn., Pergamon P.
5. C.J. Geankopolis, "Transport Processes in Chemical Operations", 4th Edn., Prentice Hall o 2004.
6. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engg.", 7th McGraw Hill Book Co., New York, 2004.

COURSE OUTCOMES

On completion of the course, the students are expected to

CO1	acquire sufficient knowledge in the concepts of mass transfer operations in Chemical Process industries.
CO2	analyze the two phase mass transfer processes and apply in Process industries.
CO3	develop equilibrium characteristics for the design of transfer operations.
CO4	apply mathematical skills in the design of equipments for the separation of components in Chemical engineering Practice.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓							✓		✓	
CO2	✓	✓	✓	✓	✓			✓		✓	
CO3	✓	✓									✓
CO4	✓	✓	✓						✓		✓

081.
e”, Printice Hall of India

ress, New York, 2002.
of India, New Delhi,

Edn.,

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. Introduce basic concepts of che and molecularity of reaction, concer
2. Build up the concepts to analyz
3. This course will guide students reactor and multiple reactors
4. Analyze multiple reactions to d
5. Work together in same-disciplin

COURSE CONTENT

Basics of Kinetics: Introduction - ki term of rate equation, Searching for

Reactor Design: Introduction to F Design for single and multiple Reac system for single reactions.

Reactions in parallel, reactions in reactions.

Flow Behaviour of Reactors: Non - calculations directly from tracer stu models

Heat Effects: Temperature and pres:

CLPC21
CHEMICAL REACTION ENGINEERING
3
CLPC16, CLPC14
PC

IVES

mical kinetics like homogeneous and heterogeneous reactions, rate of reaction, order
 tration and temperature dependency of rate of reaction

e kinetic data and determine the rate expression for a reaction

to make use of key concepts and techniques of chemical kinetics to design single

etermine selectivity and yield

ne teams to solve engineering problems

netics of homogeneous reactions: Concentration dependent & Temperature dependent
 a mechanism. Interpretation of Batch Reactor data.

Reactor Design. Single Ideal Reactors. Design of Reactor for Multiple Reaction:
 ations. Size comparison of single reactors for single reactions. Multiple Reactor

series and series - parallel reactions of first order. Recycle reactor, auto catalytic

ideal flow: Residence time distribution studies: C, E, F and I curves, conversion
 dies. Models for non-ideal flow - dispersion and tanks in series multi-parameter

sure effects on reaction,

999.
, 2013

rd Edition, 2000

reactor
. select

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To apply the basic principles/ concepts of Chemical Reaction Engineering in design.
2. To develop the skill to select appropriate design parameters.
3. To analyse and evaluate the performance of the reactor.

COURSE CONTENT

Design of Pressure Vessels: Design of vessels under combined loadings. Design of heat exchangers.

Design of Storage tanks, Agitated tanks.

Design of Phase Separation Equipment.

Design of Heat Exchangers: Double Pipe Heat Exchanger, Evaporator

Design of Mass Transfer Equipment.

Design of dryers and cooling towers.

REFERENCE BOOKS

1. R. H. Perry, "Chemical Engineering Handbook", McGraw-Hill, New Delhi, 1999.
2. R. K. Sinnott, "Chemical Engineering Design: Volume-6, Fourth Edition, Butterworth-Heinemann, Oxford, 2005.
3. L. E. Brownell and E.H. Young, "Process Equipment Design", McGraw-Hill, New Delhi, 1959.
4. B.C. Bhattacharyya, "Introduction to Chemical Engineering Design", Butterworths, New Delhi.
5. D.Q.Kern "Process Heat Transfer", McGraw-Hill, New Delhi, 1960.
6. V. V. Mahajani and S. B. Umarji, "Chemical Engineering Design", Butterworths, New Delhi, 2009.

COURSE OUTCOMES

CLPC22
CHEMICAL PROCESS EQUIPMENT DESIGN
4
CLPC16, CLPC18, CLPC20, CLPC21
PC

TIVES

concepts learned in the subjects of Momentum transfer, Heat Transfer, Mass Transfer, and the design of chemical process equipment. and design the appropriate process equipment for the required unit or process operation. performance of existing equipment.

Design of pressure vessels and its components under internal pressure, external pressure and loads/closures, Design of supports and Design of high pressure vessels

Design of storage vessels and Reaction vessels

Components – Decanter, Vapor Liquid Separator, Thickener

Double pipe heat exchanger, Shell & Tube heat exchanger, Condenser, Reboilers,

Components: Design of Tray and Packed columns for distillation, absorption operations, absorbers

Process Equipment Design Handbook", 7th Edn., McGraw Hill, New York, 1998.

Engineering Design", Coulson and Richardson's Chemical Engineering Series, Butterworth-Heinemann, Elsevier, New Delhi, 2005.

Process Equipment Design - Vessel Design", Wiley Eastern Edn. New York, 1968.

Introduction to Chemical Equipment Design Mechanical Aspects", CBS Publishers &

Transfer", Tata McGraw Hill Edn., 2004.

iii, "Joshi's Process Equipment Design", 4th Edn., Mac Millan Publishers India

On completion of the course, students can

CO1	Integrate the knowledge acquired from core chemical engineering subjects for design of che process equipment
CO2	identify the process equipment problems and provide suitable alternate solutions
CO3	analyse and evaluate the performance of existing equipment

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO1	✓	✓	✓	✓	✓						✓
CO2	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓			✓	✓	✓	✓

mical

PO 12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

To develop mathematical model and

COURSE CONTENTS

Introduction to process modeling
classification of models, Conservation
simulation, Use of simulated process

Mathematical models for chemical
units, systems yielding linear and non

Unsteady state lumped systems: liquid
isothermal CSTR, Heated tank, distillation

Unsteady State Distributed System,
exchanger, diffusion, plug flow reactor

Solution strategies for distributed parameter
partial differential equations by finite difference

Introduction to MATLAB/Aspen, Simulation

REFERENCE BOOKS

1. *W.L. Luyben, "Process Model Book Co., New York, 1996.*
2. *Amiya K. Jana, Chemical Process*
3. *Laurene V. Fausett, Applied Numerical*
2009

COURSE OUTCOMES

CLPC23
PROCESS MODELING AND SIMULATION
3
CLPC16, CLPC18, CLPC20, CLPC21
PC

IVES

dynamic simulator for chemical processes

and simulation - a systematic approach to model building, variation principles, Degrees of freedom analysis. Tools of simulation, computer model

engineering systems: Steady state lumped systems, process non-linear algebraic equations, solution of linear and non-linear algebraic equations

liquid level tank, gravity flow tank, Isothermal CSTR and Non-illation column,

Analysis laminar flow in pipe, sedimentation, conduction, heat exchanger, Solution strategies for, ODE-IVP and ODE-BVP.

parameter models. Solving parabolic, elliptic and hyperbolic finite difference method.

simulation of chemical engineering problems

Design, Simulation and Control for Chemical Engineers”, 2 nd Edn., McGraw Hill

Process Modelling and Computer Simulation, Prentice Hall of India, 2nd Edition, 2011

Numerical Analysis using MATLAB, Second edition, Pearson,

Upon completing the course, the student should have understood

CO1 : the development of process models based on conservation principles

CO2: computational techniques to solve the process models.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11
CO1	✓			✓	✓						✓
CO2	✓	✓	✓	✓	✓			✓	✓	✓	✓

PO 12
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To introduce students to the term control.
2. To impart knowledgeable in the

COURSE CONTENT

Introduction – Control system, comp

Laplace transforms - properties of L
Laplace transform techniques, piece

Dynamic behaviour of systems - der
temperature, pressure, flow and co
non-interacting systems.

Transient response of first and se
overshoot, decay ratio, rise time and

Transient analysis of control systems
regulator and servo problems, transie

Definition of stability of control s
limitations of Routh test, Pade's app

Introduction to frequency response -
controllers, transportation lag. Bode
Optimum controller settings. Nyquis
calculation of phase margin, gain ma

Advanced Control- Cascade contro
Model Control-Control valves-

REFERENCE BOOKS

1. *D.R. Coughanowr and S. E. LeB*
2. *D. E. Seborg, T. F. Edger, D Edition, 2013.*
3. *C.A.Smith and A.B.Corripio, ' 1985.*
4. *W.L.Luyben, 'Process Modelling*
5. *G. Stephanopoulous, 'Chemical India Ltd.,1984*

CLPC24
PROCESS DYNAMICS AND CONTROL
4
MAIR21
PC

VES

inology, concepts and practices of input/output modeling and automatic process

design of control systems and controller tuning for chemical processes.

ponents of a feedback control system.

aplace transform, solution of linear differential equations using
wise continuous functions.

ivation of transfer functions for first and second order systems, liquid level,
oncentration control processes, linearization of nonlinear systems, interacting and

cond order systems, natural frequency, damping factor,
settling time.

s - block diagram algebra, overall transfer function of closed loop control systems,
ent response of first and second order systems with P, PI and PID controller.

systems, Routh test,
roximation of time delay systems.

Bode diagrams, Bode diagrams for first and second order systems, P, PI, PID
stability criteria, phase margin and gain margin, Nichols chart, Ziegler - Nichols

st stability criteria,
argin, peak gain and resonant frequency using Nyquist plot.

ol - feed forward control - ratio control - dead time compensation- Internal
-Valve characteristics - Process identification.

lanc, *'Process Systems Analysis and Control'*, Mc Graw Hill, III Edition, 2009.
. A. Millichamp and F.J. Doyle III, *'Process Dynamics and Control'*, Wiley, III
Principle and Practice of Automatic Process Control', John Wiley and Sons,
; *Simulation and Control for Chemical Engineers'*, McGraw Hill, II Edition, 1990.
' *Process Control – Theory and Practice'*, Prentice Hall of

COURSE OUTCOMES

On completion of the course, the student can

CO1	construct a model of the elements used in control systems from first principles leading to the development of transfer function models and compute the response of the developed transfer function for various forcing functions
CO2	derive transfer function models of controllers and compute the transient response under closed loop conditions.
CO3	evaluate the stability of the control system given a mathematical model of a control system including its components.
CO4	design a control system for robust performance using frequency response methods.
CO5	design various advanced control algorithms for chemical processes having specific probl

Mapping of Course Outcomes with Programme Outcomes

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

Course Code	:	CLPC25
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✓
✓
✓
✓

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Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

- i. For enabling the students to acquire the necessary confidence
- ii. To make the students to understand operation
- iii. To make the students to get into industry.
- iv. To give a clear linkage between major chemical engineering unit

COURSE CONTENT

Introduction: Chemical Engineering layout, factors affecting plant layout
 Development: Process creation, process flow diagram (P&ID).

Process utilities, process water, boiler pumps, compressors, vacuum pumps

Process Instrumentation: measurement of viscosity, pH, concentration, electrical

Analysis of Cost Estimation: Capital investments, Fixed capital cost, total cost, Profit and cash flow, Net Present Value, Depreciation

Profitability Analysis: Profitability index, return on investment, Payback period, replacement investments, Replacements.

REFERENCE BOOKS:

1. *J.M. Coulson, JF Richardson*
Edition, Butterworth-Heinemann,
2. *M.S. Peters and K.D. Tim*
book Co., New York, 1991.
3. *H.E. Schwyer, "Process Eng*
4. *Peters M.S., K.D. Timmerl*
McGraw Hill, 5th Edition, 2011.
5. *V.Ganapathy, Industrial Boile*
Marcel Dekker, Inc, 2003.
6. *Turton R., R.C. Baile, W.B. W*
New Delhi, 3rd Edition, 2011.
7. *Robin Smith, "Chemical Proc*

PROJECT ENGINEERING AND ECONOMICS
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3

CLPC17

PC

FIVES

to gain experience in organisation and implementation of a small project and thus
e to carry out main project in the final year.

nderstand all the facility required for starting up a new industry apart from various unit

gain all the knowledge in terms of financial analysis for starting up a new chemical

etween technical knowledge and commercial aspects of the
t operations and design.

ng plant design, Overall design consideration, Plant location and site selection, plat
ocation, project planning and scheduling of projects, Process selection and
Process design criteria, Process flow diagram (PFD), Piping and instrumentation

oilier feed water, water treatment & disposal, steam distribution, Furnaces, process
nps, valves, Piping design, layout, Support for piping insulation, plant constructions.

ement of temperature, pressure, fluid flow, liquid weight and weight flow rate,
ctrical and thermal conductivity, humidity of gases

h flow for industrial operations, Factors affecting investment and production costs,
al and working capital, Estimation of capital investment, Cost indices, Estimation of
et present value analysis, Balance sheet and Income statements, Methods for calculating

ility standards, Costs of capital, Methods of calculating profitability, Rate of
riod, Discounted cash flow rate of return, Net present worth, Payout period, Alternative

n, RK Sinnott Butterworth Heinman, *Chemical Engineering Volume 6, Revised Second*
1996.

nmerhaus, "*Plant Design and Economics for Chemical Engineers*", McGraw Hill

ineering Economics", McGraw Hill Book Co., N.Y.

'iaus and R.E. West. "*Plant Design and Economics for Chemical Engineers*",

ers, and *Heat recovery Steam Generators Design, Applications and calculations*,

hiting, J. A. Shaeiwitz. "*Analysis, Synthesis and Design of Chemical Processes*", PHI,

ress Design", McGraw Hill Book Co., New York, 1995.

COURSE OUTCOMES

On completion of the course, the students can

CO1	understand how a project has to be started, their pre-requirements, flow chart preparation, economic calculation and so on.
CO2	draw a complete flowchart of a plant with complete cost analysis.
CO3	choose between the equipment/instruments of the same function based on both technical and commercial point of view
CO4	gain a good knowledge on when to run an industry in a profitable or without loss/gain of a particular concern.
CO5	work out the balance sheet and Income statement for a particular concern.

Mapping of Course Outcomes with Programme Outcomes

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

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PO12
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✓

Course Code	:
Course Title	:
Number of Credits	:
Co requisites	:
Course Type	:

COURSE LEARNING

To understand and apply course

LIST OF EXPERIMENT

1. Flow through str
2. Flow through pip
3. Flow through hel
4. Flow through pac
5. Flow through flu
6. Flow measureme
7. Flow measureme
8. Flow through Be
9. Performance of c
10. Flow of non-new

REFERENCE BOOKS

1. *Lab Manual provide*
2. *W.L. McCabe, J.C. S International Edn., 2005*

COURSE OUTCOMES

After completion of the c

CO1	understand and ana
CO2	understand the frictic
CO3	understand the flow 1
CO4	understand the pump

CLLR11
MOMENTUM TRANSFER LAB
2
CLPC13
ELR

OBJECTIVES

the principles and concepts of momentum transfer theory learned in the momentum transfer

ENTS

- aight pipes
- ie fittings
- ical/spiral coil
- cked bed
- idized bed
- nt using venturi and orifice meter
- nt using Pitot- static tube
- rnoulli's apparatus
- entrifugal pump
- tonian fluid

d by NITT

'mith and P. Harriott, "Unit operations of Chemical Engineering", 7th Edn., McGraw Hill,

.

S

course, students are able to

lyse the laminar and turbulent flow characteristics
on factor of fluid flow through pipes and packed column
measurement using flow meters
performance

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓
CO4	✓	✓			✓	✓	✓	✓	✓	✓	✓

PO12
✓
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✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Corequisites	:
Course Type	:

COURSE LEARNING O

1. To provide hands on tr:
(Bleaching powder, Coal, C
2. To provide practical o
equilibrium and reaction ec

LIST OF EXPERIMENT

1. Estimation of bleac
2. Proximate analysis
3. Analysis of water (j
4. Estimation of salini
5. Analysis of cement
6. Heat of solution by
7. Equilibrium consta
8. Liquid – Liquid eq
9. Excess property det
10. Vapour compressio
11. VLE using Othmer

REFERENCE BOOKS

1. *J.M. Smith, H.C. McGraw Hill, New York, 7*
2. *K.V. Narayanan, “A Hall of India, 2013.*
3. *Laboratory Manual*

CLLR12
INSTRUMENTAL ANALYSIS AND THERMODYNAMICS LAB
2
CLPC14
ELR

OBJECTIVES

aiming to the students to familiarize various analytical instruments for the analysis of Chemicals (Cement and water)

experience on the principles, viz., thermodynamic laws, Solution thermodynamics, Phase equilibrium.

[S

ashing powder

of coal

pH, turbidity, conductivity, resistivity, suspended particles)

ity of water

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solubility method

nt determination

uilibrium

termination

on refrigeration

still

Van Ness and M.M. Abbot, "Introduction to Engineering Thermodynamics", 7th Edition, 2004

Text Book of Chemical Engineering Thermodynamics," Second second Edition, Prentice

COURSE OUTCOMES

On completion of the course, the student are able to

CO1	calibrate and perform analysis the chemicals using instruments
CO2	verify the fundamentals learnt viz., application of thermodynamic laws, solution thermodyna phase equilibrium and reaction equilibrium in Chemical Engineering thermodynamics by cor experiments and carry out the evaluation

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓			✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓			✓	✓	✓	✓	✓	✓	✓

mics, ducting

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Co requisites	:
Course Type	:

COURSE LEARNING

1. To understand and ver application to various pa
2. To gain knowledge thr particulate process such a Sedimentation, storage o

LIST OF EXPERIMEN

1. Particle size char: Density, Repose Dens
2. Screen analysis fo
3. Influence of fligh
4. Evaluation of ene
5. Evaluation of filt
6. Evaluation of mix
7. Effect of inclinati
8. Evaluation of elu
9. Influence of disch
10. Discharge rates o

REFERENCE BOOKS

1. *Lab Manual*
2. *W.L. McCabe, J.C. S International Edn., 200.*
3. *Martin Rhodes [2001]*

CLLR13
PARTICULATE SCIENCE & TECHNOLOGY LAB
2
CLPC17
ELR

OBJECTIVES

ify the principles & concepts of learned in Particulate Science & Teechnology theory course and rticulate processes.

rough conducting experiments on characterization of single particle and powder samples, as Comminution, Screen Analysis, Filtration, Mixing, f solids in a silo and Elutriation.

NTS

acterization (i) Image analysis, (ii) Settling velocity (iii) Particle density, (iv) Bulk density (Tap sity), (v) Angle of repose
 or effectiveness of a screen
 t on comminution in a Ball mill
 rgy requirement in Jaw crusher
 ration characteristics for cake and filter medium
 cing characteristics and influence of baffles
 ion on sedimentation of suspension
 triation parameters
 arge opening on solid discharge rates from silo
 f non-cohesive powders through silo

mith and P. Harriott, "Unit operations of Chemical Engineering", 7th Edn., McGraw Hill, 5.

, "Introduction to Particle Technology" 2nd Edn. Elsevier Publicaitons.

COURSE OUTCOMES

After completion of the course, the students are able to

CO1	understand and interpret the particulate properties
CO2	understand the principle and evaluate the performance of comminution, screening operation, elutriation and solids discharge through silo.
CO3	use the performance characteristics to design particulate processes like sedimentation, filtration and mixing

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓

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Course Code	: CLLR15
Course Title	: MASS TRANSFER LAB
Number of Credits	: 2
Prerequisites	: CLPC18
Course Type	: ELR

COURSE LEARNING OBJECTIVES

To impart the practical experience for the students to apply the concepts of mass transfer principles and mass transfer parameters.

LIST OF EXPERIMENTS

1. Verification of Rayleigh's equation in simple distillation
2. Vaporization and thermal efficiency in steam distillation
3. Effect of temperature on surface evaporation
4. Stage efficiency in leaching
5. Diffusion of liquid and solid in air
6. Air drying characteristics
7. Vacuum drying characteristics
8. Mass transfer coefficient using a wetted wall column
9. Freundlich isotherm in batch adsorption
10. Break through point in continuous adsorption
11. Characteristics of a recirculation humidifier

REFERENCE BOOKS

1. R.E. Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1980.
2. C.J. Geankopolis, "Transport Processes in Chemical Operations", 4th Edn., Prentice Hall of India, 2004.
3. Mass transfer laboratory manual

COURSE OUTCOMES

On completion of the practical course, the students will be able to

CO1	understand the application of theoretical concepts
CO2	interpret and apply the data for process equipment design

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓	✓	✓	✓			✓
CO2	✓	✓	✓	✓	✓			✓		✓	✓

ples and estimate the

81.
of India, New Delhi,

PO12
✓
✓

Course Code	:	CLLR16
Course Title	:	CHEMICAL REACTION ENGINEERING LAB
Number of Credits	:	2
Corequisites	:	CLPC21
Course Type	:	ELR

COURSE LEARNING OBJECTIVES

Providing experience on experimentally to find activation energy and kinetics of particular evaluation of performance of single and multiples reactors and evaluation of performance of non-

LIST OF EXPERIMENTS

1. Determination of activation energy of the given reaction using adiabatic reactor
2. Analysis of kinetics of liquid phase reaction in a batch reactor with equimolar mixture.
3. Analysis of kinetics of liquid phase reaction in a batch reactor with non-equimolar mixture.
4. Evaluation of the performance of isothermal mixed flow reactor.
5. Evaluation of the performance of mixed flow reactor in series
6. Evaluation of the performance of plug flow reactor
7. Evaluation of the performance of mixed flow reactor followed by plug flow reactor
8. Residence time distribution studies in mixed flow reactor
9. Residence time distribution studies in plug flow reactor

REFERENCE BOOKS

1. O. Levenspiel, "Chemical Reaction Engineering", 3rd Edn., Wiley Eastern Ltd., New York, 1999
2. K.A. Gavhane Chemical Reaction Engineering -I, Nirali Prakashan Publications, Pune, 2013
3. Chemical reaction engineering laboratory manual.

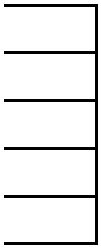
COURSE OUTCOMES

On completion of the course, the student will be

CO1	able to verify the basis learnt in theory on finding activation energy and finding kinetics of particular chemical reaction, evaluation of performance of single and multiples reactors and evaluation of performance of non-ideal reactors
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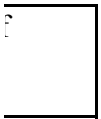
Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓			✓	✓	✓	✓	✓	✓	✓



chemical reaction,
ideal reactors

!



PO12
✓

Course Code	:	CLLR17
Course Title	:	PROCESS DYNAMICS AND CONTROL LAB
Number of Credits	:	2
Prerequisites	:	CLPC24
Course Type	:	ELR

COURSE LEARNING OBJECTIVES

To impart hands on experience on various process control systems and instrumentation

LIST OF EXPERIMENTS

1. I & II Order System Dynamics
2. Interacting & non interacting Systems
3. Flapper - Nozzle system
4. Control valve characteristics
5. Level control system
6. Flow control system
7. Pressure control system
8. Control of a thermal system
9. Design of control system for a given process
10. Simulation of a closed loop system
11. Demo Experiment using Aspen Software of a given process

REFERENCE BOOKS

1. *Process Control Laboratory Manual.*
2. *D.R. Coughanowr and S.E. LeBlanc, 'Process Systems Analysis and Control', Mc.Graw Hil.*

COURSE OUTCOMES

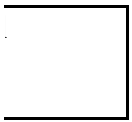
On completion of the course, the students will be

CO1	able to apply the theoretical knowledge while performing experiments for different chemical engineering processes
------------	---

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓			✓	✓	✓	✓

l, III Edition, 2009.



PO12
✓

Course Code	: CLLR18
Course Title	: PROCESS MODELING AND SIMULATION LAB
Number of Credits	: 2
Prerequisites	: CLPC23
Course Type	: ELR

COURSE LEARNING OBJECTIVES

To simulate the various chemical processes through software packages

LIST OF EXPERIMENTS:

1. Estimation of dew point and bubble point temperature of a hydrocarbon mixture
2. Simulation of flash drum
3. Design of distillation column
4. Optimization of a flow sheet or process
5. Determination of temperature profiles for heat exchanger
6. Concentration profiles for reactor
7. Simulation of Jacketed CSTR
8. Simulation of process
9. Simulation of evaporator/ distillation column/ extraction process

REFERENCE BOOKS

1. Steven C. Chapra, Applied numerical methods with MATLAB for engineers and scientists, M
2. Jana A.K., *Chemical Process Modeling and Computer Simulation*, PHI, 2008.
3. Jana A.K., *Process Simulation and Control using ASPEN*, PHI, 2009

COURSE OUTCOMES

At the end of the course students will be able to

CO1	Use design packages for the simulation of chemical processes
CO2	analyze the chemical processes and select the appropriate numerical techniques or tool for the process.

Mapping of course outcomes with programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓			✓	✓		✓
CO2	✓	✓	✓	✓	✓			✓	✓		✓

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PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To impart introductory
2. To provide an insight

COURSE CONTENT

Introduction & primary
Characterization of crude,
Secondary Processing: F
Isomerisation and polyme
Treatment Techniques:
removal of Sulphur, Treat

Petrochemicals: Building
methane and synthesis gas

Environment and safety: C
treatment, Fire hazards – e
and personal protective eq

REFERENCE BOOKS

1. *W.L. Nelson, "Petrole*
2. *B. K. Bhaskara Rao,*
New Delhi, 2012.
3. *G. D. Hobson and W.*
4. *R. A. Meyers, "Hand t*

COURSE OUTCOMES

CLPE11
PETROLEUM AND PETROCHEMICAL ENGINEERING
3
NONE
PE

OBJECTIVES

y knowledge of petroleum refining and corresponding processes.
into petrochemical industry.

processing: Origin & formation of crude oil, Classification of crude,
, distillation practise, atmospheric distillation, vacuum distillation.

CCU, Hydro cracking, Visbreaking, Coking, Reforming, Alkylation,
rization processes.

Physical & chemical impurities in petroleum fractions, General mechanisms for
ment of LPG, gasoline, kerosene, diesel and lube oils. Properties of ATF and bitumen.

; blocks, intermediates, major petrochemicals and their applications, Chemicals from
s, Chemicals from olefins, Chemicals from aromatics, Synthetic fibres, plastics and rubber.

Gaseous contaminants in refinery - sources & treatment, Process waste water - sources and
active & passive prevention, Occupational diseases
quipment, Site selection & plant layout.

um Refinery Engineering", 4th Edn., McGraw Hill, New York, 1985

"Modern Petroleum Refining Processes", 5th Edn., Oxford and IBH Publishing Company,

Pohl., *"Modern Petroleum Technology"*, John Wiley & sons Publishers, 4th Edn. 2004.

book of Petroleum Refining Processes", McGraw Hill, 3rd Edn. 2003.

On completion of the course, the students will be able to

CO1	develop overview of petroleum industry and know about origin, formation, composition and characterization of crude oil.
CO2	comprehend primary processing mechanisms of crude to obtain various petroleum cuts.
CO3	know about secondary conversion techniques and treatment processes in petroleum refinery to get products of desired yield and quality.
CO4	understand manufacturing processes and applications of various petrochemicals.
CO5	grasp environmental and safety aspects in petroleum refinery and petrochemical industries.

Mapping of Course Outcomes with Programme Outcomes

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

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECT

The main objective of this course

COURSE CONTENTS

Review of solution methods of non-linear equations (e.g. using method of quadratic factors), solution to the nonlinear equations

Numerical integration: Trapezoidal rule, Simpson's rule, curve fit

Interpolation & regression: Lagrange interpolation methods, linear regression (least squares problems): Euler method, Runge-Kutta method, predictor-corrector methods, ODE-BVP: Finite difference methods

Partial differential equations: Heat conduction, wave equation, Helmholtz equation, engineering problems by software]

REFERENCE BOOKS

1. S.K.Gupta, "Numerical methods", New Age International, 2006.
2. Finlayson B. A., "Introduction to numerical methods", Cambridge University Press, 2006.
3. Gerald C. F. and Wheatly P. W., "Numerical methods for engineers", Wiley, 2006.
4. Beers K. J., "Numerical methods for engineers", Wiley, 2006.
5. Cutlip M. B. and Shachar R., "Engineering with POLYMATH", Wiley, 2006.

COURSE OUTCOMES:

At the end of the course students will be able to

CLPE12
COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING
3
NONE
PE

OBJECTIVES:

Students are able to solve the chemical engineering problems by software packages

1. Linear single variable equations, polynomials (determination of roots), matrix operations, solution to the set of linear set of simultaneous equations, ill conditioned matrix, and solution to the set of

1. Trapezoidal and Simpson's rules, Function Approximation: Least square

2. Lagrange interpolation, forward difference, backward difference and central difference methods, polynomial regression. Ordinary Differential equations (Initial value problems), Runge-Kutta methods, predictor-corrector methods, finite difference techniques

3. Elliptical, parabolic, hyperbolic PDE's, Solving chemical engineering problems using software packages

4. *Methods for engineers*, New Age Intl. Publishers, Second Edition, 2010
Introduction to Chemical Engineering Computing, 7th Ed., Wiley Interscience

5. *P. O.; "Applied Numerical Analysis", 7th Ed., Addison Wesley, 2003.*
Methods for Chemical Engineering: Applications in Matlab, Cambridge

6. *John M., "Problem Solving in Chemical and Biochemical Engineering using EXCELL and MATLAB", 2nd Ed., Prentice Hall, 2008.*

Students will be able to

CO1	formulate the problem for chemical engineering applications
CO2	apply the appropriate numerical technique for the problem
CO3	solve the problem by using software packages

Mapping of course outcomes with programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓		✓	✓	✓			✓	✓	✓	✓
CO2	✓		✓	✓	✓			✓	✓	✓	✓
CO3	✓		✓	✓	✓			✓	✓	✓	✓

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECT

1. To provide a fundamental know
2. Emphasis is on the processing 1

COURSE CONTENT

Characteristics, Analysis of Poly
solutions. Measurement of molecu
Polymer material structure and
in crystalline polymers. Rheolog
properties.

Polymer synthesis and reactio
and coordination polymerization

Industrial polymers: Manufactur
elastomers. Other carbon chain pol

Processing of polymers: Plastics,
plastics, fibres and elastomer apj

REFERENCE BOOKS

1. *F.W. Billmeyer Jr., "Text Book*
2. *F. Rodriguez, Claude Cohen,*
5th Edn., Taylor and Francis, Was
3. *"Encyclopedia of Polymer Scie*

COURSE OUTCOMES

CLPE13
POLYMER SCIENCE AND TECHNOLOGY
3
NONE
PE

OBJECTIVES

Knowledge on polymers and their chemical, physical and mechanical behavior. Techniques, along with the production of polymers.

Polymers: The science of large molecules. Theory of polymer molecular weight and size. Analysis and testing of polymers.

Properties: Deformation, flow and melt characteristics. Morphology and order and the mechanical properties of polymers. Polymer structure and physical

Chemical engineering: Condensation polymerization. Addition polymerization. Ionic and copolymerisation. polymerization conditions and polymer reactions.

Manufacturing processes and applications: Hydrocarbon plastics and polymers. Heterochain thermoplastics. Thermosetting resins.

Fibres and Elastomers: Polymers developed for synthetic applications. Plastics technology. Fiber technology. Elastomer technology.

of Polymer Science", 3rd Edn., Wiley-Inter Science, 1984.

Christopher K. Ober and Lynden A. Archer "Principals of Polymer Systems", Washington, 2003.

Science and Technology", John Wiley-Inter Science.

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

CO1	apply the knowledge and to understand the properties and use of polymeric materials and o related environmental aspects.
CO2	acquire sufficient knowledge on how polymeric materials are build-up from molecular leve macroscopic level and the relationship between structure and material properties.
CO3	equip with knowledge on synthesis/modification, characterization, processing and applications of synthetic polymers.
CO4	understand and apply the various processing and manufacturing techniques.
CO5	correlate structure-processing-property relationships for polymers, blends and composites.

Mapping of Course Outcomes with Programme Outcomes

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

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PO12
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✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. This subject deals with the application of chemical and wastewater.
2. To understand how separation and solution of specific problems.

COURSE CONTENT

Review of Conventional separation techniques, properties, ionic properties and other properties.

Sorption Techniques: Types and Retention theory mechanism, equilibrium constants.

Membrane Techniques: Types and applications. Membrane process: ultrafiltration, Gas permeation and Permeation.

Ionic Separation: Process concept and commercial processes.

Other Techniques: Zone melting, Industrial Effluent Treatment by Membrane.

REFERENCE BOOKS

1. H.M. Schoen, "New Chemical Engineering" 1972.
2. Nakagawal, O.V., "Membrane Separation".
3. B. Sivasankar, "Bioseparation".

COURSE OUTCOMES

CLPE14
MODERN SEPERATION PROCESSES
3
CLPC18
PE

FIVES

lication of the science and engineering science that you have learned to the separation

on work, and to further develop your ability to apply basic principles to the

ion processes separation techniques based on size, surface
ner special characteristics of substances.

choice of adsorbents, chromatographic techniques, types,
pment and commercial processes, Recent advances.

nd choice of membranes, Membrane reactors, commercial
concepts- Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration ,Micro
vaporation.

of electro dialysis, Ion- exchange, electrophoresis, equipments,

ng, adductive crystallization, Supercritical fluid extraction,
Modern Techniques

ical Engineering Separation Techniques", Inter Science Publications, New York,

Science and Technology" ' Marcel Dekkar, 1992

ns – Principles and Techniques", Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

On completion of the course, the students will be able to

CO1	select appropriate separation technique for solving the industrial problems
CO2	understand the design and troubleshooting the controlling factors for modern separations,
CO3	design separation system for solids, liquids and gases for effective solution of intended problem.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To provide a general idea about
2. To imbibe in students a culture of

COURSE CONTENT

Introduction: Role of chemical engineering
Radiation hazards and control of exposure

Psychology, hygiene & other industrial
lighting and ventilation, Industrial
prevention methods, Personal protection
Instrumentation and control for safe
Hazard Analysis – Steps in risk management

Case studies pertaining to chemical
other cases; Economics of safety – I
Process safety and process safety
environment in India- The Factories
Employee State Insurance Act.

REFERENCE BOOKS

1. *Sam Mannan, Frank P. Lees, 'Assessment and Control', 4th Edition*
2. *H.H. Fawcett and W. S. Wood, '1982.*
3. *Guide for Safety in the Chemical Association. Van Nostrand Reinhold*
4. *Industrial Safety and Laws, 199.*
5. *Daniel A. Crowl and Joseph Edition, Prentice Hall, Inc. ISBN 0-*

CLPE15
SAFETY IN CHEMICAL PROCESS INDUSTRIES
3
CLPC17
PE

IVES

safety in chemical industries.
of safer practices.

neer in process industries; Industrial Hazards –.Fire hazards and it's prevention,
posure to radiation, Mechanical hazards, Electrical hazards, Construction hazards.

ustrial hazards: Industrial psychology, Industrial hygiene, Housekeeping, Industrial
l noise, Occupational diseases and
ctive equipments; Site selection and plant layout,
: operation: Pressure, Temperature and Level controllers; Risk Management and
agement, Risk analysis using HAZOP, FTA etc.

industries: Bhopal gas tragedy, causes, affects & lessons learnt,
Financial costs to individual, family, organization and society.

management, Legal framework for industrial safety and
: Act, The Environmental (Protection) Act, The Workmen's compensation Act, The

*“Lees' Loss Prevention in the Process Industries: Hazard Identification,
on, Butterworth-Heinemann, 2005.*

“Safety and Accident Prevention in Chemical Operation”, 2nd Ed, Wiley Interscience,

*al laboratory Second edition 1977, Manufacturing Chemists
d Company, New York.*

3, by Indian School of Labour Education, Madras.

*F. Louvar, “Chemical Process Safety, Fundamentals with Applications”, 2nd
13-018176-5.*

COURSE OUTCOMES

On completion of the course, the students are expected to be with familiar with

CO1	hazards in chemical industries and their mitigation
CO2	safety aspects in plan site selection, design & layout and psychological approach to process safety
CO3	occupational diseases and their prevention, process control for process safety, process safety and PSM
CO4	case studies of industrial disasters, risk management methodologies
CO5	legislations for safety in chemical industries & environmental protection, economics of providing safety

Mapping of Course Outcomes with Programme Outcomes

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

PO12
✓
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To impart the basic concept of material science.
2. To understand the various properties, characteristics and uses of materials.
3. To understand the engineering requirements of materials.

COURSE CONTENT

Atomic Bonding: Classes of engineering materials - Crystal structure of atoms and molecules - Bonding in solids.

Structure and Imperfections in Crystals: Crystal structures. Imperfection in crystals - types of dislocations, Fick's law, Applications of diffusion.

Properties and Corrosion of Material: Mechanical properties - Deformation of materials - Heat Treatment and corrosion.

Metals: Engineering materials - ferrous and non-ferrous metals and alloys - Aluminium, copper and their alloys with reference to the applications.

Non Metals: Inorganic materials: Ceramics, Composites and wood - Advanced materials (Biomaterials) and their applications in chemical Industries.

CLPE16
MATERIAL SCIENCE AND TECHNOLOGY
3
NONE
PE

Material science.

corrosion and heat treatment of engineering materials

selection and selection of materials based on the properties for various applications.

Engineering materials - engineering requirement of materials - selection of materials - bonding in solids - types of bonds and comparison of bonds.

Crystal structure Crystal geometry, structure of solids, methods of determining types of imperfection. Point imperfection, diffusion in solids - self diffusion

Mechanical, Electrical and magnetic properties of materials

Protective techniques - corrosion, theories of corrosion - control and prevention of

Metals - Iron and their alloys Iron and steel Iron carbon equilibrium diagram. Non-ferrous metals: Copper, Zinc, lead, Nickel and Alloys of these metals in chemical industries.

Polymers, Glass and refractories - organic materials: wood, plastics, and rubber (including composites, nanomaterials and composites) with special reference to the applications

REFERENCE BOOKS

1. Lawrence H. Van Vlack, "Elements of Material Science and Engineering", 1971.
2. S.K. Hajra Choudhury, "Material Science and processes", 1st Edn., 1977. Indian Bo Calcutta.
3. William D. Callister, "Materials Science and Engineering", 7th edn, John Wiley & Sons, In
4. V. Raghavan, Materials Science and Engineering, Prentice Hall.

COURSE OUTCOMES

After completion of the course, the students can

CO1	understand the basics knowledge such as internal structure, crystal geometry, crystal imperfection of the engineering materials
CO2	understand the various properties and corrosion behavior of the selected materials in chemical industries
CO3	provide experience in the metallic and nonmetallic material selection and handling material in chemical engineering in the areas of equipment design

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓			✓	✓				✓	✓	
CO2				✓					✓	✓	✓
CO3	✓		✓	✓	✓			✓	✓	✓	✓

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ic.

PO12
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

1. To impart the basic concepts of b
2. To develop understanding about a

COURSE CONTENT

Rates and Patterns of Changes in cellular cultures. Stoichiometry of g Physical Parameters in Bioreactor Bioprocesses. Product recovery ope Sensors, Monitoring and control sys

Biochemical Reaction Engineering and stability, non-ideal mixing, bio reactors. Fermentation Technology and R

REFERENCE BOOKS

1. *J. E. Bailey and D. F. Ollis, "Bio*
2. *M. D. Trevan, S. Boffly, K.H. New Delhi 1987.*
3. *R.Lovitt and M.Jones, "Biochemi F. Richardson and Peacock, Pergar.*

CLPE17
Industrial Process Biotechnology
3
NONE
PC

IVES

bioprocesses

application of engineering principles in bioprocesses.

1 cell cultures: Kinetics of substrate utilization, biomass and product formation in growth and product formation

5 and Downstream Separations: Transport phenomena and modelling in separations.

6 systems in Bioprocesses: Instrumentation and process control in Bioprocesses.

7 and Bioreactor design: Design and analysis of Bioreactors. Dynamic models residence time. Sterilisation reactors. Immobilised bio-catalysts and multiphase

8-DNA Technology: Bio-process Technology and Genetic Engineering.

chemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York, 1986.

Golding and P. Stanbury, "Biotechnology", Tata McGraw Publishing Company,

ical Reaction Engineering" in Chemical Engineering, Vol. III, 3rd Edn., Edited by J. non, London, 1994.

COURSE OUTCOMES

On completion of the course, the students can

CO1	analyze the kinetics of cell growth and product formation from biomass.
CO2	model bioprocesses and design downstream processes involved in product recovery.
CO3	identify instruments and model control systems involved in bioprocesses.
CO4	design and analyze bioreactors.
CO5	identify and familiarize with advanced technologies in bioprocesses

Mapping of Course Outcomes with Programme Outcomes

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

PO12
√
√
√
√
√

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To introduce students to the con
2. To introduce the students to dev
3. To impart knowledge on Heat at
4. To impart knowledgeable on the

COURSE CONTENT

Introduction and applications: Intro
of fluidised beds - Physical operatio
Carbonisation, Gas-solid reactions
clinkering

Gross behaviour of Fluidised beds
beds. Types of fluidisation. Design
height, viscosity and fluidity of flu
consumption

Analysis of bubble and emulsion Ph
model for bubble phase. Emulsion p
emulsion phase. Interchange co-effi

Flow pattern of Gas and heat &
Experimental findings. The bubblin
Transfer between fluid and solid: E
bubbling bed model

Heat transfer between Fluidised b
beds and surfaces: Experiment find
TDH, model for Entrainment and
entrainment model to elutriation

REFERENCE BOOKS

CLPE18
FLUIDIZATION ENGINEERING
3
CLPC13, CLPC17
PE

IVES

cepts and applications of fluidized bed systems
 elopment of models for fluidized bed systems
 nd mass transfer in fluidized bed systems
 e importance on Entrainment and elutriation in fluidized bed systems

duction to fluidised bed systems. Fundamentals of fluidisation. Industrial applications
 ns. Synthesis reactions, cracking and reforming of hydrocarbons, Gasification,
 , calcining and

ss: Gross behaviour of fluidised beds. Minimum and terminal velocities in fluidised
 of distributors. Voidage in fluidised beds. TDH, variation in size distribution with
 idised beds, Power

ase: Davidson's model, Frequency measurements, bubbles in ordinary bubbling bed
 phase: Experimental findings. Turn over rate of solids. Bubbling bed model for
 cients

mass transfer in Fluidised beds: Flow pattern of gas through fluidised beds.
 g bed models for gas inter change Interpretation of Gas mixing data. Heat and Mass
 xperiment findings on Heat and Mass Transfer. Heat and mass transfer rates from

beds and surfaces - Entrainment & Elutriation: Heat transfer between fluidised
 ing theories of bed heat transfer comparison of theories. Entrainment of or above
 . application of the

1. D. Kunii and O. Levenspiel, "Fluidisation Engineering", 2nd Edn., Butterworth Heinemann,

COURSE OUTCOMES

On completion of the course, the student can

CO1	analyze and apply fluidized bed systems for Industrial applications
CO2	analyze the fluidized bed systems and apply models to predict the bubble behaviors
CO3	analyze and estimate heat and mass transfer in fluidised beds
CO4	analyse eentrainments and elutriation in fluidized bed systems and value its importance in the design of fluidized bed columns.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓	✓	✓
CO2	✓	✓	✓		✓			✓	✓	✓	✓
CO3	✓	✓	✓		✓			✓	✓	✓	✓
CO4	✓	✓	✓		✓			✓	✓	✓	✓

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PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To provide the basic knowledge
2. To provide the basic knowledge substances.
3. To understand the properties and inorganic sources and their appl

COURSE CONTENT

Introduction to Physical pharma of matter, solutions, Phase equilil Dispersion systems

Diffusion and dissolution, kinetics a applications.

Formulations and development, P: Phenomena (Fluid Flow, Heat Trans

Particulate Technology (Particle S Operations (Mixing, Evaporation, Distillation, and Drying)

Materials of Pharmaceutical Pla Guidelines

CLPE19
PHARMACEUTICAL TECHNOLOGY
3
NONE
PE

IVES

on functional group identification, chemical bonding with their mechanism of principles involved in the identification and estimation of Pharmaceutical

d principles of medicinal agents that originates from organic lication in pharmaceutical industry.

ceutics: Metrology and calculations, Molecular structure, properties and states bra, Micromeritic and powder rheology, Surface and interfacial phenomena,

nd drug stability, Viscosity and rheology, Polymer science and

ackaging, Introduction to industrial processing, Transport sfer and Mass Transfer)

ize, Size reduction, Size Separation, Powder Flow and Compaction), Unit Filtration, Centrifugation, Extraction,

nt Construction, Good Manufacturing Practice (GMP's)

REFERENCE BOOKS

1. Alfred N. Martin, "Physical Chemical and Biopharmaceutical Principles in Sciences", 6th Edn., Lippincott Williams & Wilkins, 2006.
2. David B. Troy, Paul Beringer, "Remington: The Science and Practice of Pharmacy", 21st E Williams & Wilkins.
3. Sidney James Carter, "Cooper and Gunn's Tutorial Pharmacy", CBS Publishers Distributors, 1986.

COURSE OUTCOMES

After completion of the course, the students can

CO1	acquire basic knowledge of preformulation and formulation of drugs, pharmaceutical unit operations and manufacturing, packaging and quality control of pharmaceutical dosage f
CO2	acquire a knowledge on pharmaceutical unit operations and manufacturing, packaging and quality control of pharmaceutical dosage forms.
CO3	trained to conceptualize, design, build up, maintain and operate various industrial processes and machineries involved in the process.
CO4	understand and apply the various processing and manufacturing techniques.
CO5	formulate a pure drug substance into a dosage form.

Mapping of Course Outcomes with Programme Outcomes

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

the Pharmaceutical

Edn., Lippincott

&

forms.

PO12
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Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

To understand the scientific background of process industries

COURSE CONTENT

Introduction: Theory of Process Intensification, Benefits from process intensification

Process Intensification through micro operations and reactions, Design of reaction and unit operation devices

Scales of mixing, Flow patterns in intensified equipment, Atomizer, Reactor stirrer mixers, Applications of static mixers, Applications of static reactors.

Combined chemical reactor heat exchangers, Reactive distillation, Reactive Extraction, Compact heat exchangers: Classification, Flow pattern, Heat transfer exchangers, Phase-change heat transfer exchanger and design technology, Membrane reactors.

Enhanced fields: Energy based intensification, Electrolytic Cell, Electrostatic fields, Electromagnetic fields, Microfluidics.

CLPE20
PROCESS INTENSIFICATION
3
CLPC16, CLPC18, CLPC21
PE

IVES

round, techniques and applications of intensification in the

intensification, Process Intensification (PI) Applications, Main
on, Process-Intensifying equipment

micro reaction technology: Effect of miniaturization on unit
rules, Implementation of Micro-reaction Technology, Micro- fabrication of
;- Wet and Dry Etching processes.

reactors, Mixing in stirred tanks: Scale up of mixing, Heat transfer. Mixing in
Nebulizers, Static mixers, design of mixers, Ejectors, Tee mixers, Impinging jets, Rotor
c mixers, Higee

exchangers and reactor separators: Principles of operation; Reactive absorption,
reaction - Case Studies.

ification of compact heat exchangers, Plate heat exchangers, Spiral heat
transfer and pressure drop, Flat tube-and-fin heat exchangers, Micro channel heat
transfer, Selection of heat

Integrated heat exchangers in separation processes.

ensifications, Sono-chemistry, Basics of cavitation, Cavitation reactors, The Rotating
lds, Sonocrystallization, Supercritical

REFERENCE BOOKS

1. Stankiewicz, A. and Moulijn, (Eds.), *Reengineering the Chemical Process Plants, Process In Dekker, 2003.*
2. Reay D., Ramshaw C., Harvey A., *Process Intensification, Butterworth Heinemann, 2008.*

COURSE OUTCOMES

On completion of the course, the student can

CO1	apply process intensification in industrial processes.
CO2	implement methodologies for process intensification.
CO3	understand scale up issues in the chemical processes.
CO4	identify and solve process challenges using intensification technologies.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓							✓			
CO2	✓	✓		✓							✓
CO3	✓	✓	✓								
CO4	✓		✓		✓	✓			✓		

tensification, Marcel

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

To familiarize in the aspects of systems model

COURSE CONTENT

Electrolytic processes; current-voltage balance, and efficiency in electrolysis occurring electrodes; The estimation of Tafel coefficients under enhanced conditions

Electrolytic reactors: plug flow under constant mass flux conditions; General view of simple CSTR; CSTR analysis of semi-continuous combined with electrolyte recycling.

General aspects of thermal behavior; estimation of heat losses; the thermal reactors.

General notions on optimization; IBL formula – optimization of a process – The Beck formula.

REFERENCE BOOKS

1. Scott K, "Electrochemical Engineering"
2. Goodridge F, Scott K, "Electrochemical Engineering"
3. T.Z.Fahidy, "Principles of Electrochemistry"
4. D.J. Pickett, "Electrochemical Engineering"

COURSE OUTCOME

On completion of the course

CLPE21
ELECTROCHEMICAL REACTION ENGINEERING
3
CLPC18, CLPC21
PE

CTIVES

current-voltage relationships & estimation of mass transfer coefficient, PFR & CSTR

voltage relationships in electrolytic reactors; the limiting current plateau; mass & energy
 ochemical reactors; The estimation of mass transport coefficients at commonly
 mation of mass transport
 vection conditions.

model of electrochemical reactors employing parallel plate reactor; Plug flow model
 ions; PFM analysis with electrolyte recycling PFM and real electrochemical reactors.
 ER systems; CSTER in cascades; CSTER analysis of batch electrochemical reactors,
 uous electrochemical reactors. CSTER analysis of electrolyte recycling; Batch reactor

aviour in electrochemical reactor; Thermal behaviour under CSTER conditions; The
 ermal behaviour under PFR conditions; Thermal behaviour of batch electrochemical

1 of electrochemical reactor –elementary process optimization –
 of electro refining process – Jaskula formula – optimization of a general electrolytic

Reaction Engineering”, Plenum Press, New York, 1991.

ctrochemical Process Engineering”, Plenum Press, New York, 1995.

Electrochemical Reactor Analysis”, Elsevier, 1985

ical Reactor Designs”, Elsevier Scientific Publishing Company, New York, 1979.

IS

course, the student can

CO1	understand kinetics of single and multiple electrochemical reaction
CO2	understand mass transport process in the electrochemical system
CO3	design of electrochemical reactors.
CO4	analyze electrochemical design models, thermal behaviour of reactors electrochemical reactors

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PC
CO1		√	√									
CO2	√	√	√	√				√			√	√
CO3		√	√	√	√			√			√	√
CO4		√	√	√	√			√			√	√

and

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Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

The course is aimed to introduce students to the basic concepts and principles of food processing technology.

COURSE CONTENT

Review of mathematics prior to food processing: Dehydration, Blending, and packaging of saturated and super-heated fluids. Transportation of fluids.

Heat Transfer: Mechanism, process calculations, Aseptic processing.

Physical separation process: mass diffusion, psychrometric charts.

Food Canning Technology: metal, glass and flexible packaging.

Emerging Food process Technologies: High pressure processing, electric –Field processing,

CLPE22
FOOD PROCESSING TECHNOLOGY
3
NONE
PE

OBJECTIVES

impart knowledge of various areas related to Food processing and

principles and applications in food process engineering. Material balances: Dilution, and Multistage process. Gases and vapors, Energy Balances: Enthalpy changes. Properties of saturated steam. Fluid flow: Rheology, Continuous viscosity monitoring and control,

Temperature measuring devices, Steady state and unsteady state heat transfer. Thermal processing, Refrigeration, Evaporation, Improving the economy of evaporators.

: Filtration, sieving, gravity separation. Mass transfer: Leaching, Super critical extraction, Diffusion, Simultaneous heat and mass transfer, Drying: Spray. Freeze, Vacuum belt drier.

Fundamentals of food canning technology, Heat sterilization of canned food, containers-canning, Canning procedures for fruits, vegetables, meats, poultry and marine products

echnology: Microwave and Radio frequency heating, High pressure processing, Pulse electric field, Advanced membrane separation, Food nano- biotechnology.

REFERENCE BOOKS

1. Romeo T.Toledo,Rakesh K.Singh and Fanbin Kong, "Fundamental of Food Process Engineering",Springer,2018
2. Susanta Kumar Das and Madhu Sweta Das," Fundamental and operations in Food Process Engineering Press,2019.
3. J.M. Jackson & B.M. Shinn, "Fundamentals of Food Canning Technology", AVIPublishing Co New York, 1978

COURSE OUTCOMES

On completion of the course, the students will be familiar with

CO1	application of biotechnology in food industry.
CO2	appropriate processing, preservation, and packaging methods.
CO3	the aspects of food safety.
CO4	opportunities for higher studies in food science, chemical engineering, biotechnology, and allied fields.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		✓	✓	✓				✓	✓	✓	
CO2	✓	✓	✓	✓			✓	✓			✓
CO3		✓	✓	✓		✓	✓	✓	✓		
CO4		✓	✓	✓		✓	✓	✓	✓		

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Engineering, CRC

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PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To impart knowledge on the b
2. To illustrate the fuels and cher
3. To inculcate knowledge on the

COURSE CONTENT

Introduction: Vision of Bioenergy a
Pretreatment techniques, Processes

Lignocellulosic Biorefinery: Classif
Bioethanol, ABE fermentation, The

Platform Chemicals from bioref
the production, detailed discussion c

Biodiesel technology: Feed Stock
production, biodiesel quality assess

Waste biorefinery: Thermochemic
hydrogen production, biogas produc

REFERENCE BOOKS

1. *Hongzhang Chen, "Lignocellul*
2. *Thallada Bhaskar et al "Waste*

CLPE23
BIOREFINERY ENGINEERING
3
NONE
PE

IVES

biomass resources available and its importance
chemicals production methods from biomass.
= conversion of waste into wealth.

and Biochemicals, Biorefinery concept, Feedstock preparation and characterization,
s, Biorefinery products, Evaluation of Biorefinery performances

ification of Sources, Unit operations and processes involving in LCB biorefinery,
chemochemical conversion of lignocellulosic biomass

inery: Introduction to Platform chemicals, Chemical and biological routes for
on production of HMF, Succinic acid, Levulinic acid, and Propylene glycol.

preparation and characterization, enzymatic and catalytic
ment, storage

al conversion of waste biomass, pyrolysis, gasification, bio
:t

Case Biorefinery Engineering” Elsevier (2015)

Biorefinery” Elsevier (2018)

COURSE OUTCOMES

On completion of the course, the student can

CO1	understand the feed stock preparation and characterization of biofuels.
CO2	learn techniques and methods used in Biorefinery.
CO3	understand the concept of platform chemicals and their importance.
CO4	acquire knowledge on converting waste to biofuels.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓		✓	✓	✓	

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To impart basic knowledge on i
2. To impart knowledge on differe
3. To enable the students to design

COURSE CONTENT

Introduction to Physical/Chemical contaminants, overview of method Organic Material (NOM), Particle C

Coagulation: particle destabilizati

Flocculation and Mixing: basics, the sedimentation basins, Design of sed

Depth Filtration: history, hydraulics pathogens, disinfectants, inactivatio

Chemical Oxidation: oxidants, adva activated carbon, Ion Exchange

Air stripping, Membrane Processes: forward osmosis, fouling, removal c

REFERENCE BOOKS

1. *MWH's Water Treatment: Princ*
2. *Water Quality and Treatment, 5 (1999).*
3. *Kawamura, Susumu. Integrated Edn., John Wiley and Sons, Inc., 200*

CLPE24
Water Treatment Technology
3
NONE
PE

IVES:

importance of water treatment and quality aspects.
 unit processes and unit operations involved in water treatment.
 water treatment system

Water Treatment Processes: Objectives of water treatment, water sources, water
 used to treat water, Water Treatment Regulations, Particles in Water, Natural
 Charge (Double Layer and DLVO Theory) and Particle Size Distributions

ion, hydrolyzing metals, polymers, mechanisms, jar tests, enhanced coagulation,
 theory, practice, Sedimentation: discrete particle behavior, flocculent settling,
 sedimentation basins.

ion, particle capture Mechanisms, types of filter, Disinfection:
 reaction kinetics, disinfection by-products

Advanced oxidation processes, Adsorption: equilibrium, kinetics,

microfiltration, ultrafiltration, nanofiltration, reverse osmosis,
 removal of selected constituents

Principles and Design, 3rd edition, John Wiley (2012).
10th edition, R. Letterman, Editor American Water Works Association, Denver, CO

Design and Operation of Water Treatment Facilities, 2nd
10.

COURSE OUTCOMES

On completion of this course the students would have

CO1	required essential knowledge for the selection of water treatment processes.
CO2	knowledge on assessing the water quality.
CO3	the ability to design water treatment plant.

Mapping of course outcomes with programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓		✓	✓	✓			✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓			✓	✓		✓
CO3	✓	✓	✓	✓	✓			✓			✓

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To impart the basic concepts of
2. To develop understanding about

COURSE CONTENT

Introduction to Bioscience: Types o
microbial growth, batch and contin
Measurement.

Functioning of Cells and Fundam
metabolism, EMP pathway, tricarl
pathways. Synthesis and regulatio
fundamentals of microbial genetics,

Enzyme kinetics: Simple enzyme
Other influences on enzyme activity
particle systems. Industrial applicati
Cell kinetics and fermenter design:
Multiple fermenters connected in se

Introduction to Bioreactor design: C
Determination of volumetric mass t
on oxygen transfer rate, heat transfe
processing and product recovery in
bioprocesses.

CLPE25
BIOCHEMICAL ENGINEERING
3
NONE
PE

YES

biochemical engineering

: biochemistry and bioprocesses

f Microorganisms: Structure and function of microbial cells. Fundamentals of
ous culture. Isolation and purification of Enzymes from cells. Cell Growth

ental Molecular Biology: Metabolism and bio-energetics, Photosynthesis, carbon
bocyclic cycle and electron transport chain, aerobic and anaerobic metabolic
n of biomolecules,
role of RNA and DNA.

kinetics, Enzyme reactor with simple kinetics. Inhibition of enzyme reactions.

7. Immobilization of enzymes. Effect of mass transfer in immobilised enzyme
ions of enzymes.

: Growth cycle for batch cultivation, Stirred-tank fermenter,
ries. Cell recycling. Structured Model.

Continuously Stirred aerated tank bioreactors. Mixing power correlation.

ransfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration
r and power consumption. Multiphase bioreactors and their applications. Downstream

REFERENCE BOOKS

1. J. E. Bailey and D. F. Ollis. "Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York, 1986.
2. Trevan, Boffey, Goulding and Stanbury, "Biotechnology", Tata McGraw Hill Publishing Co., New Delhi, 1990.
3. H. W. Blanch and D. S. Clark, "Biochemical Engineering", Marcel Dekker, Inc., New York, 1990.
4. M. L. Shuler and F. Kargi, "Bio Process Engineering: Basic concepts", 2nd Edn., Prentice Hall of India, New Delhi, 2002.

COURSE OUTCOMES

On completion of the course, the students can

CO1	enhance knowledge in the aspects of cell structure and its functions
CO2	identify the importance of biomolecules in metabolic processes.
CO3	analyze the kinetics of enzymatic reactions and their inhibitions.
CO4	evaluate and model the cell growth kinetics in a bioreactor.
CO5	design a bioprocess with various unit operations involved in it.

Mapping of Course Outcomes with Programme Outcomes

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

Hill, New York,

New Delhi, 1987.

1996.

1

PO12
✓
✓
✓

Course Code	: CLPE26
Course Title	: Air Pollution Control Engineering
Number of Credits	: 3
Prerequisites	: NONE
Course Type	: PE

COURSE OBJECTIVES :

To understand the air pollutants, measurement techniques, control methods.

COURSE CONTENT:

Emission sources, types of air pollutants, effects of air pollutants on human, materials and plants] pollution control acts.

Air pollution measurements, emission estimates: sample collection, standard analytical methods, metrology for air pollution control engineers.

Air pollutant concentration models: Fixed box and Diffusion models

Particulate Emission Control: Nature of Particulate pollutants, Control of primary particulates: Control of VOCs. Control of sulphur and nitrogen oxides. Air pollutants effect on global climate

Reference Books

1. *Nevers, Noel de, "Air Pollution Control Engineering", McGraw-Hill, Inc*
2. *AP Sincero and GA Sincero "Environmental Engineering", Prentice Hall of India, (2015)*
3. *CS Rao "Environmental Pollution Control Engineering" Wiley Eastern Ltd (2006)*
4. *H Brauer and YBG Verma, "Air Pollution Control Equipment", Springer-Verlag Berlin Heid Delhi, 1996*

COURSE OUTCOMES

On completion of this course the students would have

CO1	The knowledge on different air pollutants and their impacts.
CO2	The ability to select the treatment mechanisms for various air pollutants.
CO3	The knowledge on the design of various equipments used for air pollution control.

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓			✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓			✓	✓		✓
CO3	✓	✓	✓	✓	✓			✓			✓

Introduction to air

s,

elberg, NY, New

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE OBJECTIVES:

To understand the sources of wastewater
 To learn the treatment methods and

COURSE CONTENT:

Introduction: Characterisation and techniques;

Physico-Chemical Treatment Methods
 floatation.

Biological Treatment Fundamentals
 denitrification and phosphorus r

Aerated lagoon, activated sludge systems
 bioreactors.

Advanced Treatment Processes: Advanced
 oxidation; Membrane processes, W

Reference books

1. Tchobanoglous G., Burton F.I and Reuse”, Tata McGraw-Hill (20
2. Arceivala S.J. and Asolekar S McGraw Hill (2009)
3. Sincero A.P. and Sincero G., Prentice-Hall (2006)

COURSE OUTCOMES

On completion of this course the student

CLPE27
Industrial Wastewater Treatment
3
NONE
PE

water,
equipments

monitoring of industrial waste water, recycling and reuse. Selection of treatment

methods: sedimentation, coagulation, flocculation, thickening,

processes: Microbial metabolism, bacterial growth kinetics; Biological nitrification, phosphorus removal; Anaerobic fermentation and aerobic treatment.

reactors: trickling filter, sequential batch reactor, fluidized bed

advanced oxidation systems – Fenton process, electrochemical oxidation, sono-chemical oxidation, ozonation, Adsorption and ion- exchange, Sludge treatment.

1., Stensel H.D., “Metcalf and Eddy Inc.-Waste Water Engineering Treatment (3rd Ed.)”

2., “Wastewater Treatment for Pollution Control and Reuse”, 3rdEd., Tata

3., “Environmental Engineering –A Design Approach”,

identifications can

CO1	have the essential knowledge on different water pollutants.
CO2	acquire knowledge on different industrial water treatment methodologies.
CO3	have an exposure to advanced treatment processes

Mapping of course outcomes with programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓			✓	✓	✓		✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓			✓	✓		✓
CO3	✓	✓	✓	✓	✓			✓			✓

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

To understand working principles, t

COURSE CONTENTS:

Basic concepts – Components of ce.
 Specifications – Free energy, theore
 cycle life, shelf life, state of charge (

Electrochemical principles and reac
 Electrode processes and Tafel pol
 batteries – Zn/C, Zn/air, alkaline cel
 batteries (Components, Chemistry a
 Performance characteristics). Applic

Fuel Cells: Basic principle, anodi
 temperature effect. Types of Fuel C
 oxide, molten carbonate, direct metl
 PEM Fuel Cell components: Anode
 - Rate of mass transfer of reactants ;

Fuels for Fuel Cells: Hydrogen, 1
 processes for hydrogen – clean up a
 cell outlook, Applications of fuel ce

CLPE28
Fuel Cells and Batteries
3
NONE
PE

IVES:

types and design of primary and secondary batteries and fuel cells

cells and batteries, Classification of cells and batteries, Operation of a cell, theoretical cell voltage, specific capacity, specific energy, energy density, memory effect, (SOC) and depth of discharge (DOD), internal resistance and coulombic efficiency.

phenomena – electrical double layer, discharge characteristics of cell and polarization, polarization, thermodynamic background and Nernst equation. Primary and secondary cells, lithium primary batteries, lead-acid, Ni/Cd, Ni/MH and Lithium secondary and applications of storage batteries.

anode and cathodic reaction, Nernst equation and open circuit potential, pressure and cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid methanol fuel cells.

anode and Cathode materials, catalysts, membrane, PEM Flow field design, Fuel Cell Stack and products - water management, Heat removal from the stack.

hydrogen, methane, methanol - Sources and preparation, reformation and storage of the fuels, advantages and disadvantages of using hydrogen as fuel. Fuel cells – Industrial and commercial.

REFERENCE BOOKS

1. *Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by David Linden and Thomas. B. ... Book Company, N.Y. 2002.*
2. *Modern Electrochemistry 2A, Fundamentals of Electrodeics, 2nd Edition, John O'M Bockris, ... and Maria Gamboa-Aldeco, Kluwer Academic Publishers, Newyork.*
3. *Fuel Cells, Principles and Applications, Viswanathan, B. and Scibioh, Aulice M, Universities*
4. *F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).*

COURSE OUTCOMES

After studying this course, the students will able to

CO1	know the basics and working principles of the batteries and Fuel cells
CO2	understand the various types and applications of primary and secondary batteries,
CO3	select suitable materials for electrode, catalyst and membrane for fuel cells
CO4	design stacks, fuels and reformation of fuels for fuel cells

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	√	√	√	√	√	√	√			√	√
CO2	√	√		√	√						√
CO3		√	√	√	√	√					√
CO4		√	√			√	√	√		√	√

Reddy, McGraw Hill

Amulya K. N. Reddy

Press, 2006.

PO12
√
√
√
√

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To understand the catalyst phy
2. To understand the kinetics of c reactor design.
3. To understand the operation at

COURSE CONTENT

Analysis of Non-catalytic fluid solid various models, application to desig

Catalyst preparation and characteriz affecting the choice of catalysts, prc characterization of catalysts, surface method, pore size distribution, catal

Physical adsorption and chemical ac application to design. Physical abso consecutive reversible reactions b irreversible reactions, estimation of

Reaction kinetics, accounting por internal and external transport proce stability analysis.

Modeling of chemical reactors: Mo and slurry reactors.

REFERENCE BOOKS

CLPE29
Heterogeneous Chemical Reaction Engineering
3
CLPC21
PE

IVES

Physical characterisation of surface area, pore volume, and pore size.
 Catalytic chemical reaction and reactor design and non-catalytic chemical reaction and
 and troubleshooting of heterogeneous reactors.

Fluid reaction: Kinetics of non-catalytic fluid-particle reactions,
 and

Catalysis: Catalysis - Nature of catalyses, methods of evaluation of catalysis, factors
 promoters, inhibitors, and supports, catalyst specifications, preparation and
 surface area measurement by BET
 Catalyst, poison, mechanism and kinetics of catalyst, deactivation.

Absorption: Fluid-fluid reactions different regimes, identification reaction regime,
 absorption with chemical reaction, simultaneous absorption of two reacting cases
 between gas and liquid,
 effective interfacial area in absorption equipment.

Steady state nature of catalyst: Heterogeneous catalytic reactions - effectiveness factor,
 processes, non-isothermal reacting systems, uniqueness and multiplicity of steady states,

Design of multiphase reactors - Fixed, fluidized, trickle bed,

၁၉.

India Ltd., 2008.
1976.

ey, New York, 1990.

PO11
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To impart the basic concepts of
2. To understand the problems of p
3. To understand the control methc

COURSE CONTENT

Environment, Environmental quality
Pollutants, Air quality standards
height-plume rise estimation – efflu
human health, on animals.

Measurements of air pollution, Equi

Sources and types of industrial w
environmental impacts. Regulatory
Treatment methods: Equalization
anaerobic biological treatment, Cl
Exchange – Membrane
Technologies

Solid Waste Management: Type o
techniques for collection system.
user for separation and processing, l
systems – e waste - sources, collecti
and reuse management. Hazardous v

Sources of noise pollution. Noise pc
noise pollution. Effects on human b

Historical development of Environn
in India. – Types and limitations of
EIA. EIA process- screening – scop
EIA. Prediction tools for
EIA – Mathematical modeling for ir

REFERENCE BOOKS

CLOE11
ENVIRONMENTAL ENGINEERING
3
NONE
OE

YES

environmental engineering
 pollution and its treatment methodology.
 methodologies of pollutants and uses Environmental Impact Assessment (EIA)

and degradation, Industrial scenario in India. Sources and classification of Air
 : – Meteorology and Air Pollution: Atmospheric stability and inversions-mixing
 ent dispersion theories effects of air pollution on the environment, on materials, on
 ipments for control of air pollution.

Wastewater – Nature and Origin of Pollutants - Industrial wastewater and
 requirements for treatment of industrial wastewater. Industrial Wastewater
 - Neutralization – Oil separation – Flotation – Precipitation, Aerobic and
 chemical oxidation – Ozonation – carbon adsorption -Photo catalysis, Ion

of waste collection systems, analysis of collection system – alternative
 Separation and Processing and Transformation of Solid Waste: unit operations
 Landfills: Site selection, design and operation, drainage and leachate collection
 on, treatment
 waste treatment technologies

pollution standards and measurements - controlling methods of
 eing.

Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects
 EIA – Cross sectoral issues and terms of reference in EIA – Public Participation in
 ing - setting – analysis – mitigation, Software packages for EIA – Expert systems in

Impact prediction

1. M.N. Rao, "Air Pollution", Tata McGraw Hill, 1989.
2. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New York, 1979.
3. George Tchobanoglous et al, "Integrated Solid Waste Management", McGraw-Hill, New York, 1993.
4. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
5. C. S. Rao, "Environmental Pollution Control Engineering", New Age International Pvt. Ltd., New Delhi, 1998.
6. Richard W. Boubel et al "Fundamentals of Air pollution", Academic Press, New York, 1994

COURSE OUTCOMES

On completion of the course, the student can

CO1	understand the sources and effects of pollutants to the environment
CO2	understand the various treatment technologies for wastewater, air effluents, solid waste, noise pollution released from Process industries
CO3	understand the development and applications of various unit operation to control the toxic elements
CO4	understand the Limitation and Importance of Environmental Impact Assessment (EIA)

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO4	✓		✓	✓	✓	✓		✓	✓	✓	

Delhi, 2003.
Publication, 1993.

2003.

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES:

1. To understand the concepts and applications of optimization
2. To get a broad picture of the various optimization techniques
3. Optimize the different methods in various applications

COURSE CONTENT:

Linear algebra and matrices, Introduction to Linear Programming, Simplex method

Unconstrained Minimization: One Dimensional Search Methods: Newton's method

Constrained Optimization: Lagrange Multiplier Method

Non-linear problems: Non-linear programming methods

REFERENCE BOOKS:

1. *T.F. Edgar and D.M. Himmelberg, "Optimization and Nonlinear Programming", Wiley, 1985.*
2. *S.S.Rao, "Engineering Optimization: Theory and Practice", Wiley, India.*
3. *K. Deb, "Optimization Techniques for Design Engineers", Wiley, India.*

CLOE12
OPTIMIZATION TECHNIQUES
3
NONE
OE

YES

origin of the different optimization methods.

ous applications of optimization methods

1 industry for design and production of products, both economically and efficiently.

ction to optimization, Classification of optimization problems,

od, Transportation Problems

dimensional search methods: Exhaustive search method, Fibonacci method etc.,
method, Secant method etc., Conjugate direction and quasi-Newton methods

e theorem, FONC, SONC, and SOSC conditions

constrained optimization models, KKT conditions, Projection

ibblau, " Optimization Techniques for Chemical Engineers", McGraw-Hill, New York,

nization Theory and Practice", Third edition, New Age International Publishers,

iques", Wiley Eastern, 1995.

COURSE OUTCOMES

After completion of course, the students can

CO1	apply the knowledge of different optimization methods for an optimum design.
CO2	acquire sufficient knowledge in this subject related to applications, where optimal decisions need to be taken in the presence of trade-offs between two or more conflicting c
CO3	implement the theory and applications of optimization techniques in a comprehensive manner for solving linear and non-linear, constrained and unconstrained programming techniques.
CO4	identify, formulate and solve a practical engineering problem of their interest by applying or modifying an optimization technique.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								
CO2	✓	✓	✓	✓		✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓		✓	✓	✓		✓

objectives

PO12

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To identify different types of fue
2. To appreciate the advantages of

COURSE CONTENT:

Coal - Coal and Coal derived fuels; technology, waste heat recovery.

Oil and Gases- Fuels from oil ar
Technology for combustion of fuels

Renewable Energy - Solar energy ut
Wind, geothermal and hydro energy
nuclear reactors.

Bio Energy, Biomass conversion for
thermochemical and bioconversion,

Cogeneration: cogeneration alternat
Diesel engine, utility cogeneration

REFERENCE BOOKS

1. G.D. Rai, "Non-conventional en
2. Samir Sarkar, "Fuels and Comb
3. D.A. Reay, "Industrial energy
Oxford, UK, 1977.
4. O.P. Gupta, "Fundamentals of l

COURSE OUTCOMES

On completion of the course, the stu

CLOE13
ENERGY ENGINEERING
3
NONE
OE

YES

el sources for energy production.

energy production from renewable energy resources.

Characteristics, production methods and uses. Coal combustion

and gases: Characteristics, production methods and uses.

derived from oil and gas.

utilization, Thermal application and photovoltaic applications;

utilization; Nuclear Energy, Nuclear fission fuels processing, Nuclear reactions and

r fuels, characteristics and uses; production methods based on

design of digesters.

ives, Gas turbine cogeneration, Steam turbine cogeneration,

energy sources," Khanna Publishers, New Delhi, 2011.

ustion", 3rd Edn, University press Publication, 2008.

conservation: a handbook for engineers and managers, Pergamon Press,

Nuclear power reactors", Khanna Publishers, New Delhi, 1983.

idents can

CO1	familiar with energy production from conventional fuels and renewable energy resources.
CO2	familiar with energy conservation through waste heat recovery.
CO3	familiar with the challenges associated with the use of various energy sources.
CO4	familiar with information on renewable energy technologies as a basis for further analysis and evaluation.

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓
CO4	✓	✓	✓		✓			✓	✓		✓

i

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECT

To understand the measurement composition etc.

COURSE CONTENT

Characteristics of Measurement concepts and qualities of measurement thermometer

Pressure measurement: Pressure, Measurement of vacuum, Force Calibration of pressure measuring repair of pressure measuring instru

Temperature measurement: Temperature Expansion temperature, Filled-s optical

Flow Measurement: Methods of flowmeters, Calibration of flowme

Level measurement: Methods of level measurement of interface level, level-recording instruments, indicating

Methods of composition analysis spectroscopy, Mass spectroscopy, c

CLOE14
PROCESS INSTRUMENTATION
3
NONE
OE

IVES

techniques for the process variables such as temperature. Pressure, flow, level,

System -Elements of instruments, static and dynamic characteristics, basic
 ment, basic concepts of response of first order type instruments, mercury in glass

Methods of pressure measurement, Manometers, Elastic pressure transducers,
 e-balance pressure gauges, Electrical pressure transducers, Pressure switches,
 instruments, Maintenance and
 ments, Troubleshooting

perature, Temperature scales, Methods of temperature measurement,
 ystem thermometers, Electrical temperature instruments. Pyrometers: Radiation and

flow measurement, Inferential flow measurement, Quantity flowmeters, Mass
 ters, Selection of flowmeters.

iquid level measurement, Direct methods, level measurement in pressure vessels,
 vel of dry materials. Instruments for Analysis
 and signaling instruments, instrumentation diagram.

: Spectroscopic analysis, Absorption spectroscopy, Emission
 chromatography

REFERENCE BOOKS

1. D. P. Eckman, *Industrial Instrumentation*, Wiley Eastern Ltd., 2004
2. J. P. Bentley, *Principles of Measurement Systems*, Longman
3. G. C. Barney, *Intelligent Instrumentation*, PHI Pvt Ltd.
4. D. Patranabis, *Principles of Industrial Instrumentation*, 2nd Edition, Tata McGraw Hi New Delhi, 1999.
5. William C. Dunn, *Fundamentals of Industrial Instrumentation and Process Control*, 1st Edition, Tata McGraw-Hill Education Private Limited, 2009.

COURSE OUTCOMES

On completion of the course, the student can

CO1	analyze repeatability, precision and accuracy of the instruments
CO2	understand the measurement techniques for pressure
CO3	understand the measurement techniques for temperature
CO4	understand the measurement techniques for flow and Level
CO5	understand the measurement techniques for composition

Mapping of Course Outcomes with Programme Outcomes

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

ill Publishing Company,

st

PO12
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECT

1. To impart the basic concepts of
2. To understand the synthesis and

COURSE CONTENT

Overview of nanoscience: Nanor
Chemistry, Definition and example
processes in organic systems.

Nanomaterials: Metal and Semic
Molecule to bulk transitions, Buck
Methods of synthesis of Nanomete
as bio-chips, power devices, and
down (breakdown of microcrys

Instrumentation for Nanoscale Cha
nanometer scale. The measurable
measurements in the nanometer rai

Applications: Solar energy convers
Polymers with a special architec
Advanced organic materials for
Nanobiotechnology.

REFERENCE BOOKS:

1. *Jonathan Steed and Jerry Atwo*
2. *Joel I. Gersten, "The Physics a*
3. *Hari Singh Nalwa, "Nanostruc*
4. *Guozhong Cao, "Nanostructure*
Press, 2004.
5. *C.Dupas, P.Houdy, M.Lahm*
Heidelberg, 2007
6. *Nanobiotechnology; ed. C.M.N*
ed. Bharat Bhushan.

CLOE15
NANO TECHNOLOGY
3
NONE
OE

IVES

f nanomaterials and nanotechnology
d applications of nanomaterials.

evolution, Properties at nanoscale. Theory, definitions and scaling. Supramolecular
es of the main intermolecular forces used in supramolecular chemistry. Self-assembly

onductor Nanomaterials, Quantum Dots, Wells and Wires,
y balls and Carbon Nanotubes.

rials: Equipment and processes needed to fabricate nanodevices and structures such
l opto-electronic structures. Bottom-up (building from molecular level) and top-
stalline materials) approaches.

racterization: Instrumentation required for characterization of properties on the
e properties and resolution limits of each technique, with an emphasis on
nge.

sion and catalysis, Molecular electronics and printed electronics Nanoelectronics,
ture, Liquid crystalline systems, Linear and nonlinear optical and electroopticals.
data storage, Photonics, Plasmonics, Chemical and biosensors, Nanomedicine and

od, *Supramolecular Chemistry*.

nd *Chemistry of Materials*", Wiley, 2001.

rtured *Materials and Nanotechnology*", Academic Press, 2002.

es and *Nanomaterials, synthesis, properties and applications*", Imperial College

ani, *Nanoscience: "Nanotechnologies and Nanophysics"*, Springer-Verlag Berlin

liemeyer, C.A. Mirkin. *Springer Hand book of Nanotechnology*,

COURSE OUTCOMES

On completion of the course, the student can

CO1	understand the chemistry involved in the synthesis of nanomaterials.
CO2	identify and understand the peculiar properties of materials at nanoscale.
CO3	differentiate various synthesis techniques of nanomaterials for different applications.
CO4	analyze the properties and identify the instrumentation for characterization of nanomaterials.
CO5	find the importance of applications of nanomaterials in biological processes.

Mapping of Course Outcomes with Programme Outcomes

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

PO12
✓
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

Gain a comprehensive understanding

COURSE CONTENT

Biomass characteristics & preparation and properties of biomass. Energy handling of biomass.

Biogas technology: Feedstock for 1 residues sugar rich materials. Micro Kinetics and mechanism. Dry and wet Digestors for rural application-High

Pyrolysis and thermo-chemical conversion for safe disposal of hazardous waste regime, effect of particle size, temperature products obtained.

Gasification of biomass: Thermocatalytic oxygen. Design and operation of Fixed

Combustion of biomass and cogeneration of equipment, Cogeneration in biomass for cogeneration.

CLOE16
BIOENERGY
3
NONE
OE

YES

g of the principle of generation of energy from biomass.

on: Biomass sources and classification. Chemical composition
y plantations. Size reduction, Briquetting of loose biomass, Drying, Storage and

producing biogas. Aqueous wastes containing biodegradable organic matter, animal
icrobial and biochemical aspects and operating parameters for biogas production,
wet fermentation,
rate digesters for industrial waste water treatment.

onversion: Thermo-chemical conversion of ligno-cellulose biomass. Incineration
te, Biomass processing for liquid fuel production, Pyrolysis of biomass-pyrolysis
emperature, and

hemical principles: Effect of pressure, temperature and of introducing steam and
ked and Fluidised Bed Gasifiers, Safety aspects.

eneration systems: Combustion of woody biomass-theory, calculations and design
omass processing industries. Case studies: Combustion of rice husk, Use of bagasse

REFERENCE BOOKS

1. A.Chakraverthy, *Biotechnology and Alternative Technologies for Utilisation of Biomass* Oxford & IBH publishing Co., New Delhi, 1989.
2. K.M.Mital, *Biogas Systems: Principles and Applications*, New Age International Publishers
3. P.VenkataRamana and S.N.Srinivas, *Biomass Energy Systems*, Tata Energy Resea Delhi, 1996.
4. D.L. Klass and G.M. Emert, *Fuels from Biomass and Wastes*, Ann Arbor Science publ. Inc. A
5. George J Banward, *Basic Food Microbiology*, CBS Publishers, New Delhi, 1987.
6. Lindsay, *Biotechnology challenges for the flavour and food industry*, Elsevier Applied Scienc
7. H.G.Muller, *An Introduction to Tropical Food Science*, C L P Edition, Cambridge Universit Press, 1989.

COURSE OUTCOMES

On completion of the course, the students will be familiar with

CO1	understanding of availability of biomass feedstocks and their potential attributes to biofuels production.
CO2	evaluation of methodologies for biomass preparation.
CO3	concepts of the second and third generation of bioenergy, and the conversion processes of biomass feedstock to biofuels.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		✓	✓	✓				✓		✓	
CO2	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓	✓	✓			✓		✓	✓

or Agricultural Wastes,

*(p) Ltd., 1996.
rch Institute, New*

Michigan, 1985.

ce, 1988.

y

PO12
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. Describe how to design experiments
2. Investigate the logic of hypothesis testing using experimental data.
3. Understand the process of design optimization
4. Learn the technique of regression analysis during the course.
5. Understand the role of response surface methodology

COURSE CONTENT

Introduction to probability, Guidelines for hypothesis testing, Experiments of

Randomized blocks, Latin squares, Fractional factorial

Three level Factorial design and fractional factorial

Fitting regression methods, Least squares regression, Polynomial regression

Introduction to optimization, Response surface methodology

CLOE17
DESIGN AND ANALYSIS OF EXPERIMENTS
3
NONE
OE

YES

ments, carry them out, and analyze the data they yield.
 thesis testing, including analysis of variance and the detailed analysis of

ning an experiment including factorial and fractional factorial designs.
 sion analysis, and how it compares and contrasts with other techniques studied in
 surface methodology and its basic underpinnings.

ries for experimental design, simple comparative experiments:
 a single factor, ANOVA

k

Introduction to factorial design, Factorial design, Blocking
 ctional factorial design, Blocking and confounding in three
k

square method, Simple linear regression, multiple linear
 nse surfaces, Method of steepest ascent, EVOP

REFERENCE BOOKS

1. Douglas C. Montgomery, *Design and Analysis of Experiments*, Wiley, 6th Edition
2. Zivorad R. Lazic, *Design of Experiments in Chemical Engineering: A Practical Guide*, Jhon Wiley & Sons Inc. 2nd ed.
3. Robert L. Mason, Richard F. Gunst, James L. Hess, *Statistical Design and Analysis Experiments: With Applications to Engineering and Science*, Jhon Wiley & Sons Inc. 2nd ed.

COURSE OUTCOMES

On completion of the course, the student can

CO1	Plan experiments and testing the hypothesis
CO2	apply factorial design and fractional factorial design
CO3	develop the regression models from the experimental data
CO4	find the optimum solution

Mapping of Course outcomes with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓				✓		✓
CO2	✓	✓	✓	✓	✓				✓		✓
CO3	✓	✓	✓	✓	✓			✓	✓		✓
CO4	✓	✓	✓	✓	✓			✓	✓		✓

Wiley & Sons Inc.
of

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

The course will introduce students to the program in data science

Course content:

Descriptive statistics and data visualization (variance), Chebyshev's inequality, plots, histograms, quantiles, pie charts

Random variables and expectation, cumulative distribution function, moments, moment generating function (binomial, poisson), special continuous random variables (exponential, gaussian)

Distribution of Sampling Statistics: normal distribution, central limit theorem;

Parameter Estimation and Confidence intervals on mean and variance of normal distributions, confidence interval on success probability p in binomial

Hypothesis testing: hypothesis testing for mean of normal distribution, hypothesis testing for variance of normal distribution, hypothesis testing on success probability, paired t-tests,

REFERENCE BOOKS:

1. Douglas C. Montgomery, *G. C. ...*
2. Sheldon M. Ross, *Introduction to Probability*, Elsevier, 4th Edition

CLOE18
Introduction to Data Analysis
3
NONE
OE

YES

o the fundamental mathematical concepts required for a

lization: quantities frequently used to describe data (mean, median, mode, range, es, correlation, data visualization tools/techniques such scatter plots, stem and leaf rts, use of dynamically changing plots to visualize evolving data;

is: discrete and continuous random variables, probability density/mass function, nditional probability, Bayes rule, joint density, marginal density, expectation, ions, special discrete random variables (bernoulli, binomial, geometric, negative ous ssian, chi-squared, t, F);

s: sample mean and its distribution, sample variance and its

ence Intervals: maximum likelihood estimation, properties of estimators, concept s, concept of confidence intervals for parameters based on estimators, confidence ormal distribution for various cases, confidence intervals on difference of means of

a binomial distribution;

ng framework, type I and type II errors, effect of sample size on these errors, p-value, ial distribution for some commonly encountered situations, hypothesis testing for othesis testing for equality of means and variances of data coming from two normal

bility p in a binomial distribution

*Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons, 2003.
o Probability and Statistics for Engineers and Scientists,*

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	gain knowledge on statistics and density functions
CO2	determine mean and variance
CO3	test hypothesis for the problems

Mapping of Course outcomes with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	√	√	√	√	√						√
CO2	√	√	√	√	√						√
CO3	√	√	√	√	√					√	√

PO12
√

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVE

The primary objective of this course is to understand the techniques, and applications of soft computing.

COURSE CONTENT:

Introduction of soft computing, various applications, and Networks:

Artificial Neural Networks: Basic principles of single layer and multilayer Feedforward networks, Computational complexity

Imprecision, Ambiguity, Uncertainty, operations on fuzzy sets, Fuzzy Inference, defuzzification Case study

Introduction to artificial neural networks and fuzzy logic.

Basic concept of Genetic algorithm

REFERENCE BOOKS:

1. *Kosco B, Neural Networks* John Wiley & Sons, New York, 1992.
2. *S.N.Sivanandam, S.N.Deepa, Introduction to Artificial Neural Networks*, Prentice Hall of India, 1992.

CLOE19
Soft-computing Techniques
3
NONE
OE

IVES:

is to provide an introduction to the basic principles, computing.

ous types of soft computing techniques, Introduction to Neural

roperties of Neurons, Neuron Models, activation functions, orward networks. McCullochPitts neuron model-perceptron model-, learning y of ANNs. Case study

y, Fuzziness and certainty, Fuzzy sets and crisp sets. Fuzzy Properties, Mathematical erence system, fuzzification, rules, defuzzification, different methods of

y inference system

and detail algorithmic steps-GA Application to optimization problems.

and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Prentice

Principles of Soft Computing, John Wiley & Sons, 2007.

COURSE OUTCOMES:

Upon successful completion of the course,

CO1	students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
CO2	Provide the mathematical background for carrying out the optimization associated with neural network learning

Mapping of Course outcomes with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	√	√	√	√	√						√
CO2	√	√	√	√	√						√

PO12

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To give students fundamental knowledge on basic laws governing chemical operations
2. To impart knowledgeable on material balance

COURSE CONTENT

Basics of Unit operations and Unit operations
 Stoichiometric principles –composition
 ideal gas law - gaseous mixtures

Vapour pressure - effect of Temperature
 immiscible liquids - solutions. Humidity
 thermometry.

Material Balance - Processes involving
 sulphur - Recycling operations - by
 Unsteady state problems

Energy Balance: Thermo chemistry
 combustion and mixing - mean specific

REFERENCE BOOKS

1. *O. A. Hougen, K. M. Watson and
Distributors, New Delhi, 1995.*
2. *V. Venkataramani, N. Anantharaman,
Hall of India Ltd, New Delhi. 2013*
3. *B. I. Bhatt, "Stoichiometry", 5th*
4. *Himmelblau, "Basic Principles
Prentice Hall of India Ltd, India 20*

COURSE OUTCOMES

CLMI 11
CHEMICAL PROCESS CALCULATIONS
3
NONE
MR

YES

Knowledge on Unit processes and Unit operations, Units and conversions and also the relations.

Material and energy balance with and without reactions

Processes. Units and Dimensions.

Equation relations, density and specific gravity. Behaviour of Ideal gases - application of Charles's law - volume changes with change in composition.

Effect of temperature on vapour pressure - vapour pressure plots - vapour pressure of water - Humidity and Solubility: Humidity - saturation - vaporization - wet and dry bulb

Stoichiometry of chemical reaction - Combustion of coal, fuel gases and air - passing streams - Degree of conversion – excess reactant - limiting reactant.

Calorimetry - Hess's law of summation - heat of formation, reaction, combustion, specific heat - Theoretical flame Temperature.

By *R. A. Ragatz, "Chemical Process Principles", Vol- I, CBS Publishers and*

Man and K.M. Meera Sheriffa Begum, 2nd Edn., 'Process Calculations' Prentice

Hall, Edn., Tata McGraw Hill Publishers Ltd., New Delhi, 2010.

and Calculations in Chemical Engineering", 8th Edn.,

12.

On completion of the course, the students will have

CO1	the capability to understand the need for study of unit operations and processes. Convert units and dimensions and also modify equations from system to another.
CO2	the capability to apply the laws of physics and chemistry in solving process industry related applications.
CO3	proficiency to integrate the data and formulate the mass and energy balance problems.
CO4	the capability to use mathematical knowledge for solving mass and energy balance problems with and without chemical reactions.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓		✓	✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓
CO4	✓	✓	✓		✓			✓	✓		✓

PO12
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECT

1. To impart the fundamental c
2. To enable students to compute
3. To impart the knowledge of me
4. To understand basic principles

COURSE CONTENT

Properties of fluids and concept of fluids. Fluid statics: Pressure - c
Dimensional analysis

Momentum Balance and their App
Newtonian and non-Newtonian f
Bernoulli's equation - Correctio
Correction for pump work.

Flow of Incompressible Fluids Thr
through closed conduits - velocity]
fitting etc. Transportation and Met
of fluid flow: Orifice meter, ventur

Characteristics of Particulate Ma
methods for size and surface area c
equipment, energy and power requ
operations.

CLMI 12
TRANSFER OPERATIONS - I
3
NONE
MR

TOPICS

Concepts of fluid statics, pressure distribution and dimensional analysis
 velocity profile, friction factor and head loss in pipes and fittings
 storage and transportation of fluids and fluid moving machinery performance
 of particle preparation, their characterization and equipments

Pressure: Introduction - Nature of fluids - physical properties of fluids - types of
 density - height relationships. Pressure Measurement. Units and Dimensions -

Applications: Kinematics of fluid flow: Stream line -stream tube - velocity potential.
 fluids - Time dependent fluids - Reynolds number - experiment and significance -
 dimension for fluid friction -

Flow through Ducts: Flow of incompressible fluids in pipes - laminar and turbulent flow
 profile & friction factor for smooth and rough pipes - Head loss due to friction in pipes,
 measurement: Measurement
 devices: Pitot tube, rotameter

Material: Properties and characterisation of particulate solids, analysis and technical
 distribution of powder; Flow properties of particulates. Introduction to size reduction
 equipment in milling

REFERENCE BOOKS

1. *Mc Cabe and J.C .Smith," Unit Operation of Chemical Engineering", 7th Edn., McGraw H*
2. *M. Coulson and J.F .Richardson, "Chemical Engineering", Vol. II, 5th Edn., Butterwort - Heinemann, 2002.*

COURSE OUTCOMES

On completion of the course, the student can

CO1	understand the fundamental concepts in fluids statics and to use dimensional analysis for scaling experimental results
CO2	analyze frictional flow in pipes and piping networks and to compute the head loss and power requirements for chemical process equipments
CO3	select the metering equipments and fluid moving machinery for an appropriate chemical engineering operations
CO4	understand the basic principles of particles preparation and their characterization
CO5	have knowledge on different size reducing equipment and power requirements during size reduction

Mapping of Course Outcomes with Programme Outcomes

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

ill., New York, 2004.

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Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTI

1. To impart the basic concepts of
2. To understand the transfer opera

COURSE CONTENT

Principles of Mass transfer: Fick's 1
mass transfer and mass transfer c
Equipments-Plate and Packed colun

Unit Processes in Mass Transfer: Pr
distillation, continuous fractionator

Basic concepts of heat Transfer: He:
transfer coefficient, thermal bounda
Types of heat exchangers, charts, pe
analysis of heat exchangers.

Simultaneous Heat and Mass Transl
Super saturation theory, crystallizer:

REFERENCE BOOKS

1. *R. E. Treybal, "Mass Transfer C*
2. *W. L. Mccabe, J. C. Smith and
Co., New York, 2004.*
3. *W.L.Badger and J.T.Banchero, '*
4. *Binay. K. Dutta, "Heat Transfer*
5. *D.Q. Kern," Process Heat Tran.*

COURSE OUTCOMES

CLMI 13
TRANSFER OPERATIONS – II
3
CLMR12
MR

IVES

transfer operations.
 tions and equipments in process industries.

aw of diffusion, unsteady state diffusion, Convective mass transfer, Inter phase
 oefficients, Mass transfer theories. Equilibrium stages and transfer units,
 nns, stage efficiency.

inciple and theory of Gas absorption, Distillation- Types of
 1, Liquid-Liquid extraction, Leaching, Adsorption.

at conduction, types and governing equation, natural and forced convection heat
 ry layer, laws of thermal radiation, shape factor, radiation shield, green house effect.
 rformance

fer : Humidification- cooling towers, Drying, Crystallization-
 s, evaporators and condensers.

Operations", 3rd Edn., McGraw Hill Book Co., New York, 1981.

P. Harriot, "Unit Operations in Chemical Engg. ", 7th Edn., McGraw Hill Book

"Introduction to Chemical Engineering", McGraw Hill Book Co., New York, 1955.

"Principles and applications" Prentice Hall of India Pvt. Ltd., 2003.

sfer," McGraw Hill Publishing Co., 1950.

PO12
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Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE OBJECTIVES

To impart knowledge on reactors for

COURSE CONTENT

Basics of Kinetics: Introduction - k term of rate equation, Searching for Reactor data

Reactor Design: Introduction to Reactor Design of Reactor for Multiple reactors for single reactions. Multiple series - parallel reactions of first reactor, auto catalytic reactions.

Flow Behaviour of Reactors: Non-linear calculations directly from tracer studies. Heat Effects: Temperature reaction,

REFERENCE BOOKS

1. O. Levenspiel, "Chemical Reaction Engineering"
2. K. A. Gavhane Chemical Reaction Engineering
3. J.M. Smith, "Chemical Engineering Kinetics"
4. Fogler.H.S., "Elements of Chemical Reaction Engineering"

CLMI 14
CHEMICAL REACTION ENGINEERING
3
CLMR11,CLMR13
MR

for chemical processes and kinetics

kinetics of homogeneous reactions: Concentration dependent & Temperature dependent
for a mechanism. Interpretation of Batch

Reactor Design. Single Ideal Reactors.

Reaction: Design for single and multiple Reactions. Size comparison of single
Reactor system for single reactions. Reactions in parallel, reactions in series and
order. Recycle

- ideal flow: Residence time distribution studies: C, E, F and I curves, conversion
studies. Models for non-ideal flow - dispersion and tanks in series multi-parameter
models and pressure effects on

Chemical Engineering", 3rd Edn., Wiley Eastern Ltd., New York, 1999.

Chemical Engineering -I, Nirali Prakashan Publications, Pune, 2013

Chemical Reaction Kinetics", 3rd Edn., McGraw Hill, New York, 1981.

Chemical Reaction Engineering", Prentice Hall of India Ltd., IIIrd Edition, 2000

ons
reaction
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PO12
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✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. To impart the basic concepts of
2. To develop understanding about
3. To learn manufacturing processes

COURSE CONTENT

Natural Products Processing: Production of Natural Products
 Petroleum and Petrochemicals: Primary and Secondary processing

Alkalies and Acids: Chlor - alkali process, common salt. Sulphur and Sulphuric acid: Manufacture of sulphuric acid. Manufacture of hydrogen
 Cement Gases, Water and Paints: Treatment of Industrial Gases: Carbon dioxide, Nitrogen

Fertilisers: Nitrogen Fertilisers; Synthesis of Phosphate rock, phosphoric acid, superphosphate

REFERENCE BOOKS

1. *G.T. Austin, N. Shreve's Chemical Engineering*
2. *W.V. Mark, S.C. Bhatia "Chemical Engineering"*
3. *R. Gopal and M. Sittig "Dryden's Chemical Engineering"* East-West Publishers, 1997.
4. *S. D. Shukla and G. N. Pandey "Chemical Engineering"*

COURSE OUTCOMES

CLMI 15
CHEMICAL TECHNOLOGY
3
NONE
MR

IVES

chemical technology.

: unit process and unit operations in various industries.

es of organic and Inorganic Chemicals and its applications.

ction of pulp, paper and rayon, Manufacture of sugar

Characteristics, Fuels/chemicals from petroleum and petrochemicals,
3, Treatment techniques and applications. Building blocks of the petrochemicals.

industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine -

c acid: Mining of sulphur and manufacture

ydrochloric acid.

ypes and Manufacture of Portland cement, Glass:

itrogen, Hydrogen, Oxygen and Acetylene - Manufacture of paints – Pigments

ynthetic ammonia, nitric acid, Urea, Phosphorous Fertilisers:

per phosphate and Triple Super phosphate

anical Process Industries", 5th Edn., McGraw Hill, NewYork, 1984.

cal Process Industries volume I and II", 2nd Edition 2007

i's Outlines of Chemical Technology: For The 21st Century" Third Edition, Affiliated

ey, "Text book of Chemical Technology" Vol 2, 1984

On completion of the course, the student can

CO1	understand the manufacturing process organic and Inorganic materials
CO2	understand the unit operation in process.
CO3	understand various chemical reaction in the process

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓			✓	✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓
CO3	✓	✓	✓		✓			✓	✓		✓

PO12
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

Expose students to the advanced control systems. This course prepares the student to take up such

COURSE CONTENT

Review of Systems: Review of first order systems, step, impulse and sinus response to step, impulse and sinus. Stability Analysis: Frequency response, root locus, Nichols and Cohen-Coon tuning.

Special Control Techniques: Advanced control, Smith predictor, internal model control.

Multivariable Control Analysis: Introduction to multivariable control, Bristol arrays, Niederlinski index.

Sample Data Controllers: Basic review of discrete systems, loop response to step, impulse and sinus of discrete systems. Design of digital controllers.

CLHO11
ADVANCED PROCESS CONTROL
3
CLPC24
HONORS

IVES

control methods used in industries and research. This course challenges in his profession.

and higher order systems, closed and open loop response. sinusoidal disturbances. Transient response. Block diagrams.

response, design of control system, controller tuning and process identification. Zeigler-methods, Bode and Nyquist stability criterion. Process identification.

advanced control techniques, cascade, ratio, feed forward, adaptive model control, model predictive control.

introduction to state-space methods, Control degrees of freedom analysis, Interaction, MIMO, design of controllers, Tuning of multivariable controllers.

Review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to sinusoidal inputs, closed loop response to step inputs, digital controllers. Introduction to PLC and DCS.

REFERENCE BOOKS

1. *D.R. Coughanowr and S.E.LeBlanc, 'Process Systems Analysis and Control', Mc.Graw Hill,*
2. *D.E.Seborg, T.F.Edger, D.A.Millichamp and F.J. Doyle III, 'Process Dynamics and Control 2013.*
3. *B.A.Ogunnaike and W.H.Ray, "Process Dynamics, Modelling and Control", Oxford Press, 1*
4. *B.W. Bequette, 'Process Control: Modeling, Design and Simulation', PHI, 2006.*
5. *S. Bhanot, 'Process Control: Principles and Applications', Oxford University Press, 2008.*

COURSE OUTCOMES

On completion of the course, the student can

CO1	analyze the transient response of a system and perform system identification
CO2	apply the knowledge of stability and perform controller design and tuning
CO3	design various advanced control algorithms for chemical processes having specific problems
CO4	analyze multivariable control systems and tuning of multivariable controllers
CO5	understand the sampled data systems and design of digital controllers

Mapping of Course Outcomes with Programme Outcomes

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

III Edition, 2009.
, Wiley, III Edition,

1994.

PO12
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✓
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✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. Understanding on Pinch
2. Identification of Energy
3. Retrofitting Concepts and

COURSE CONTENT

Thermodynamical review (First and Second Law)
 Threshold problems, capital cost estimation

Targeting: Heat exchanger targeting, cost targeting, superheating

Pinch Methodology: Problem structure, Heat content diagram, Temperature

Pinch Design and Optimization: pinch, cp table, the tick of heat network, Sensitivity analysis

Energy and Resource Analysis: process, evaporation process

REFERENCE BOOKS

1. Robin Smith, "Chemical Process Design and Simulation"
2. V. UdayShenoy "Heat Exchanger Design Handbook"
3. D.W. Linnhoff et al., "Pinch Design and Optimization", Chemical Engineers, U.K., 1982.
4. James M. Douglas "Chemical Process Design: Part 1: Analysis and Synthesis", McGraw-Hill, 1988.

CLHO12
PINCH ANALYSIS AND HEAT EXCHANGE NETWORK DESIGN
3
CLPC14, CLPC16
HONORS

OBJECTIVES

concept, and application to Process Heat Exchange Networking.

Minimization in the Process

and Setting up Targets for Energy Minimization

of the process, Pinch Concept, significance of pinch, pinch in grid representation, cost implication of the pinch.

networks, energy targeting, area targeting, unit targeting, shell and core targeting, continuous targeting.

in representation, temperature enthalpy diagram, simple match matrix. Temperature interval diagram.

Pinch Point: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the heuristic, case studies, optimization of heat exchanger network optimality for a minimum area.

Analysis of various processes, Batch process, flexible process, distillation, reaction process, process using mass separating agent. Heat pipes and Heat pumps,

"Process Design and Integration" Wiley – India, 2006

"Heat exchanger network synthesis" Gulf Publishing Co, USA, 1995

"User Guide on Process Integration for the efficient use of Energy", Institution of Chemical Engineers, 1994.

"Conceptual Design of Chemical Process", McGraw Hill, New York,

Course Outcomes:

On completion of the course, the student can

CO1	understand the concept of the Pinch analysis and appreciate the pinch analysis concept and process thermodynamics.
CO2	identify the minimum energy targets, different choices and constraint during heat exchange networking.
CO3	represent the pinch Methodology using different presentations.
CO4	design and Optimization of HENS
CO5	form strategies for retrofitting existing process plant, integration of energy demands of multiple processes.

Mapping of Course Outcomes with Programme Outcomes

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

PO12
✓
✓
✓
✓
✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING C

1. Describe chemical eng
macroscopic balances
2. Identify if an analytical
3. Derive and interpret pl

COURSE CONTENTS

Design of engineering exp
single factor: the analysis of

Formulation of physical
based on the first principle

Analytical solutions of e
singular solutions.

Numerical solution of no
solution of ordinary diff
Numerical solution of part

Optimization: Types of c
unconstrained minimizatio

CLHO13
APPLIED MATHEMATICS IN CHEMICAL
3
CLPC16, CLPC18, CLPC21
HONORS

OBJECTIVES

engineering processes in mathematical form by employing the appropriate microscopic and

1 solution to the differential equations is possible

physically the solution to differential equations amenable to analytical solution

experiments: Treatment of experimental data and interpretation of results. Experiments with a
of variance. Factorial designs. Curve fitting methods, Interpolation and extrapolation.

problems: Mathematical modelling of chemical engineering processes
s.

equations: Separable forms, homogeneous equations, exact solutions,

non-linear equations: Linearization of nonlinear equations. Numerical

differential equations: Initial value and boundary value problems. Stiff differential equations.
partial differential equations.

optimization problems, optimization of a function of single variable,
n, constrained minimization.

REFERENCE BOOKS

1. Douglas C. Montgomery, "Design and Analysis of Experiments" John Wiley, 8th Edition, 2011
2. Harold S. Mickley, Thomas S. Sherwood, Charles E. Reed, "Applied Mathematics in Chemical Engineering" McGraw Hill Publishing Company Limited, Second Edition, 1975.
3. Richard G. Rice & Duong D. D, "Applied Mathematics and Modelling for Chemical Engineers" John Wiley & Sons, 1995.
4. Mark E. Davis, "Numerical Methods and Modelling for Chemical Engineers", John Wiley & Sons, 1995.
5. S. K. Gupta, "Numerical Techniques for Engineers", Wiley Eastern Ltd., New York, 1995

COURSE OUTCOMES

On completion of the course, the student can

CO1	apply mathematical concepts and principles for perform the computations
CO2	create, use and analyze graphical representations of mathematical relationships.
CO3	apply mathematics to solve the chemical engineering problems.
CO4	develop mathematical representation for chemical process system

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓		✓						✓
CO2	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓		✓			✓			✓
CO4	✓	✓	✓		✓			✓			✓

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al Engineering” Tata

Engineers” John Wiley

Sons, 1984.

PO12
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Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES

1. Understanding on the concept of conduction problems by using various methods.
2. Understanding of the heat conduction problems by using various methods.
3. Application of governing equations knowing the dimensionless parameters.
4. Analyzing the external and internal convection problems.
5. Understanding of the boiling and condensation processes.

COURSE CONTENT

Heat conduction, transient and steady state conduction, boundary layer approximation, boundary layer solutions, correlations.

Radiation heat transfer, estimation of radiation heat transfer coefficient. Combined conduction, convection and radiation.

Heat Transfer with phase change: laminar film condensation, influence of horizontal tubes, other configurations. Design of equipment with phase transformation.

Advances in heat exchanger design. Heat transfer in packed and fluidised beds.

REFERENCE BOOKS

1. Ozisik, M. Necati, "Heat Transfer by Conduction", Wiley, 2008.
2. Yunus A Sengel, "Heat and Mass Transfer", Wiley, 2008.
3. J. M. Coulson, J. F. Richardson, "Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer", 5th Revised edition, Elsevier, 2008.
4. F.P. Incropera, D.P. DeWitt, "Fundamentals of Heat and Mass Transfer", 6th Edition, John Wiley and Sons inc, 2008.
4. A.Bejan Convective Heat Transfer, Wiley, 2003.

CLHO14
ADVANCES IN HEAT TRANSFER
3
CLPC16, CLPC13
HONORS

IVES

f thermal conduction; should be able to get analytical solutions for 2D/3D steady heat
ble separation method.

ction with phase change, and knowing how to solve it.

uations for convection heat transfer; and

eters

nal laminar flow heat transfer using boundary layer concept

d condensation mechanism; Thermal performance analysis for a heat pipe.

steady state heat conduction. Convective heat transfer,- conservation
ations. Forced convective laminar and turbulent flow solutions. Natural convection

of view factors and emissivity factors for different situation.

and radiation heat transfer and its applications

condensation – mechanism, controlling parameters. Nusselt Theory; solution to
nce of other parameters, correlations for single horizontal tube, vertical bank
gurations. Dropwise condensation. Boiling mechanisms regimes. Selection and

and compact heat exchangers, Heat transfer in liquid metals.

d beds.

er: *A basic approach*”, McGraw Hill Book Company, 1985.

s transfer – *A Practical Approach*” Tata McGraw Hill Publishing Company Ltd.,

*J. R. Backhurst, J. H. Harker, “Coulson and Richardson's Chemical Engineering:
Mass Transfer v. 1: 001 (Chemical Engineering Vol. 1)” Butterworth-Heinemann
(31 December 1995)*

*T.L. Bergman, A.S. Lavine, Fundamentals of Heat and Mass Transfer, 6th
011.*

er, Fourth Edition, John Wiley and Sons, 2013.

COURSE OUTCOMES

On completion of the course, the student can

CO1	solve the 2-D transient heat conduction problems by using variable separation method.
CO2	understand and solve conduction, convection and radiation problems
CO3	design and analyze reactor heating and cooling systems.
CO4	design and analyze the performance of heat exchangers and evaporators.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓		✓	✓						✓
CO2	✓	✓		✓							✓
CO3	✓		✓	✓	✓			✓		✓	✓
CO4	✓	✓	✓	✓	✓			✓		✓	✓

PO12
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Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE OBJECTIVES:

To understand the theory of governi
 To solve fluid flow problems involv

COURSE CONTENT:

Governing equations of fluid flow a
 for a Newtonian fluid, Classificatio
 for viscous fluid flow equations

Transition from laminar to turbulen
 of simple turbulent flows, Free turbl
 length model, The k-e model, Reyno
 models, Algebraic stress equation m

Introduction, one-dimensional stead
 dimensional diffusion problems , di

Steady one-dimensional convection
 Conservativeness, Boundedness, T
 diffusion problems, The upwind dif
 order differencing schemes for
 convection-diffusion, Quadratic upv

One-dimensional unsteady heat cc
 procedures for unsteady flow calcul
 pressure boundary condition.

CLHO15
COMPUTATIONAL FLUID DYNAMICS
3
CLPC13
HONORS

ng equations representing fluid flow behavior
 ving diffusion and convection phenomena using Finite volume method

nd heat transfer, Equations of state, Navier-Stokes equations
 1 of physical behaviour, Classification of fluid flow equations, Auxiliary conditions

t flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics
 ulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing
 lds stress equation
 odels

ly state diffusion, two-dimensional diffusion problems, three-
 scretised equations for diffusion problems

and diffusion, The central differencing scheme, Properties of discretisation schemes-
 ransportiveness, Assessment of the central differencing scheme for convection-
 ferencing scheme, The hybrid differencing scheme, The power-law scheme, Higher

vind differencing scheme

roduction, Discretisation of transient convection-diffusion equation, Solution
 ations, Implementation of Inlet, outlet and wall boundary conditions, constant

REFERNCE BOOKS

1. H. K. Versteeg and W. Malalasekera, *An introduction to computational fluid dynamics: the*, Longman scientific & technical publishers, 1995
2. John D. Anderson, *Computational fluid dynamics: The Basics with Applications* McGraw-H
3. Vivek V. Ranade, *Computational flow modeling for chemical reactor engineering* Academic Press, San Diego, 2002

COURSE OUTCOMES

Upon completion, the students can

CO1	impart knowledge on theory of governing equations representing fluid flow behavior
CO2	understand the concept of turbulence and its modeling
CO3	solve steady state diffusion and convection fluid flow problems using Finite volume method
CO4	solve unsteady state fluid flow problems using finite volume method

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓						✓
CO2	✓	✓									✓
CO3	✓		✓	✓	✓					✓	✓
CO4	✓	✓	✓	✓	✓					✓	✓

finite volume method ,

Hill, Inc. New York, 1995.

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PO12
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✓

Course Code	:
Course Title	:
Number of Credits	:
Prerequisites	:
Course Type	:

COURSE LEARNING OBJECTIVES:

1. To inculcate the importance
2. To imbibe an extensive know
3. To provide technical inputs p

COURSE CONTENT:

Introduction: Industrial processes and hazards regulations, Industrial hygiene (Protection) Act, 1986 and rules the

Fire and Explosion: Shock wave pressure (BLEVE), mechanical and chemical protective management from fires and proofing, relief systems – relief valves, flares, scrubbers.

Hazards identification-toxicity, fire, data sheet, hazards indices- Dow

Leaks and Leakages: Spill and leakage Estimation of leakage/spill rate through spillage and leakage of flashing liquid and dense gas dispersion models; E

Case Studies: Flixborough, Bhopal storage depot incident; Oil, natural g

CLHO16
Process Safety Management
3
CLPE15
HONORS

IVES

of process safety practices.
 vledge on the management of safety
 pertaining to safety.

id hazards potential, mechanical electrical, thermal and process hazards. Safety and
 ne. Factories Act, 1948 and Environment
 reof.

opagation, vapour cloud and boiling liquid expanding vapours explosion (VCE and
 explosion, multiphase reactions, transport effects and global rates. Preventive and
 nd explosion - inerting, static electricity passivation, ventilation, and sprinkling,
 ves,

static electricity, noise and dust concentration; Material safety
 and Mond indices, hazard operability (HAZOP) and hazard analysis (HAZAN).

age of liquids, vapors, gases and their mixture from storage tanks and equipment;
 rough hole, pipes and vessel burst; Isothermal and adiabatic flows of gases,
 ids, pool evaporation and boiling; Release of toxics and dispersion. Naturally buoyant
 ffects of momentum and buoyancy; Mitigation measures for leaks and releases.

ul, Texas, ONGC offshore, HPCL Vizag and Jaipur IOC oil-
 gas, chlorine and ammonia storage and transportation hazards.

2nd Ed., Prentice Hall.

, Butterworth

ng 2003

PO12
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