Department of Chemical Engineering

Vision:
Department of Chemical Engineering strives to become well known in India by creating quality chemical engineers who will be highly successful in academia, industries and research. The research motive is to develop sustainable technologies for the betterment of society.

Mission:
1. To disseminate high quality Chemical Engineering Education
2. To perform high impact research for the benefit of community
3. To collaborate with industries for innovative concepts/ideas
4. To develop quality engineers and technocrats with inter-disciplinary skills
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To impart knowledge to students in the latest technological aspects of Chemical Engineering and to provide them with opportunities in taking up advanced topics of the field of study.

2. To provide a solid foundation in mathematical, scientific and engineering fundamentals required to develop problem solving ability for higher level learning.

3. To prepare Post graduate students for a successful career with effective communication skills, teamwork skills and work with values that meet the diversified needs of industry, academia and research.

4. To train Post graduate’s in comprehending, analyzing, designing and creating new technologies that provide solution frameworks to real world problems.

5. To broaden and deepen their capabilities in experimental research methods, analysis of data, and drawing relevant conclusions for scholarly writing and presentation.

6. To create a congenial environment that upholds learning, growth and impart ability to work with inter-disciplinary groups in professional, industry and research organizations

2. PROGRAMME OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document

PO3: Ability to demonstrate mastery over the specialized area of study higher than the appropriate bachelor program

PO4: Ability to undertake problem identification, formulation and providing optimum solution.

PO5: Ability to identify, formulate, and solve multidisciplinary engineering problems.

PO6: Ability to use the techniques, skills, and modern engineering tools necessary for academic and engineering practice

PO7: Understanding of the social, cultural, global and environmental responsibilities as a professional engineer.

PO8: Understanding the principles of inter-disciplinary domains for sustainable development.

PO9: Understanding professional & ethical responsibilities and commitment to them.

PO10: Ability to function effectively as an individual and in a group with the capacity to be a team leader.

PO11: Ability to communicate effectively, Understanding of engineering and management principles, work culture and apply to multidisciplinary environments.

PO12: Recognizing the need to undertake life-long learning, and possess/acquire the capacity to do so.
### 3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
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### SEMESTER IV

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**TOTAL CREDITS: 70**
**PROGRAM CORE COURSES (PCC)**

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**PROFESSIONAL ELECTIVE COURSES (PEC)**

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## RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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## OPEN ELECTIVE COURSES [OEC]*

*(Out of 6 Courses one Course must be selected)*

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## AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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# EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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SYLLABI
SEMESTER I

CL5101  ADVANCED TRANSPORT PHENOMENA

OBJECTIVE

To understand and appreciate the transport processes in chemical engineering and to seek solution of the macroscopic balances for isothermal and non-isothermal system and to identify convenient coordinate systems for the solution.

UNIT I

Phenomenological Equations and Transport properties, Rheological behaviour of fluids, Models for Rheological Behaviour- Balance Equations – Differential and Integral equations – Conversion from Cartesian, Cylindrical and Polar coordinates

UNIT II

Applications in laminar and turbulent transport in compressible and incompressible fluids. Boundary layer theory – Momentum, Thermal and Concentration Boundary layer – Similarity Transformation – Blasius Solution

UNIT III

Reynolds Transport Theorem – application of RTT to solutions for Macroscopic balance for isothermal and non isothermal systems and their applications in Momentum, Heat and Mass transport problems.

UNIT IV


UNIT V

Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and dropwise condensation and equations for heat transfer, Heat transfer in boiling liquids- Graetz Heat transfer, Heat transfer in tubes in laminar and turbulent regime with constant wall temperature and constant heat flux- Mass Transfer co-efficient in single and multiple phases at low and high mass transfer rates, Film theory, Penetration theory, Boundary layer theory, Macroscopic balance to solve steady and Unsteady state problems.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand and identify transport properties for the three transport phenomena and analyze the mechanisms of molecular and turbulent momentum, energy and mass transport.

CO2: Identify the convenient coordinate systems viz., rectangular, cylindrical and spherical, for transport phenomena problems

CO3: Formulate the differential forms and integral form of the equations of change for momentum, heat and mass transport in compressible and incompressible fluids for steady-state and unsteady flows

CO4: Apply RTT for macroscopic balances for isothermal and non isothermal systems.

CO5: Evaluate the flow behavior for external and internal flows

CO6: Evaluate thermal conductivity and mass diffusivity for flow through porous media.

CO7: Formulate methods for estimation of heat and mass transfer coefficients
TEXT BOOKS

REFERENCES
### Course Articulation Matrix:

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<th>Program Outcomes</th>
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<td>Understand and identify transport properties for the three transport phenomena and analyze the mechanisms of molecular and turbulent momentum, energy and mass transport.</td>
<td>PO 1  PO 2  PO 3  PO 4  PO 5  PO 6  PO 7  PO 8  PO 9  PO 10  PO 11  PSO 1  PSO 2  PSO 3  PSO 4</td>
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<td>CO2</td>
<td>Identify the convenient coordinate systems viz., rectangular, cylindrical and spherical, for transport phenomena problems</td>
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<td>CO3</td>
<td>Formulate the differential forms and integral form of the equations of change for momentum, heat and mass transport in compressible and incompressible fluids for steady-state and unsteady flows</td>
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<td>Evaluate the flow behavior for external and internal flows.</td>
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<td>Evaluate thermal conductivity and mass diffusivity for flow through porous media.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To educate students with advanced knowledge on Reaction Engineering.

UNIT I  KINETICS OF HETEROGENEOUS REACTIONS  9
Catalytic reactions, rate controlling steps, Langmuir-Hinshelwood model, Eley Rideal mechanism, steady state approximation, non-catalytic fluid-solid reactions, shrinking and unreacted core model.

UNIT II  CATALYSIS  9
Nature of catalyses, mechanism and kinetics of catalyst, Adsorption Isotherms, properties and characterization of catalysts, surface area measurement, pore size distribution, evaluation of catalysis, choice of catalysts, promoters, inhibitors, poison, supports, Catalyst deactivation.

UNIT III  EXTERNAL DIFFUSION EFFECTS IN HETEROGENEOUS REACTIONS  9
Mass and heat transfer coefficients in packed beds, quantitative treatment of external transport effects, effect of external transport on selectivity, modeling diffusion with and without reaction.

UNIT IV  INTERNAL TRANSPORT PROCESSES IN POROUS CATALYSTS  9
Intra pellet mass and heat transfer, evaluation of effectiveness factor, mass and heat transfer with reaction.

UNIT V  ANALYSIS AND DESIGN OF HETEROGENEOUS REACTORS  9
Isothermal and non-isothermal fixed bed reactors, Fluidized bed model, slurry reactor model, trickle bed reactor model.

COURSE OUTCOMES:
The students will be able to
CO1: Understand the kinetics of Heterogeneous reactions using various Theories
CO2: Understand properties and function of Catalyst
CO3: Obtain knowledge on External Diffusion effects in a Heterogeneous Reactions
CO4: Gain knowledge on Internal Transports in the Porous Catalysts
CO5: Design Heterogeneous Reactors
CO6: Obtain detailed knowledge on Chemical Reactions

REFERENCES
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<td>Understand properties and function of Catalyst</td>
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<td>Gain knowledge on Internal Transports in the Porous Catalysts</td>
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<td>Design Heterogeneous Reactors</td>
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<td>Obtain detailed knowledge on Chemical Reactions</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CL5103 ADVANCED PROCESS CONTROL

OBJECTIVE

To instruct students to build and analyze models for time-varying systems and non-linear systems.

UNIT I ADVANCED CONTROL STRATEGIES 9

Linear, nonlinear regression fitting for first order, second order models without and with time delay, development of discrete time model and parameter identification. Feed forward, cascade, dead time compensation, split range, inferential, selective and override control; smith predictor, automatic tuning and gain scheduling.

UNIT II INTERNAL MODEL CONTROL 9

Model based control – IMC structure – development and design; Direct synthesis method, IMC based PID control, Overview of MPC, prediction for SISO and MIMO models, MPC calculation, set point calculation, selecting the tuning parameters in MPC–Design examples for typical case studies.

UNIT III MULTIVARIABLE CONTROL 9

Control loop interaction – general pairing problem, relative gain array and application, sensitivity. Multivariable control – zeros and performance limitations, directional sensitivity and operability, decoupling

UNIT IV DISCRETE SYSTEMS & NON-LINEAR SYSTEMS 9


UNIT V DIGITAL FEEDBACK & ADAPTIVE CONTROLLERS 9


TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand the dynamic response of open and closed loop systems, control loop components and stability of control systems along with instrumentation

CO2: Understand and analyze models for time-varying systems and non-linear systems.

CO3: Obtain skills needed to design adaptive controllers such as gain-scheduled adaptive controller

CO4: Gain knowledge on Model-reference adaptive controller and Self-tuning controller

CO5: Design MPC, Multivariable controls

CO6: Obtain familiarity on time-varying systems and non-linear systems for various applications
TEXT BOOKS:


REFERENCES

### Course Articulation Matrix:

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<tr>
<th>Course Outcomes</th>
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<td>CO1</td>
<td>Understand the dynamic response of open and closed loop systems, control loop components and stability of control systems along with instrumentation</td>
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<td>Understand and analyze models for time-varying systems and non-linear systems.</td>
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<td>CO3</td>
<td>Obtain skills needed to design adaptive controllers such as gain-scheduled adaptive controller</td>
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<td>CO4</td>
<td>Gain knowledge on Model-reference adaptive controller and Self-tuning controller</td>
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<td>CO5</td>
<td>Design MPC, Multivariable controls</td>
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<td>CO6</td>
<td>Obtain familiarity on time-varying systems and non-linear systems for various applications</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

Students will learn individual aspects of chemical engineering for chemical plant design, optimization and the hierarchy of analysis and decisions in synthesis for chemical process and its alternatives.

UNIT I THE NATURE OF CHEMICAL PROCESS DESIGN AND INTEGRATION 9
Formulation of Design Problem-The Hierarchy and Approaches of Chemical Process Design and Integration.

UNIT II DESIGN OF REACTORS 9
Choice of Reactor- Reactor Performance- Reactor Conditions- Reactor Configuration

UNIT III DESIGN OF SEPARATION SYSTEM 9
Separation systems Introduction- Choice of Separator for Homogeneous Fluid Mixtures- Choice of separator for heterogeneous fluid mixtures- Distillation Sequencing.

UNIT IV ENERGY INTEGRATION AND HEAT EXCHANGER NETWORK SYNTHESIS 9
Heat Exchanger Networks Design- Network Energy Targets- Capital and Total Cost Targets, Energy Integration- Basic Principles- Composite Curves, Problem Table Algorithm- Pinch Design Method

UNIT V RECYCLE SYSTEMS FOR CONTINUOUS AND BATCH PROCESS 9
Functions of process Recycles in continuous and batch processes- Process Yield- optimization of recycle loop in continuous and batch process.

COURSE OUTCOMES: The students will be able to
CO1: Learn various aspects of process design project objectives, approaches of process design.
CO2: Learn various Choice of reactors and its performance assessment, reactor configuration
CO3: Learn design of different types of separations process for homogeneous and heterogeneous mixtures.
CO4: Learn types of Heat exchanger networks for the target of energy and costs.
CO5: Learn and Analyze Recycle systems in order to optimize the process
CO6: Learn design principles to attain cost, energy efficient and environment compliant process.

TEXT BOOKS

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<td>Learn design of different types of separations process for homogeneous and heterogeneous mixtures.</td>
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<td>Learn types of Heat exchanger networks for the target of energy and costs.</td>
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<td>Learn and Analyze Recycle systems in order to optimize the process</td>
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<td>CO6</td>
<td>Learn design principles to attain cost, energy efficient and environment compliant process.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I      RESEARCH PROBLEM FORMULATION       6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II     LITERATURE REVIEW                   6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III    TECHNICAL WRITING / PRESENTATION   6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV     INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

UNIT V     INTELLECTUAL PROPERTY RIGHTS (IPR)   6

TOTAL: 30 PERIODS

COURSE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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</table>
REFERENCES:

OBJECTIVE

To understand the principles of chemical reaction engineering

List of Experiments:

1. To find the reaction rate constant in a stirred batch reactor.
2. To find the effect of reactant concentration on the reaction rate by using batch reactor.
3. To find the reaction rate constant in a continuous stirred tank reactor.
4. To determine the effect of inadequate mixing on the reaction rate using stirred tank reactor
   Dynamic behavior of continuous stirred tank reaction.
   Dynamics of stirred tank reactor in series
   Effect of step input change.
   Response of tank concentration to an impulse change.
5. Determination of the influence of flow rate on three tank system following a step change in
   input concentration.
6. Determination of the response to a step change in the input concentration of a system
   comprising one stirred vessel and a “dead time” module.
7. To determine the rate constant using tubular reactor.
8. To investigate the effect of throughput on the conversion using tubular reactor.
9. To demonstrate the temperature dependence of the reaction and the rate constant using
   tubular reactor.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand the kinetics of Heterogeneous reactions using Laboratory experiments
CO2: Understand properties and function of Catalyst from Packed bed data
CO3: Obtain knowledge on External Diffusion effects in a Heterogeneous Reactions
CO4: Gain knowledge on Internal Transports in the Porous Catalysts
CO5: Analyze data on homogenous and heterogenous reactions
CO6: Obtain practical knowledge on Chemical Reactions

REFERENCES:

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<td>Understand properties and function of Catalyst from Packed bed data</td>
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<td>Analyze data on homogenous and heterogenous reactions</td>
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<td>CO6</td>
<td>Obtain practical knowledge on Chemical Reactions</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To develop lumped and distributed models for processes and to model them using SIMULINK, to model and control thermal process, level using P, PI, PID control and to study the dynamics of inherent and installed characteristics of different process valves.

LIST OF EXPERIMENTS:

1. Realtime position control of a servo problem
2. Level control using P, PI and PID controllers
3. Tank Level control using LabView for single tank, two tanks and four tanks
4. Determination of control characteristics of a pneumatically actuated valve – with and without positioner
5. Installed and inherent Valve characteristics of valves – Linear, quick opening, equal percentage and hyperbolic valve
6. Dynamics and control of Rotary Inverted pendulum
7. Cascade Control of a Jacketed CSTR
8. Inferential Control of composition in a distillation column using thermocouples
9. Closed loop control for a servo problem for thermal process
10. Closed loop control for a servo problem for thermal process
11. Simulation and control of a lumped parameter process using SIMULINK
12. Simulation and control of a distributed parameter process using SIMULINK
13. Simulation of relay auto tuning of PID controllers using SIMULINK
14. Implementation of Model Predictive Control using SIMULINK for an industrial process
15. Simulation of closed loop response for an inverse response process using SIMULINK

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Implement closed loop control for servo and regulatory problems of thermal processes and level.
CO2: Determine the rangeability and flow parameters for various process valves
CO3: Design and implement control structure for cascade control
CO4: Design and implement Model Predictive control
CO5: Design and implement inferential control in a distillation column
CO6: Simulate process control techniques using SIMULINK
REFERENCES


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<tr>
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<td>Simulate process control techniques using SIMULINK</td>
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SEMESTER II

CL5201 SEPARATION PROCESSES

OBJECTIVE

To gain knowledge about advanced separation process. Also to learn conceptual design of separation processes and design of equipment involved.

UNIT I GENERAL

Review of conventional processes, recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. Process concept, theory and equipment used in cross flow filtration, cross flow electro-filtration, dual functional filter, surface based solid-liquid separations involving a second liquid, sirofloc filter.

UNIT II MEMBRANE SEPARATIONS

Types and choice of membranes, plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, commercial, pilot plant and laboratory membrane permeators involving dialysis, reverse osmosis, nanofiltration, ultrafiltration, microfiltration and Donnan dialysis, economics of membrane operations, ceramic membranes.

UNIT III SEPARATION BY ADSORPTION TECHNIQUES

Mechanism, types and choice of adsorbents, normal adsorption techniques, affinity chromatography and immuno chromatography, types of equipment and commercial processes, recent advances and process economics

UNIT IV IONIC SEPARATIONS

Controlling factors, Applications, Types of equipment employed for electrophoresis, dielectrophoresis, Ion Exchange chromatography and electrodialysis, Commercial processes

UNIT V OTHER TECHNIQUES

Separations involving lyophilization, pervaporation and permeation techniques for solids, liquids and gases, industrial viability and examples, zone melting, adductive crystallization, other separation processes, supercritical fluid extraction, oil spill management, industrial effluent treatment by modern techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the key concepts of conventional and advanced aspects of separation processes and the selection of separation processes.

CO2: Understand the concepts and develop design equations for membrane separation processes.

CO3: Understand the principles and processes of adsorption and chromatographic techniques and to design an absorber to achieve specific separation.

CO4: Analyze the separation system for multi-component mixtures, design separation processes based on electrical properties.

CO5: Apply the latest concepts like super critical fluid extraction, pervaporation, lyophilisation etc. also to understand Innovative techniques for controlling and managing oil spills in Chemical process industries.

CO6: Understand and select appropriate separation technique for intended problem.
TEXT BOOKS


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<td></td>
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<td>PO 1</td>
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<tr>
<td>CO1</td>
<td>Understand the key concepts of conventional and advanced aspects of separation processes, and the selection of separation processes.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the concepts and develop design equations for membrane separation processes.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the principles and processes of adsorption and chromatographic techniques and to design an absorber to achieve specific separation.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the separation system for multi-component mixtures, design separation process based on electrical properties.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply the latest concepts like super critical fluid extraction, pervaporation, lyophilisation etc., also to understand innovative techniques for controlling and managing oil spills in Chemical process industries.</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Understand and select appropriate separation technique for intended problem.</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

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

UNIT I

Basic thermodynamic concepts, Energy and first Law; Reversibility and second Law; Review of Basic Postulates, equation of state and its applications, corresponding states, equilibrium criteria, Legendre Transformation and Maxwell’s relations

UNIT II

Phase rule, Stability of thermodynamic systems, first order phase transitions and critical phenomenon, single component phase diagrams, thermodynamic properties from volumetric and thermal data

UNIT III

Partial molar properties, Gibbs-Duhem equation, fugacities in gas and liquid mixtures, activity coefficients, Ideal and Non-ideal solutions, azeotropes, Wilson, NRTL, and UNIQUAC equations, UNIFAC method.

UNIT IV

Vapour Liquid Equilibrium involving low pressure, high pressures and multi component systems, VLE in ideal and non-ideal solutions, Henry’s Law, Other phase equilibriums - SLE/LLE/VLLE.

UNIT V

Criteria of chemical reaction equilibrium in thermodynamic systems, Homogeneous gas and liquid phase reactions, heterogeneous reactions – phase and chemical equilibrium

TOTAL: 45 PERIODS

COURSE OUTCOMES: The students will be able to

CO1: Associate the concepts of energy, laws of thermodynamics to applications that require quantitative knowledge of thermodynamic properties at macroscopic level.

CO2: Understand the thermodynamics of phase equilibria typically encountered in design of chemical processes such as separation operations.

CO3: Relate the theoretical results used to physical systems that convert matter and energy in terms of the laws of thermodynamics.

CO4: Analyze many of the thermodynamic properties of dilute solutions can be derived analytically from statistical formulations.

CO5: Apply the various phase equilibrium models in practical situations

CO6: Apply in the area of thermodynamics principles to various chemical engineering processes
TEXT BOOKS


REFERENCES

1. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad, 2005
Course Articulation Matrix:

<table>
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<th>Course Outcomes</th>
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<td>CO1</td>
<td>Associate the concepts of energy, laws of thermodynamics to applications</td>
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<td>that require quantitative knowledge of thermodynamic properties at</td>
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<td>macroscopic level.</td>
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<tr>
<td>CO2</td>
<td>Understand the thermodynamics of phase equilibria typically encountered</td>
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<td></td>
<td>in design of chemical processes such as separation operations.</td>
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<tr>
<td>CO3</td>
<td>Relate the theoretical results used to physical systems that convert</td>
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<td>matter and energy in terms of the laws of thermodynamics.</td>
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<td>CO4</td>
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<td>derived analytically from statistical formulations.</td>
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<tr>
<td>CO5</td>
<td>Apply the various phase equilibrium models in practical situations</td>
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<tr>
<td>CO6</td>
<td>Apply in the area of thermodynamics principles to various chemical</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
To develop steady state and transient models for processes and unit operations and to
understand lumped and distributed parameter models and to seek solution of models using
analytic and numerical techniques and to construct data driven models and estimate the
parameters.

UNIT I
9
Need for developing models for a process - Incentives of process modeling and simulation -
classification of mathematical models, conservation equations and auxiliary relations - Closed form
of solution – Well posedness of Models.

UNIT II
9
Degree of freedom analysis - Design and Control degrees of Freedom - Degrees of Freedom
Analysis for flowsheets involving single and multiple process units - Flowsheeting - Models yielding
linear and non-linear algebraic equations - Solution to linear and non-linear algebraic equations -
Convergence - Types of Convergence - Wegstein’s Algorithm - Levenberg-Marquadt Method,
Application of algebraic models to dimensional analysis and determination of independent species
in a set of reactions.

UNIT III
9
Models yielding ODE - Classification of ODE - Solution of ODE - analytical methods using matrices
and numerical methods - Stiff ODE’s - Gear’s algorithm - Stability analysis of Euler’s algorithm,
Runge- Kutta methods of various orders, Predictor - Corrector methods - Adaptive stepsize
algorithm - Perturbation methods, Mathematical models with Initial and or Boundary conditions of
surge tank, Transient isothermal and nonisothermal Mixed flow reactor, separation systems such
as distillation, flashing, Coiled and Jacketed heaters.

UNIT IV
9
Models yielding PDE’s - Characteristics and differences between Lumped and Distributed
Parameter systems - classification and solution of partial differential equations – Characteristic
curves for parabolic, Elliptic and Hyperbolic equations - Mathematical models of Heat Exchanger,
Packed bed reactor, Monolith Reactor Modeling – Pseudohomogeneous and Heterogeneous
models for catalytic reactors, plug flow reactor, Convection-Diffusion-Reaction (CDR) model,
packed bed adsorption- solution of ODE boundary value problems – Method of Characteristics -
shooting Method.

UNIT V
9
Empirical modeling, parameter estimation, principle of linear and non-linear least squares -
Population balance and stochastic modeling- Application of population balance models in
crystallization, particle comminution, RTD in reactors - Principal Component Analysis - Kernel PCA
- Singular Value Decomposition.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
The students will be able to

CO1: Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics

CO2: Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods

CO3: Create the mathematical models for different unit operations equipments such as stirred tank heaters, Heat exchangers, Evaporators, Reactors, distillation columns

CO4: Analyze the principles of steady state/unsteady state lumped systems and steady state/unsteady state distributed systems

CO5: Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions

CO6: Appreciate the applicability of stochastic, population balance model and data driven models

TEXT BOOKS


REFERENCES

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<td>CO2</td>
<td>Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods</td>
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<td>CO3</td>
<td>Create the mathematical models for different unit operations equipments such as stirred tank heaters, Heat exchangers, Evaporators, Reactors, distillation columns</td>
<td>PO 1</td>
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<tr>
<td>CO4</td>
<td>Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems</td>
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<td>CO5</td>
<td>Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions</td>
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<td>CO6</td>
<td>Appreciate the applicability of stochastic, population balance model and data driven models</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To understand the basics of various separation techniques and to select appropriate separation methodology, to determine the mass transfer coefficient for designing the size of the separator, to understand the preparatory and analytical chromatographic techniques.

List of Experiments:

1. Determination of VLE for a binary mixture at different temperatures
2. Determination of VLE & VLLE for a ternary mixture (azeotropic binary mixture and entrainer)
3. LLE of Extraction system of Type I, II and Type III systems
4. Study of extraction efficiency for the extraction of essential oils
5. Aqueous Two Phase Extraction and Design of ATPE using Hofmeister Series
6. Cross flow filtration using Microfiltration to characterize Specific cake resistance and filter medium resistance of membranes
7. Tangential flow filtration using Ultrafiltration for finding flux in membranes and to characterize concentration polarization and fouling
8. Verification of Vant Hoff Equation and design of reverse osmosis systems
9. Adsorption Equilibria and fixed bed adsorption studies for generation of breakthrough curves
10. Gas Hold up studies in sparged column, bubble column, wetted wall column
11. Determination of mass transfer coefficient in a wetted wall column
12. Preparative HPLC
13. Thin Layer and paper chromatography
14. Calculation of yield in crystallization process
15. Simulation of refinery operations (catalytic cracking, hydrocracking) using ASPEN HYSYS

COURSE OUTCOMES:

The students will be able to
CO1: Determine the VLE for binary and VLLE for ternary mixtures
CO2: Determine LLE for Type I, II, III L-L or L-S ternary mixtures
CO3: Understand and apply chromatographic techniques
CO4: Assess the performance in Cross Flow and Tangential Flow Filtration
CO5: Design RO systems based on Vant Hoff Equation
CO6: Simulate Industrial processes using ASPEN HYSYS

REFERENCES

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<td>Determine LLE for Type I, II, III L-L or L-S ternary mixtures</td>
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<td>CO3</td>
<td>Understand and apply chromatographic techniques</td>
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<td>Assess the performance in Cross Flow and Tangential Flow Filtration</td>
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<td>CO5</td>
<td>Design RO systems based on Vant Hoff Equation</td>
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<tr>
<td>CO6</td>
<td>Simulate Industrial processes using ASPEN HYSYS</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To develop and apply modern numerical methods to problems arising in chemical engineering. The overall aim is to shorten the development period from research bench to the industrial production stage by providing insight into the underlying processes to industrial level.

List of Experiments:
1. Practice in Computer simulation and mathematical modeling
2. Computational modeling of catalysts and materials
3. Computationally investigate the fundamental transport and kinetic properties
4. Symbiotic relationships of microbes and engineering the process
5. Development of predictive theories of Electro catalysis
7. Computational chemistry and modeling of elementary reaction
8. Computational modeling mechanisms and structure-function relationships
9. Mathematical Modeling and Computer Simulation for Oil Spills
10. Mathematical Model and Computer Simulation for petroleum reserves

TOTAL: 60 PERIODS

COURSE OUTCOMES:
The students will be able to
CO1: Understand about the various software’s used in chemical engineering industries and its applications
CO2: Learn about computing the laboratory data and analysis
CO3: Understand about Microsoft excel for solving various chemical engineering problems
CO4: Learn about the role of MATLAB in various chemical industries and its applications
CO5: Have basic knowledge about ASPEN and its application in various chemical industries
CO6: Learn about HYSYS and its application in chemical and petroleum refining industries

REFERENCES:
2. A Step by Step Approach to the Modeling of Chemical Engineering Processes - Ferrareso Lona, Liliane Maria, Springer, 2018
<table>
<thead>
<tr>
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<tr>
<td>CO1</td>
<td>Understand about the various software’s used in chemical engineering industries and its applications</td>
<td>![](1 1 2 2 2 - 1 - 1 1 - 1 - 2 1 1)</td>
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<tr>
<td>CO2</td>
<td>Learn about computing the laboratory data and analysis</td>
<td>![](2 2 3 3 2 - 1 - 1 1 - 1 1 2 1 1)</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand about Microsoft excel for solving various chemical engineering problems</td>
<td>![](2 2 3 3 2 - 1 - 1 1 - 1 1 2 1 1)</td>
</tr>
<tr>
<td>CO4</td>
<td>Learn about the role of MATLAB in various chemical industries and its applications</td>
<td>![](2 2 3 3 2 - 1 - 1 1 - 1 1 2 1 1)</td>
</tr>
<tr>
<td>CO5</td>
<td>Have basic knowledge about ASPEN and its application in various chemical industries</td>
<td>![](2 2 3 3 2 - 1 - 1 1 - 1 1 2 1 1)</td>
</tr>
<tr>
<td>CO6</td>
<td>Learn about HYSYS and its application in chemical and petroleum refining industries</td>
<td>![](2 2 3 3 2 - 1 - 1 1 - 1 1 2 1 1)</td>
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<tr>
<td><strong>Over all</strong></td>
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<td>![](2 2 3 3 2 - 1 - 1 1 - 1 1 2 1 1)</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5213  MINI PROJECT WITH SEMINAR

OBJECTIVE

To provide exposure to the recent developments, and to improve the student’s presentation skills.

COURSE OUTCOMES:

The students will be able to

CO1: Understand the basic mathematical calculations for project

CO2: Understand chemical properties and use it effectively in design of project work

CO3: Obtain knowledge on theoretical approach to utilize it in practical analysis

CO4: Gain knowledge on practical based work and use it to computational methods

CO5: Analyze data on CFD and other softwares

CO6: Take the lab data and analyze with real time problems to bring solutions
## Course Articulation Matrix:

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<td>CO1</td>
<td>Understand the basic mathematical calculations for project</td>
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<tr>
<td>CO2</td>
<td>Understand chemical properties and use it effectively in design of project work</td>
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<tr>
<td>CO3</td>
<td>Obtain knowledge on theoretical approach to utilize it in practical analysis</td>
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<tr>
<td>CO4</td>
<td>Gain knowledge on practical based work and use it to computational methods</td>
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<tr>
<td>CO5</td>
<td>Analyze data on CFD and other softwares</td>
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<tr>
<td>CO6</td>
<td>Take the lab data and analyze with real time problems to bring solutions</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
## PROJECT PHASE I

### OBJECTIVE

- To identify a specific problem related to Chemical Engineering and carrying out a detailed literature review.
- To identify the materials and methods required to carry out the project.
- To guide the students in preparing project reports, to present their findings in reviews and viva-voce examination.

### COURSE OUTCOMES:

The students will be able to

**CO1:** Demonstrate a depth of knowledge of Chemical Engineering.

**CO2:** Implement knowledge, processes, concepts, tools and techniques through literature review.

**CO3:** Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements.

**CO4:** Interact with team in a professional manner to ensure a collaborative project environment.

**CO5:** Experimental/Conceptual studies chosen based on area.

**CO6:** Ability to express clearly the findings and relate to theoretical background.

**TOTAL: 180 PERIODS**
## Course Articulation Matrix:

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<td>CO2</td>
<td>Implement knowledge, processes, concepts, tools and techniques through literature review.</td>
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<tr>
<td>CO3</td>
<td>Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements.</td>
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<td>CO4</td>
<td>Interact with team in a professional manner to ensure a collaborative project environment.</td>
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CL5411 PROJECT PHASE II

OBJECTIVE

- To execute the proposed procedure to solve the identified problem.
- To develop skills to analyze and discuss the results obtained and make conclusions.

COURSE OUTCOMES:

The students will be able to

CO1: Utilize technology and software tools for support.

CO2: Relate the findings to existing systems and priority for novel outcomes

CO3: Complete an independent research project, resulting in demonstration in Indian/International Conference

CO4: Research output by means of publications in Indian/International Journals

CO5: Research output by means of publications in proceedings and patents proposal.

CO6: Demonstrate an ability to present and defend their research work to a panel of experts.

TOTAL: 360 PERIODS
## Course Articulation Matrix:

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<tr>
<td>CO2</td>
<td>Relate the findings to existing systems and priority for novel outcomes</td>
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<tr>
<td>CO3</td>
<td>Complete an independent research project, resulting in demonstration in</td>
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<td>Research output by means of publications in Indian/International Journals</td>
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<td>CO5</td>
<td>Research output by means of publications in proceedings and patents</td>
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<td>CO6</td>
<td>Demonstrate an ability to present and defend their research work to a</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
PROFESSIONAL ELECTIVE COURSES [PEC]

Program Elective -I

CL5071

COMPUTATIONAL FLUID DYNAMICS

OBJECTIVE

To educate engineering graduates in the principles of computational fluid dynamics modeling and in interpretation of fluid dynamics principles.

UNIT I  INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS AND PRINCIPLES OF CONSERVATION

Basics Of Computational Fluid Dynamics, Fundamental principles of conservation, Governing equations of fluid flow and heat transfer –mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form.

UNIT II  FINITE DIFFERENCE APPROXIMATION

Classification of Partial Differential Equations, Mathematical behaviour of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods. Error and stability analysis

UNIT III  FINITE VOLUME METHOD

Diffusion problems – explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

UNIT IV  FLOW FIELD COMPUTATION

Pressure velocity coupling, staggered grid, SIMPLE algorithm, PISO algorithm for steady and unsteady flows

UNIT V  TURBULENCE MODELING AND GRID GENERATION

Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence Models - one and two equation, Reynolds stress, LES and DNS, Physical aspects of Grid generation, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

COURSE OUTCOMES:

The students will be able to

CO1: Understand the basics of CFD and governing equations for conservation of mass momentum and energy

CO2: Understand mathematical characteristics of partial differential equations.

CO3: Learn computational solution techniques for time integration of ordinary differential equations

CO4: Understand various discretization techniques used in CFD

CO5: Understand flow field computation techniques for steady and unsteady flows

CO6: Understand various turbulence models and grid generation techniques.

TOTAL: 45 PERIODS
TEXT BOOKS

REFERENCES
<table>
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<tr>
<th>Course Outcomes</th>
<th>Statement</th>
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<td>Understand the basics of CFD and governing equations for conservation of mass momentum and energy</td>
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<tr>
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<td>CO4</td>
<td>Understand various discretization techniques used in CFD</td>
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<td>CO5</td>
<td>Understand flow field computation techniques for steady and unsteady flows</td>
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<tr>
<td>CO6</td>
<td>Understand various turbulence models and grid generation techniques.</td>
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Over all

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5001  

DISTILLATION COMPONENTS AND ITS PROCESSES  

OBJECTIVE  

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To instruct Post graduates in the principles of Multi component Distillation and in designing.

UNIT I  

UNIT II  
Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III  

UNIT IV  
Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures – Hengstebeck Diagrams – Minimum reflux by Hengstebeck Diagrams – Key ratio Plots.

UNIT V  

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will understand

CO1: Basic thermodynamics properties such as fugacity coefficient ,activity coefficient with respect to multi component mixtures

CO2: Basic principle involved in separation multi component mixture and MC distillation

CO3: The general considerations in designing a multi component distillation column and different methods of column sequencing

CO4: The available methods for calculating minimum reflux ratio in a multi component distillation column

CO5: Different methods used in designing a multi component distillation column

CO6: The application of multi component distillation in petroleum industries
REFERENCES

## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Basic thermodynamics properties such as fugacity coefficient, activity coefficient with respect to multi component mixtures</td>
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<tr>
<td>CO2</td>
<td>Basic principle involved in separation multi component mixture and MC distillation</td>
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<tr>
<td>CO3</td>
<td>The general considerations in designing a multi component distillation column and different methods of column sequencing</td>
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<tr>
<td>CO4</td>
<td>The available methods for calculating minimum reflux ratio in a multi component distillation column</td>
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<tr>
<td>CO5</td>
<td>Different methods used in designing a multi component distillation column</td>
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<tr>
<td>CO6</td>
<td>The application of multi component distillation in petroleum industries</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To enable the Engineers to gain authority as Business analyst.

UNIT I BUSINESS ANALYTICS


UNIT II SUPPORT BUSINESS ANALYTICS


UNIT III BUSINESS ANALYTICS BE APPLIED


UNIT IV DESCRIPTIVE ANALYTICS


UNIT V PREDICTIVE ANALYTICS


TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Identify and describe complex business problems in terms of analytical models.

CO2: Apply appropriate analytical methods to find solutions to business problems that achieve stated objectives.

CO3: Translate results of business analytic projects into effective courses of action.

CO4: Demonstrate ethical decision-making in structured or unstructured and ambiguous situations.

CO5: Communicate technical information to both technical and non-technical audiences in speech, in writing, and graphically.

CO6: Exhibit effective collaboration and leadership skills.

REFERENCE BOOKS

1. Fundamentals of Business Analytics, 2ed Kindle Editionby Seema Acharya R N Prasad
2. Business Analytics: Applications To Consumer Marketing Hardcover – 1 Mar 2015by SandhyaKuruganti (Author), HindolBasu (Author)
## Course Articulation Matrix:

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<tr>
<th>Course Outcomes</th>
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<td>Identify and describe complex business problems in terms of analytical models.</td>
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<td>Apply appropriate analytical methods to find solutions to business problems that achieve stated objectives.</td>
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<td>CO3</td>
<td>Translate results of business analytic projects into effective courses of action.</td>
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<td>CO4</td>
<td>Demonstrate ethical decision-making in structured or unstructured and ambiguous situations.</td>
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<tr>
<td>CO5</td>
<td>Communicate technical information to both technical and non-technical audiences in speech, in writing, and graphically.</td>
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<td>Exhibit effective collaboration and leadership skills.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES

- To discuss mainly on the role of enzymes and microbes in biotechnology sectors.
- To understand the design parameters in designing biochemical reactors.

UNIT I  ENZYME CATALYSIS
Overview of biotechnology, Principles of Enzyme catalysis, Enzyme inhibition, Immobilized enzyme kinetics, internal mass transfer effects in immobilized enzyme kinetics.

UNIT II  MICROBIAL GROWTH
Stoichiometry and energetics of microbial growth, Metabolic pathways and energetics of the cell, concept of energy coupling, ATP and NAD, Unstructured models of microbial growth, Structured models of microbial growth.

UNIT III  BIOREACTOR DESIGN AND ANALYSIS
Bioreactors: CSTR, Plug flow and packed bed bioreactors, Fed batch reactors, Mass balances for two phase reactors, Power requirements, sterilization

UNIT IV  PRODUCT RECOVERY
Bioproduct recovery- Centrifugation, Filtration, Ultra filtration, Precipitation of Protein, Chromatography, Fixed bed adsorption, Phase theory of chromatography, Electrophoresis, Crystallization

UNIT V  BIOPRODUCTS AND ECONOMICS
Manufacturing of biological products, Economic analysis of bioprocesses, Capital costs and manufacturing costs, case studies.

COURSE OUTCOMES
The students will be
CO1: The students would develop the ability to design novel bioprocesses for their research.
CO2: The students will have the ability to improve skills in engineering aspects of biological systems
CO3: Students will find solutions to the problems with biomaterials and processes
CO4: Students will gain knowledge in bioreactors
CO5: Students will study economy of biobased industries.

REFERENCES

## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcomes</th>
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</thead>
<tbody>
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<td>The students would develop the ability to design novel bioprocesses for their research.</td>
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<tr>
<td>CO2</td>
<td>The students will have the ability to improve skills in engineering aspects of biological systems</td>
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<tr>
<td>CO3</td>
<td>Students will find solutions to the problems with biomaterials and processes</td>
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<tr>
<td>CO4</td>
<td>Students will gain knowledge in bioreactors</td>
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<tr>
<td>CO5</td>
<td>Students will study economy of biobased industries.</td>
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<td>CO6</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

To introduce the student to the principles and methods of statistical analysis of designed experiments, understand hypothesis testing, perform factorial designs for experiments and model using response surface techniques.

UNIT I

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments. Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.

UNIT II

Experiments with Single Factor; An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Nonparametric methods in the analysis of variance, Problems.

UNIT III

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments. Parameter Estimation

UNIT IV

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a second order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, Designs for fitting the second-order model, Blocking in response surface Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems

UNIT V

Design and Analysis: Introduction, Preliminary examination of subject of research, Screening experiments: Preliminary ranking of the factors, active screening experiment-method of random balance, active screening experiment Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Latin Square, Youdens Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Nongradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1: Understand sampling and sampling distribution

CO2: Apply Hypothesis testing with different confidence intervals

CO3: Perform ANOVA and regression analysis

CO4: Perform statistically designed experiments with and without blocking

CO5: Model the given data using Response Surface Methodology

CO6: Perform optimized experimentation like Plackett Burman design, Youden square
TEXT BOOKS


REFERENCES

## Course Articulation Matrix:

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<tr>
<th>Course Outcomes</th>
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**Over all**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
Program Elective -II

CL5004 MULTIPHASE FLOW

OBJECTIVE

- To analyze, characterize the multiphase systems and appreciate the role of structure in multiphase flows.
- To understand the limitations of modeling in multiphase flows and to comprehend engineering problems involving multiphase flows.

UNIT I

UNIT II
Prediction of holdup and pressure drop or volume fraction, Bubble size in pipe flow, Lock chart-Martinelli parameters, Bubble column and its design aspects, Minimum carryover velocity, holdup ratios, pressure drop and transport velocities and their prediction.

UNIT III
Flow patterns - identification and classification - flow pattern maps and transition - momentum and energy balance - homogeneous and separated flow models - correlations for use with homogeneous and separated flow models - void fraction and slip ratio correlations - influence of pressure gradient - empirical treatment of two phase flow - drift flux model - correlations for bubble, slug and annular flows.

UNIT IV
Averaging procedures - time, volume, and ensemble averaging, quasi-one-dimensional flow, two-fluid volume-averaged equations of motion, turbulence and two-way coupling.

UNIT V
Flow regime Hydrodynamic characteristics of gas-solid liquid contactors (agitated vessels, packed bed, fluidized bed, pneumatic conveying, bubble column, trickle beds), Applications of these contactors. Measurement techniques in multiphase flow: Conventional and novel measurement techniques for multiphase systems (Carpt, Laser Doppler anemometry, Particle Image Velocimetry)

TOTAL :45 PERIODS
COURSE OUTCOMES:
CO1: Understand the significance of multiphase flows and different flow pattern in multiphase flow.
CO2: Understand the determination of hydrodynamic parameters in the multiphase flow system.
CO3: Understanding the concept of different flow models
CO4: Understand the one dimensional two dimensional flow equation in turbulent condition
CO5: Understanding the Hydrodynamic characteristics in different contactors
CO6: Measurement techniques in multiphase flow: Conventional and novel measurement techniques

REFERENCES
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- Students will gain some knowledge of the main types of nanocomposite materials and their specific physical and chemical properties required in applications.

UNIT I


UNIT II

Hydroxyapatite composites with zirconia, alumina and titania – preparation and properties. SiC whisker reinforced hydroxyapatite and bioactive glass ceramics composites, zirconia toughened and bioactive glass ceramics composites, bioglass-hydroxyapatite composites, carbon composites

UNIT III

Elastic and strength properties – fracture behavior – fibre matrix load transfer – failure of a composite – criteria, damage of composites from physical and mechanisms to modeling, long term behavior of composite materials, high temperature stability – wear and friction.

UNIT IV

Nanotubes, nanoparticles and inorganic-organic hybrid systems: Single walled carbon nanotubes in epoxy composites; Fullerene/carbon nanotube (CNT) composites; Filled polymer nanocomposites containing functional nanoparticles; Polymer/calcium carbonate nanocomposites; Magnetic polymer nanocomposites; Phenolic resin/SiO2 organic-inorganic hybrid nanocomposites; Polymer/graphite nanocomposites; Wear resisting polymer nanocomposites: Preparation and properties

UNIT V


TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand importance of nano composite materials in engineering applications.

CO2: Understand various metal oxide nano composite preparation

CO3: Understand estimation of physical and chemical properties of nano composites

CO4: Understand polymeric nano composite synthesis

CO5: Understand biological synthesis of nano composites

CO6: Understand Multiscale modeling of nano composites
REFERENCES

2. Krishan Kumar Chawla, Composite Materials: Science and Engineering, springer
3. Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5006 PIPING AND INSTRUMENTATION

OBJECTIVE

- The students will be able to learn the key concepts in piping and instrumentation of process plants.

UNIT I
Types of fluid flow, Friction factor, line sizing, pressure drop and velocity calculation, selection of material under various condition, codes and standards, selection of pipe fittings, flanges, fasteners, and gaskets

UNIT II
Design principles, insulation concept, manual valves and automatic valves, ease of maintenance, pumps and compressors, pressure relief devices, heat transfer units, utilities, plant interlocks and alarms, stress analysis.

UNIT III
Block flow diagram, process flow diagram, symbols, P&ID, P&ID symbols, line and valve numbering concept, equipment identification, detailed engineering of the process.

UNIT IV
P&ID control and safety systems, Distributed Control Systems, signal lines, instruments used for pressure, temperature, flow.

UNIT V
Final Control Elements; application of P&ID in HAZOP, what – if, Fault tree analysis, Event tree analysis, & Risk analysis, Management of Change, cost approach.

TOTAL: 45 PERIODS

COURSE OUTCOME :
The students will be able to

CO1 : Recognize the materials, codes & standards used for piping the process plants.

CO2 : Explain the piping design principle & importance of utilities in industrial process plants.

CO3 : Understand the use of block diagram, process flow diagram and the detailed engineering concept.

CO4 : Understand the importance of safety control systems during piping instrumentation

CO5 : Explain the importance control elements for the efficient design of process control loops for process engineering plants.


TEXT BOOKS

## Course Articulation Matrix:

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<td>Recognize the materials, codes &amp; standards used for piping the process plants.</td>
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<td>Understand the use of block diagram, process flow diagram and the detailed engineering concept.</td>
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<td>Explain the importance control elements for the efficient design of process control loops for process engineering plants.</td>
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<td>CO6</td>
<td>Draw a complete Process &amp; Instrumentation Diagram with effective plant wide control strategies using appropriate heuristics and its application.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- This course introduces the principles and methods to control air, water and soil pollution

UNIT I

Introduction: Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents.

UNIT II

Pollution Prevention: Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance

UNIT III

Air Pollution Control: Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers.

UNIT IV

Water Pollution Control: Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.

UNIT V


TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand importance of environment and different types of pollution

CO2: Explain causes and preventive measures against air pollution

CO3: Select and design Pollution control equipments

CO4: Describe causes and preventive measures against water pollution.

CO5: Design anaerobic treatment devices

CO6: Understand solids disposal and their effective handling
TEXT BOOKS


REFERENCES

1. "Pollution Control Acts, Rules, Notifications issued there under" CPCB, Ministry of Env. and Forest, G.O.I., 3rd Ed. 2006
2. Eckenfelder W.W;“Industrial Water Pollution Control”, 2 Ed; McGraw Hill
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<td>Explain causes and preventive measures against air pollution</td>
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<tr>
<td>CO3</td>
<td>Select and design Pollution control equipments</td>
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<tr>
<td>CO4</td>
<td>Describe causes and preventive measures against water pollution.</td>
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<tr>
<td>CO5</td>
<td>Design anaerobic treatment devices</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Understand solids disposal and their effective handling</td>
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<td><strong>Over all</strong></td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5008  POLYMER PROCESSING TECHNOLOGY

OBJECTIVE

- Students will gain knowledge about mechanism of polymer process and its application

UNIT I  GENERAL ASPECTS OF POLYMERS  9

Classification of polymers, Types and mechanism of polymerization, Functionality-degree of polymerization, Techniques of polymerization, properties - molecular weight, glass transition temperature, crystallinity, thermal, electrical and mechanical properties.

UNIT II  MIXING AND MOULDING TECHNIQUES  9


UNIT III  PROCESSING AND TESTING OF POLYMER MATERIALS  9

Processing additives, plasticzer, antiaging additives, Catalysts, Analytical tests: determination of specific gravity, water absorption, Non-destructive testing: ultrasonic testing, X-ray fluorescence, Acoustic emission (AE) testing.

UNIT IV  ELASTOMERS AND APPLICATION ORIENTED POLYMERS  9


UNIT V  POLYMER COMPOSITES  9


TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1: Understand the fundamentals of polymers and mechanism of polymerization techniques.

CO2: Apply the mechanism and effectiveness of polymerization in making finished materials.

CO3: Understand the knowledge of developing new formulations and products from elastomers.

CO4: Understand the knowledge of polymer stability and unique definition of the product by evaluating molecular weight

CO5: Understand the manufacture and properties of application oriented industrial polymers.

CO6: Acquire knowledge on different tests for characterization of polymer for applications in R & D work
TEXT BOOKS

## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO 1</th>
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<th>PSO 3</th>
<th>PSO 4</th>
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<tr>
<td>CO1</td>
<td>Understand the fundamentals of polymers and mechanism of polymerization techniques.</td>
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<tr>
<td>CO2</td>
<td>Apply the mechanism and effectiveness of polymerization in making finished materials.</td>
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<tr>
<td>CO3</td>
<td>Understand the knowledge of developing new formulations and products from elastomers.</td>
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<tr>
<td>CO4</td>
<td>Understand the knowledge of polymer stability and unique definition of the product by evaluating molecular weight</td>
<td>3</td>
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<tr>
<td>CO5</td>
<td>Understand the manufacture and properties of application oriented industrial polymers.</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Acquire knowledge on different tests for characterization of polymer for applications in R &amp; D work</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To gain knowledge on the various risks encountered in the chemical industries to analyze its cause and how it can be effectively managed.

UNIT I
General: Risk types, Completion, Permitting, Resource, Operating, Environmental, Manageable, Insurable, Risk Causes, Risk Analysis types and causes.

UNIT II

UNIT III
Risk Management: Emergency relief Systems, Diers program, Bench scale experiments, Design of emergency relief systems, Internal emergency planning, Risk management plan, mandatory technology option analysis, Risk management alternatives, risk management tools, risk management plans, Risk index method, Dowfire and explosion method, Mond index Method.

UNIT IV

UNIT V

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Investigate characteristics of risk management system
CO2: Learn techniques such as Quantitative Sensitivity Analysis, Goal programming for Risk Management.
CO3: Design Risk management systems
CO4: Perform Risk Assurance and Assessment
CO5: Perform Fault tree analysis and Event tree analysis
CO6: Assess Risk in Process industries and manage the risks
TEXT BOOKS


REFERENCES

## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcomes</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Investigate characteristics of risk management system</td>
<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
</tr>
<tr>
<td>CO2</td>
<td>Learn techniques such as Quantitative Sensitivity Analysis, Goal programming for Risk Management.</td>
<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
</tr>
<tr>
<td>CO3</td>
<td>Design Risk management systems</td>
<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
</tr>
<tr>
<td>CO4</td>
<td>Perform Risk Assurance and Assessment</td>
<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
</tr>
<tr>
<td>CO5</td>
<td>Perform Fault tree analysis and Event tree analysis</td>
<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
</tr>
<tr>
<td>CO6</td>
<td>Assess Risk in Process industries and manage the risks</td>
<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
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<tr>
<td>Over all</td>
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<td>PO1 2 2 2 2 - 1 - 2 1 3 3 - 1 2 1</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5010

PROJECT ENGINEERING OF PROCESS PLANTS

OBJECTIVE

• To educate students about various Management roles and responsibilities in a Process Plants

UNIT I

Basic considerations in chemical engineering plant design: Preliminary data collection, Plant Location and Site Selection, Construction of Plant, Layout diagrams, Flow diagrams, Plot plans

UNIT II


UNIT III

Plant Engineering Management, Objectives, Programme, Control, use of scale models, Scheduling, Engineering design and Drafting, Selection and procurement of equipment and machineries, Installation, pre commission, Commissioning and performance appraisal, Product planning and development, Provision and maintenance of service facilities.

UNIT IV

Process safety, Materials safety and Handling regulations, Hazard studies, Safety in equipment and machinery operations, Design considerations of safety organization and control, Pollution, Pollution control and Abatement, Regulations of Pollution Control Board, Industrial Safety Standard Analysis.

UNIT V

Government regulations on procurement of raw materials and its allocation. Export – Import regulations, Pricing policy, Industrial licensing procedure, Excise and other commercial taxes, Factory act, Value Engineering

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to

CO1: Obtain basic knowledge on subject and various graphical representations of a process plant

CO2: Carry out the primary techno-economic feasibility of project.

CO3: Understand the sequential process in starting a Chemical Plant

CO4: Gain knowledge on Safety, Environmental and Legal aspects of Process Plants

CO5: Obtain knowledge on various procedures involved in Taxes, Export/ Import, Licensing etc.,

CO6: Select appropriate process for a project.
REFERENCES

8. Gillian lawson Stephen wearne and Peter iles-smith., “Project management for the process industries”, Institution of Chemical Engineers, IChemE, 1999
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<th>PSO 2</th>
<th>PSO 3</th>
<th>PSO 4</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Obtain basic knowledge on subject and various graphical representations of a process plant</td>
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<tr>
<td>CO2</td>
<td>Carry out the primary techno-economic feasibility of project.</td>
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<tr>
<td>CO3</td>
<td>Understand the sequential process in starting a Chemical Plant</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Gain knowledge on Safety, Environmental and Legal aspects of Process Plants</td>
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<tr>
<td>CO5</td>
<td>Obtain knowledge on various procedures involved in Taxes, Export/Import, Licensing etc.,</td>
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<tr>
<td>CO6</td>
<td>Select appropriate process for a project.</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
### OBJECTIVE
- To develop the Expertise for optimization in various decision making.

### UNIT I  
**LINEAR MODELS**


### UNIT II  
**TRANSPORTATION MODELS AND NETWORK MODELS**


### UNIT III  
**INVENTORY MODELS**

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

### UNIT IV  
**QUEUEING MODELS**

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

### UNIT V  
**DECISION MODELS**


### COURSE OUTCOMES:

The students will be able to

- **CO1:** To use the optimization techniques for use of Technology and Business problems
- **CO2:** Acquire knowledge in resource management techniques and tools and have the capability apply in any systems concerned, like, computer system or electrical system or mechanical system, or so.
- **CO3:** Have the capability to apply mathematical knowledge, data structure and algorithmic principles in design and development for software system
- **CO4:** Acquire leadership/managerial capabilities in decision making, analyse the alterable and mange the digital assets.
- **CO5:** Acquire knowledge in the area of computer networks, including wireless mobile networks, with the due experience
- **CO6:** Ability to write object oriented programs in linear models.
REFERENCES:

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<th>PSO 1</th>
<th>PSO 2</th>
<th>PSO 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To use the optimization techniques for use of Technology and Business problems</td>
<td>1</td>
<td>2</td>
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<tr>
<td>CO2</td>
<td>Acquire knowledge in resource management techniques and tools and have the capability apply in any systems concerned, like, computer system or electrical system or mechanical system, or so.</td>
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<tr>
<td>CO3</td>
<td>Have the capability to apply mathematical knowledge, data structure and algorithmic principles in design and development for software system</td>
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<tr>
<td>CO4</td>
<td>Acquire leadership/managerial capabilities in decision making, analyse the alterable and manage the digital assets.</td>
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<tr>
<td>CO5</td>
<td>Acquire knowledge in the area of computer networks, including wireless mobile networks, with the due experience</td>
<td>1</td>
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<tr>
<td>CO6</td>
<td>Ability to write object oriented programs in linear models.</td>
<td>1</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To develop the Expertise for optimization in various decision making.

UNIT I INTRODUCTION

Problem formulation, degree of freedom analysis, objective functions, constraints and feasible region, Types of optimization problem.

UNIT II LINEAR PROGRAMMING

Simplex method, Barrier method, sensitivity analysis, Examples.

UNIT III NONLINEAR UNCONSTRAINED OPTIMIZATION

Convex and concave functions unconstrained NLP, Newton’s method Quasi-Newton’s method, Examples.

UNIT IV CONSTRAINED OPTIMIZATION

Direct substitution, Quadratic programming, Penalty Barrier Augmented Lagrangian Methods.

UNIT V MULTI OBJECTIVE OPTIMIZATION

Weighted Sum of Squares method, Epsilon constrain method, Goal attainment, Examples. Introduction to optimal control and dynamic optimization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Understand the basics problem formulation and optimization.
CO2: Understand mathematical characteristics of Linear programming.
CO3: Learn computational solution techniques for nonlinear unconstrained optimization.
CO4: Understand various techniques used in constrained optimization
CO5: Understand the optimal and dynamic optimization.
CO6: Understand constrained and unconstrained related design problems.

REFERENCES

## Course Articulation Matrix:

| Course Outcomes | Statement                                                                 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|-----------------|---------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| CO1             | Understand the basics problem formulation and optimization.              | 1    | 2    | 3    | 3    | 3    | 1    | -    | 1    | 3    | 3     | 2     | 3     | 1     | 2     | 3     | 1     |
| CO2             | Understand mathematical characteristics of Linear programming.          | 1    | 2    | 3    | 3    | 3    | 1    | -    | 1    | 3    | -     | 2     | -     | 1     | 2     | 2     | -     |
| CO3             | Learn computational solution techniques for nonlinear unconstrained optimization. | 2    | 2    | 3    | 3    | 3    | 1    | -    | 1    | 2    | -     | 2     | -     | 1     | 2     | 2     | -     |
| CO4             | Understand various techniques used in constrained optimization          | 1    | 3    | 3    | 3    | 3    | 1    | -    | 1    | 2    | -     | 2     | -     | 1     | 2     | 2     | -     |
| CO5             | Understand the optimal and dynamic optimization.                         | 2    | 2    | 3    | 3    | 3    | 1    | -    | 1    | 2    | -     | 1     | -     | 1     | 2     | 2     | -     |
| CO6             | Understand constrained and unconstrained related design problems.       | 2    | 2    | 3    | 3    | 3    | 1    | -    | 1    | 3    | -     | 1     | -     | 1     | 2     | 2     | -     |
| **Overall**     |                                                                           | 2    | 2    | 3    | 3    | 3    | 1    | -    | 1    | 3    | 3     | 2     | 3     | 1     | 2     | 2     | -     |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE

- To introduce computer and its application to solve problems in Chemical Engineering operation thru required software.

UNIT I INTRODUCTION TO C LANGUAGE
Introduction on Programming languages, C and C++, Review on operating system commands. Use of C programs to solve chemical engineering problems.

UNIT II MICROSOFT EXCEL

UNIT III MATLAB
Introduction to MATLAB, workspace environment, variable and data entry, matrix operations, MATLAB functions, Programming in MATLAB to solve Chemical engineering problems. Introduction to Simulink.

UNIT IV ASPEN
Introduction to ASPEN, application of ASPEN in chemical engineering problems, simulation of Individual process equipment and flow sheet using Aspen Plus and property analysis and estimation using Aspen Properties.

UNIT V HYSYS
Introduction to HYSYS, process modelling and simulation using HYSYS, design performance monitoring using HYSYS, application of HYSYS in petroleum industries, case studies.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Students will
CO1: Understand about the various software’s used in chemical engineering industries and its applications
CO2: Learn about C and C++ language and its application in chemical engineering industries
CO3: Understand about Microsoft excel for solving various chemical engineering problems
CO4: Learn about the role of MATLAB in various chemical industries and its applications
CO5: Have basic knowledge about ASPEN and its application in various chemical industries
CO6: Learn about HYSYS and its application in chemical and petroleum refining industries

TEXT BOOKS

REFERENCES
## Course Articulation Matrix

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<th>Course Outcomes</th>
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<td>CO3</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CL5014 THERMAL PROCESSING OF FOOD PRODUCTS

OBJECTIVE

Students develop a sound working knowledge on different types of thermal processing of food products.

UNIT I PRINCIPLES OF MASS AND ENERGY BALANCE

Transport phenomena with respect to foods; Factors affecting heat and mass transfer; Study of heat transfer and its application in the design of thermal processes and freezing. Thermal processing; calculation of process time temperature-schedules.

UNIT II PROCESSING AND PRESERVATION BY LOW TEMPERATURE METHODS

Use of low temperature – Principles, equipment and effect on quality: Chilling, cold storage. Principles of food freezing: freezing point of foods, Psychrometric chart, Freeze concentration, freeze drying, IQF. New direction in freeze bed drying, cyclic pressure freeze drying, types of dryers including Microwave drying and vacuum drying, efficient drying systems, freezing of foods, types of freezing equipments, freezing point curves, phase diagrams, methods of freeze concentration, design problems

UNIT III DRYING

Principles of drying, drying rate, factors affecting heat and mass transfer during drying; different drying methods including tray, drum, foam mat, spray, freeze and other newer drying methods; construction and design of drying equipment; adiabatic driers, influence of drying on pigments and enzymes; Dehydration of fruits, vegetables, milk, animal products etc. Design parameters of different type of dryers; properties of air-water mixtures

UNIT IV ASEPTIC PROCESSING

Canning and Retort treatment of foods; spoilage of canned foods, storage of canned foods; Influence of canning on the quality of food; improvement in canning technology; Pasteurization, TST and UHT treatment of milk, fruit juices and other liquid foods. In Package and In flow thermal processing equipments- plate, spiral and shell and tube heat exchangers

UNIT V EMERGING PROCESSING TECHNOLOGIES

High Pressure Processing – principles, mechanism of action, advantages and disadvantages over conventional processing; Equipment and applications in food industry, Pulsed electric field processing - principles, mechanism of action, advantages and disadvantages over conventional processing; Equipment and applications in food industry. Ohmic heating of foods - principles, mechanism of action, advantages and disadvantages over conventional processing; Equipment and applications in food industry, Infra – red heating – principles, mechanism of action food application. Principles of radiation processing, applications like disinfection, pasteurization and sterilization, extending shelf life of plant products, advantages and limitations

TOTAL: 45 PERIODS
COURSE OUTCOMES

The students will be able to

CO1: Understand and apply engineering principle to food processing
CO2: Develop problem solving ability on types of loads and capability to design cold storage systems for food products
CO3: Understand the role of drying in preservation of different foods
CO4: Understand the principles of aseptic processing of foods
CO5: Gain knowledge on the recent developments in food processing techniques
CO6: Apply heat transfer principles for processing and preserving food

TEXT BOOKS

3. Barbosa-Canovas, Gustavo et al., “Novel Food Processing Technologies”, Marcel Dekker/CRC, 2005

REFERENCES

2. S. Yanniotis, B. Sunden, Heat Transfer in Food Processing, Recent Developments and Applications, WIT Press, Southampton, 2007
## Course Articulation Matrix:

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Over all: - - 3 2 2 1 1 2 1 1 1 2 2 3 3 2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CL5015  ENERGY FROM WASTE

OBJECTIVE

- Students will gain knowledge about valuing the needs of energy saving and how to convert waste to wealth.

UNIT I

Waste to energy—an introduction—energy supply and waste management—Importance of energy management, Energy auditing; methodology and analysis of past trends (plant data)—Sources of energy-renewable and non-renewable sources of energy

UNIT II


UNIT III


UNIT IV


UNIT V

Pollution control systems for waste to energy technologies-transformation of waste combustion facilities from major polluters to pollution sinks—Air quality equipment and systems for waste to energy conversion plants; case studies

TOTAL: 45 PERIODS
COURSE OUTCOMES:
The students will be able to

CO1: Understand the knowledge of Valuing energy sources
CO2: Defining the concept of various energy saving technologies
CO3: Reviews the waste hierarchy and waste to energy systems options along with the environmental and social impact of WTE conversion plants
CO4: Explores the engineering and technology behind WTE systems including considerations of municipal solid waste (MSW) its treatment, combustion and gasification
CO5: Considers pollution control systems for WTE technologies including the transformation of wast combustion facilities from major polluters to pollution sinks

TEXT BOOKS
Waste to energy conversion Technology by M Castaldi, N Klinghoffer, Woodhead Publishing

REFERENCE BOOKS
### Course Articulation Matrix:

| Course Outcomes | Statement                                                                                   | PE O1 | PE O2 | PE O3 | PE O4 | PE O5 | P O 1 | P O 2 | P O 3 | P O 4 | P O 5 | P O 6 | P O 7 | P O 8 | P O 9 | P O 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|-----------------|---------------------------------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| CO1             | Understand the knowledge of Valuing energy sources                                           | 1     | 1     | 1     | 3     | 2     | 3     | 2     | 3     | 2     | 3     | 2     | 3     | 2     | 3     | 2     | 2     | 3     | 2     |
| CO2             | Defining the concept of various energy saving technologies                                   | 2     | 2     | 1     | 2     | 3     | -     | -     | 2     | 2     | 3     | 2     | 3     | -     | 2     | 2     | 3     | 2     | 3     |
| CO3             | Reviews the waste hierarchy and waste to energy systems options along with the environmental and social impact of WTE conversion plants | 2     | 2     | 2     | 3     | 2     | 3     | -     | 3     | -     | 2     | 2     | 3     | 2     | 3     | -     | -     | -     | -     |
| CO4             | Explores the engineering and technology behind WTE systems including considerations of municipal solid waste (MSW) its treatment, combustion and gasification | 2     | 2     | 3     | 2     | 3     | 2     | -     | -     | -     | 2     | 2     | 2     | 3     | 2     | 3     | 2     | 2     | 3     | 3     |
| CO5             | Considers pollution control systems for WTE technologies including the transformation of wast combustion facilities from major polluters to pollution sinks | 2     | 2     | 2     | 3     | 2     | 3     | -     | 3     | -     | 2     | 2     | 3     | 2     | 3     | -     | 2     | 2     | 3     | 3     |

**overall** 2 2 2 3 3 3 1 3 2 2 2 2 2 2 2 2 2 2 3 3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- To encompass the new areas and introduce reactor models specifically for these Contacting regimes.

UNIT I INTRODUCTION

Phenomenon of fluidization, behaviour of fluidized beds, Characterization of particles, particle forces, operating models for fluidization systems, Industrial application of fluidized beds

UNIT II HYDRODYNAMICS OF FLUIDIZATION SYSTEMS

General bed behaviour, Incipient Fluidization, Pressure fluctuations, Phase Holdups, Measurements Techniques minimum fluidization velocity, pressure drop, fluidization with carryover of particles, mapping of fluidization regimes.

UNIT III DENSE BEDS

Distributor types, gas entry region of a bed, gas jets, pressure drop across distributors, design of a gas distributors, power consumption, single rising bubbles, coalescence and splitting of bubbles, bubble formation. Slug flow.

UNIT IV BUBBLING FLUIDIZED BEDS, ENTRAINMENT AND ELUTRIATION

Estimation of bed properties, physical model and flow model, freeboard behaviour, entrainment from tall and short vessels, high velocity fluidization.

UNIT V SOLID MOVEMENT, MASS AND HEAT TRANSFER

Solid movement, mixing, segregation and staging, gas dispersion and gas interchange in bubbling beds, Particle to gas mass and heat transfer, applications of two phase and three phase fluidized beds

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students would be able to

CO1: Understand the basics of fluidization and know the various industrial applications of fluidization
CO2: Learn the concepts of hydrodynamics in fluidized bed
CO3: Comprehend the formation and growth of bubble dynamics
CO4: Understand the bed behavior for various geometries of fluidized beds
CO5: Identify with the transport processes of fluidized beds
CO6: Gain knowledge on the fundamentals, transport processes and applications of fluidized beds.

REFERENCES

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- To have a complete knowledge about industrial safety of a chemical process plant.

UNIT I

Safety, safety responsibility and organization, OHS, safety policy, safety inspection, employees participation in safety, safety legislation, plant siting and layout, regulatory agencies with safety in India and Abroad, types of accidents in industry, case study.

UNIT II

Industrial hazard, hazard management program, hazard identification and assessment, Material hazard: Toxicity, Radiation, Flammability, fires, explosion, runaway chemical reaction, MSDS sheet, list of industries involving hazardous process, Factory Act, 1948

UNIT III

Environment, Need for environment control, lighting, importance of adequate lighting, lighting design, colour codes used in industry, heat control, ventilation and air conditioning, legal requirements, noise, noise measurement and control, vibration, industrial fatigue, EIA

UNIT IV

Industrial waste, waste classification, waste water treatment, waste disposal, storage, occupational health problems, medical examination in industry, PPE, Training & Maintenance of PPE.

UNIT V

Quality standards, ISO 9000, ISO 9000 : 2000 Quality Management principles, Benefits, workplace emergency, emergency planning, on-site and offsite planning, fire emergency procedure, safety symbols, safety signs and colour at work, training.

TOTAL: 45 PERIODS

COURSE OUTCOME:

The students will be able to

CO1: Understand the importance of industrial safety and safety regulations all over the world.

CO2: Analyse the effect of material hazard

CO3: Evaluate the importance of EIA in chemical industries

CO4: Classify the industrial waste and recommend the relevant PPE.

CO5: Be familiar with quality management principles and the importance of emergency planning.

CO6: Have a complete knowledge on industrial safety, environmental impact, rules and regulations.

TEXT BOOKS:

1. Industrial Safety and Environment, Amit Kumar Gupta, Laxmi Publications Ltd., 2006
2. Chemical process industrial safety, KSN Raju, McGraw Hill, 2014

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<td>Understand the importance of industrial safety and safety regulations all over the world.</td>
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<td>Analyse the effect of material hazard</td>
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<td>CO3</td>
<td>Evaluate the importance of EIA in chemical industries</td>
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<td>CO4</td>
<td>Classify the industrial waste and recommend the relevant PPE.</td>
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<td>CO5</td>
<td>Be familiar with quality management principles and the importance of emergency planning.</td>
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<td>CO6</td>
<td>Have a complete knowledge on industrial safety, environmental impact, rules and regulations.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CL5017  MEMBRANE TECHNOLOGY FOR WATER AND WASTEWATER TREATMENT

OBJECTIVE

The objective of the course is to give the students the technical background on membrane technology and to provide wide level of understanding that will allow them to design, using appropriate combinations of unit processes and water treatment plant.

UNIT I  INTRODUCTION

Solid Liquid separation systems- Filtration systems- Theory of Membrane separation – mass Transport Characteristics, Cross Flow filtration-Membrane Filtration- Types and choice of membranes, porous, non porous, symmetric and asymmetric, Membrane modules – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes

UNIT II  MEMBRANE PROCESSES AND SYSTEMS


UNIT III  MEMBRANE BIOREACTORS


UNIT IV  PRETREATMENT SYSTEMS

Membrane Fouling – Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning, Biofoulant control

UNIT V  CASE STUDIES

Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1:  Understand the basic principle, different types of membrane and membrane modules.

CO2:  Understand the various membrane process and design of membrane systems

CO3:  Understand the concepts of MBRs, Configuration and their design aspects

CO4:  Understand operational issues, limitations and System Configuration.

CO5:  Design, using appropriate combinations of unit processes and waste water treatment plant.

CO6:  Select appropriate membrane separation technique for intended problem.
REFERENCES

1. Water Environment Federation (WEF), Membrane Systems for Wastewater Treatment, McGraw-Hill, USA, 2005
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<th>Course Outcomes</th>
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<td>Understand the basic principle, different types of membrane and membrane modules.</td>
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<td>Understand the concepts of MBRs, Configuration and their design aspects</td>
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<td>Understand operational issues, limitations and System Configuration.</td>
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<td>CO5</td>
<td>Design, using appropriate combinations of unit processes and waste water treatment plant.</td>
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<td>Select appropriate membrane separation technique for intended problem.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE

- To introduce fundamental concept of Bioprocesses to Chemical Engineers to deal with the design and construction of unit processes that involve biological organisms or molecules.

UNIT I FRONTIERS OF BIOPROCESSING


UNIT II INTRODUCTION TO CELLULAR MICROBIOLOGY


UNIT III REACTION STOICHIOMETRY, THERMODYNAMICS, AND KINETICS


UNIT IV Upstream Processing

Bioreactors, Batch Culture, Continuous Culture, Fed-Batch Culture, Perfusion Culture, Suspension Culture, Microcarrier Support, Roller Bottle Culture System, Spinner Flask Culture, Other Scale up Options, Wave Bioreactor, Cell Cube Technology, Rotary Culture System, Media.

UNIT V DOWN STREAM PROCESSING

Purification Processes - Centrifugation, adsorption, Electrophoresis, Crystallization Protein Properties, Chromatography, Scale-up and Optimization.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understand all Bioprocesses and need of chemical basics in bioprocesses.
CO2: To study the basic of cell and its internal constituents
CO3: To express reaction mechanisms in terms of chemical kinetics.
CO4: To utilize all unit operations in upstream process in manufacturing Industries.
CO5: Understand the downstream processing and industrial bioreactors
CO6: To apply theoretical knowledge to industrial production.

TEXT BOOKS


REFERENCES

## Course Articulation Matrix:

<table>
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<tr>
<th>Course Outcomes</th>
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<tr>
<td>CO1</td>
<td>Understand all Bioprocesses and need of chemical basics in bioprocesses.</td>
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<td>CO2</td>
<td>To study the basic of cell and its internal constituents</td>
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<td>CO3</td>
<td>To express reaction mechanisms in terms of chemical kinetics.</td>
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<td>CO4</td>
<td>To utilize all unit operations in upstream process in manufacturing Industries.</td>
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<td>CO5</td>
<td>Understand the downstream processing and industrial bioreactors</td>
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<td>CO6</td>
<td>To apply theoretical knowledge to industrial production</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I  OVERVIEW OF BUSINESS ANALYTICS  9

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II  ESSENTIALS OF BUSINESS ANALYTICS  9

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III  MODELING UNCERTAINTY AND STATISTICAL INFERENCE  9

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
UNIT IV  ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK


Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V  OTHER DATA ANALYTICAL FRAMEWORKS

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the student will be able to:
- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I  INTRODUCTION

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II  FUNDAMENTALS OF MAINTENANCE ENGINEERING

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III  WEAR AND CORROSION AND THEIR PREVENTION


UNIT IV  FAULT TRACING

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V  PERIODIC AND PREVENTIVE MAINTENANCE

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

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OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I  LINEAR PROGRAMMING  9
Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II  ADVANCES IN LINEAR PROGRAMMING  9
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III  NETWORK ANALYSIS – I  9
Transportation problems -Northwest corner rule, least cost method, Voges’s approximation method - Assignment problem - Hungarian algorithm

UNIT IV  NETWORK ANALYSIS – II  9
Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method - CPM/PERT

UNIT V  NETWORK ANALYSIS – III  9
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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REFERENCES:

OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I  INTRODUCTION TO COSTING CONCEPTS  9
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II  INTRODUCTION TO PROJECT MANAGEMENT  9
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning, Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III  PROJECT EXECUTION AND COSTING CONCEPTS  9
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV  COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL  9
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V  QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT  9
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES
- CO1 – Understand the costing concepts and their role in decision making
- CO2 – Understand the project management concepts and their various aspects in selection
- CO3 – Interpret costing concepts with project execution
- CO4 – Gain knowledge of costing techniques in service sector and various budgetary control techniques
- CO5 – Become familiar with quantitative techniques in cost management

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2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
OBJECTIVES:
- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES

UNIT V STRENGTH
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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REFERENCES:
OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE
- Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS
- Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION

UNIT IV BIOMASS COMBUSTION
- Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY
- Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructive features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 – Understand the various types of wastes from which energy can be generated
- CO2 – Gain knowledge on biomass pyrolysis process and its applications
- CO3 – Develop knowledge on various types of biomass gasifiers and their operations
- CO4 – Gain knowledge on biomass combustors and its applications on generating energy
- CO5 – Understand the principles of bio-energy systems and their features

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AX5091  ENGLISH FOR RESEARCH PAPER WRITING  L T P C  2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I  INTRODUCTION TO RESEARCH PAPER WRITING  6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II  PRESENTATION SKILLS  6

UNIT III  TITLE WRITING SKILLS  6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV  RESULT WRITING SKILLS  6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V  VERIFICATION SKILLS  6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I  INTRODUCTION  6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II  REPERCUSSIONS OF DISASTERS AND HAZARDS  6

UNIT III  DISASTER PRONE AREAS IN INDIA  6
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV  DISASTER PREPAREDNESS AND MANAGEMENT  6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V  RISK ASSESSMENT  6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C 2 0 0 0

OBJECTIVES
• Illustrate the basic sanskrit language.
• Recognize sanskrit, the scientific language in the world.
• Appraise learning of sanskrit to improve brain functioning.
• Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
• Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6
Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6
Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES
• CO1 - Understanding basic Sanskrit language.
• CO2 - Write sentences.
• CO3 - Know the order and roots of Sanskrit.
• CO4 - Know about technical information about Sanskrit literature.
• CO5 - Understand the technical concepts of Engineering.

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1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbashastrī, Rashtriya Sanskrit Sansthanam, New Delhi Publication
OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Workethics, Indian vision of humanism. Moral and non-moral evaluation. Standards and principles. Value judgements

UNIT II

UNIT III

UNIT IV

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of human values.
- Developing the over all personality.

Suggested reading
OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reform sliding to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party (CSP) under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading
1. The Constitution of India, 1950 (Bare Act), Government Publication.
OBJECTIVES
Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT II INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading
OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects - Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. “YogicAsanasforGroupTraining-Part-I”: Janardan Swami Yogabhyasi Mandal, Nagpur
2. “Rajayogaorconquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama
(Publication Department), Kolkata
OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I

Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont’s) - Verses- 71,73,75,78 (do’s)

UNIT II

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrmsadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagy, New Delhi,2010