# BRANCH-CHEMICAL ENGINEERING

**Specialization:** Chemical Engineering

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<tr>
<th>Second Semester</th>
<th>Theory</th>
<th>Practical</th>
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<tr>
<td><strong>Course Name</strong></td>
<td><strong>Hours/Week L/T</strong></td>
<td><strong>Credit</strong></td>
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<tr>
<td>Specialization Core-1 Petroleum Refinery Engineering</td>
<td>4-0</td>
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<tr>
<td>Specialization Core-2 Advanced Separation Techniques</td>
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<tr>
<td>Elective I (Specialization related)</td>
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<tr>
<td>1. Advanced Fluid Dynamics</td>
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<td>2. Mineral Beneficiation</td>
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<td>3. Advance Process Control</td>
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<td>4. Advance Chemical Reaction Engineering &amp; Reactor Design</td>
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<tr>
<td>Elective II (Departmental related)</td>
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<tr>
<td>1. Multiphase Flow</td>
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<td>2. Bioprocess Engineering</td>
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<td>3. Advances in Bio-Chemical Engineering</td>
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<td>4. Process Plant Simulation</td>
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<td>Elective III (from any department)</td>
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<td>1. Air Pollution Control Equipment Design</td>
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<td>2. Thermodynamics in Process Design</td>
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<td>3. Non-conventional Energy</td>
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<td>4. Industrial Pollution Control</td>
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<td>Lab-2 (Specialization lab to be decided by the department)</td>
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<td>Seminar/Project</td>
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<td>Total Marks: 1050</td>
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<td>Total Credits: 28</td>
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PETROLEUM REFINERY ENGINEERING

UNIT I

Origin, Exploration and production of petroleum, Types of crudes, Composition, characteristics, products pattern and characteristics, indigenous and imported crudes, Availability Vs Demands, Future outlook.

UNIT II

Engineering aspects of refining, Reaction stoichiometry; Chemical kinetics; Thermochemistry and chemical equilibrium; Mixing in flow systems; Reactor design. Crude heating, Primary distillation, principles, Separation of cuts, Gaps/ overlaps, Stripping, Desalting, heat balance in distillation, Energy input and recovery, Vacuum distillation, Types of trays, Draw offs, intermediate product quality control.

UNIT III

Lube oil and wax processing, Solvent extraction, Dewaxing, Deciling, Deasphalting, Clay contacting, principles, technologies, operating parameters, Feed and product qualities and yields. Asphalt Manufacture, product qualities, Air blowing technology, Tankage operations, Storage and handling of crude products.

UNIT IV

Fluid catalytic cracking, principles, recent developments, Feedstocks and product yields and qualities, Catalysts and operating parameters. Hydrocracking, principles, process requirements, product yields and qualities, Residcracking – implications and technology.


REFERENCES

ADVANCED SEPARATION TECHNIQUES

MOUDLE – I
Separation by sorption techniques: Types and choice of adsorbents, reaction theory mechanism, design controlling factors in ion exchange chromatography equipments.

MOUDLE – II
Membrane Separations: Types and choice of membranes, their merits, commercial, pilot plant polarization of membrane processes and laboratory membrane permeators, dialysis, reverse osmosis, ultra titration, concentration and economics of membrane operations, design controlling factors.

MOUDLE – III
Thermal Separation: Thermal Diffusion, basic rate law, phenomenological theories of thermal diffusion for gas and liquid mixtures, equilibrium diagrams, controlling factors.

MOUDLE – IV
Other Techniques: Adductive crystallization, economics and commercial processes, foam separation, nature foams, controlling factors, superficial fluid extraction.

Text and Reference Books:
ADVANCED FLUID DYNAMICS
(Will be uploaded soon)
MINERAL BENEFICIATION

MOUDLE – I

MOUDLE – II
Classification, design and application of crushers and grinders. Industrial screening, classification and performance of screens. Dry and wet classifiers. Thickeners, hydrocyclones, filtration, tabling, jigging, magnetic and electrostatic separation.

MOUDLE – III
Surface behavior and flotation principles. Flotation machines, differential flotation and flotation circuit design. Elements of hydrometallurgy. Important beneficiation circuits of minerals like chalcopyrites, galena, bauxite, and hematite.

Text and Reference Books:
ADVANCED PROCESS CONTROL

Module I


Module II


Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control.

Module III

Multivariable Control Analysis: Introduction to state-space methods, Control degrees of freedom analysis and analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable controllers.

Module IV

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers. Introduction to PLC and DCS.

TEXT BOOKS:


REFERENCES:

ADVANCED CHEMICAL REACTION ENGINEERING AND REACTOR DESIGN

Module I

BASICS OF REACTOR DESIGN Kinetics of homogeneous reactions: concentration-dependent term of a rate equation, temperature-dependent term of a rate equation, predictability of reaction rate from theory. Interpretation of batch reactor data: constant-volume batch reactor, varying-volume batch reactor, temperature and reaction rate, search for a rate equation.

Module II

IDEAL REACTORS Introduction to reactor design. Ideal reactors for a single reaction: ideal batch reactors, steadystate mixed flow reactors, steady-state plug flow reactors.

Module III


Module IV


TEXT BOOK


REFERENCE BOOKS:

MULTIPHASE FLOW

Module I

Two phase flow: Gas/Liquid and Liquid/liquid systems: Flow patterns in pipes, analysis of two phase flow situations,

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

Module II

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

Module III

Introduction to three phase flow, Dynamics of gas-solid liquid contactors (agitated vessels, packed bed, fluidized bed, pneumatic conveying, bubble column, trickle beds), Flow regimes, pressure drop, holdup, distributions, mass and heat transfer, reactions, Applications of these contactors

Module IV

Measurement techniques in multiphase flow: Conventional and novel measurement techniques for multiphase systems (Laser Doppler anemometry, Particle Image Velocimetry)

TEXT BOOKS/REFERENCES:

BIOPROCESS ENGINEERING

Module I


Module II


Module III

Bioreactor And Product Recovery Operations: Operating considerations for bioreactors for suspension and immobilised cultures, Selection, scale-up, operation of bioreactors-Mass Transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes; oxygen uptake rates and determination of oxygen transfer rates and coefficients; role of aeration and agitation in oxygen transfer. Heat transfer processes in Biological systems. Recovery and purification of products.

Module IV

Introduction To Instrumentation And Process Control In Bioprocesses: Measurement of physical and chemical parameters in bioreactors- Monitoring and control of dissolved oxygen, pH, impeller speed and temperature in a stirred tank fermenter.

TEXT BOOKS:


REFERENCE:

ADVANCES IN BIO-CHEMICAL ENGINEERING

(Will be uploaded soon)
PROCESS PLANT SIMULATION

(Will be uploaded soon)
AIR POLLUTION CONTROL EQUIPMENT DESIGN

Module I

Air Pollutant Sources, Effects and Clean Air Acts: Pollution of air: Sources and effects of air pollutants on physical environment and living systems, Monitoring air pollution, Air pollution Laws and Minimum national standards.

Module II

Air Pollutant Formation, Dispersion, Analysis: Formation of pollutants through large-scale combustion of fossil fuels, mineral processing, automobiles in urban areas and at source minimisation of release - Meteorological aspects of air pollutant dispersion. Chemical reactions in a contaminated atmosphere, urban air pollution, acid rain Air sampling and measurement, Analysis of air pollutants

Module III

Air Pollution Control Methods for Particulates Removal: Control Methods - Source Correction methods - Particulate emission control: Dry techniques industrial dust collectors, cyclone and multiclone separators, bag filters, electrostatic precipitators, relative merits and demerits, choice of equipments, design aspects economics. Wet techniques wet dust collection, wet cyclone, empty scrubber, column (packed) scrubber, ventury scrubber, suitability, merits and demerits, design aspects and economics.

Module IV

Control of Specific Gaseous Pollutants: Cleaning of Gaseous effluents - Control of sulphur dioxide emission by various methods - Control of nitrogen oxides in combustion products - Control of release of carbon monoxide and hydrocarbons to the atmosphere. Noise Pollution and Control: Sound pressure, Power and Intensity - Measures of Noise- Outdoor noise propagation- Indoor Noise propagation- Noise Control

TEXT BOOKS:


REFERENCES:


THERMODYNAMICS IN PROCESS DESIGN

(Will be uploaded soon)
NON-CONVENTIONAL ENERGY

Module I
Introduction various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. 3 Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations.

Module II

Module III

Module IV

References Books:
INDUSTRIAL POLLUTION CONTROL

MODULE-1

Definition and classification of pollutants, Environmental protection Acts, Conceptual aspects of EIA (Environmental Impact Assessment), ES (Environmental standards), EMP (Environmental Management plans), Hazardous wastes.

MODULE-2

Water pollution: physical, chemical and biological characteristics of waste water, measurement of water pollutants (BOD, COD, suspended particles etc.), physical unit operation, chemical and biological unit processes used in waste water treatment and their design.

MODULE-3

Air pollution: Sources and effects, temperature lapse rate and stability, tropo-graphical effects, plume behavior, effective stack height, air pollution control equipments and their design like settling chamber, cyclone separator, fabric filters, electrostatic precipitator, venturi scrubber.

MODULE-4

Noise pollution: Definition, causes and effects, control measures. Solid waste: classification, collection and disposal management.

TEXT BOOKS: