### UNIVERSITY DEPARTMENTS
### ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025
### REGULATIONS - 2009
### CURRICULUM I TO IV SEMESTERS (FULL TIME)
### M.TECH. PETROLEUM REFINING AND PETROCHEMICALS

#### SEMESTER I

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MA9120</td>
<td>Advanced Numerical Methods</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>CL9111</td>
<td>Advanced Reaction Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CL9112</td>
<td>Advanced Transport Phenomena</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CL9113</td>
<td>Advanced Thermodynamics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>PP9111</td>
<td>Petroleum Refinery Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>E1</td>
<td>Elective I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td><strong>Instrumental Methods of Analysis Lab</strong></td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL CREDITS</strong></td>
<td></td>
<td>18</td>
<td>1</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>

#### SEMESTER II

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CL9121</td>
<td>Advanced Separation Processes</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>CL9122</td>
<td>Advanced Process Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>PP9121</td>
<td>Natural Gas Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>PP9122</td>
<td>Petrochemicals</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>E2</td>
<td>Elective II</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>E3</td>
<td>Elective III</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td><strong>Petroleum Testing Lab</strong></td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL CREDITS</strong></td>
<td></td>
<td>18</td>
<td>0</td>
<td>2</td>
<td>19</td>
</tr>
</tbody>
</table>

#### SEMESTER III

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CL9131</td>
<td>Process Modeling and Simulation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>PP9131</td>
<td>Catalyst Design &amp; Application</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>E4</td>
<td>Elective IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td><strong>Project Work (Phase I)</strong></td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL CREDITS</strong></td>
<td></td>
<td>9</td>
<td>0</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>
### SEMESTER IV

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>PP9141</td>
<td>Project Work (Phase II)</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>

TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 66

### LIST OF ELECTIVES

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PP9151</td>
<td>Solvent Extraction</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>PP9152</td>
<td>Environmental Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>PP9153</td>
<td>Safety and Hazard Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>PP9154</td>
<td>Energy Management</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>PP9155</td>
<td>Polymer Technology</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>PP9156</td>
<td>Industrial Instrumentation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>PP9157</td>
<td>Gas Transportation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>PP9158</td>
<td>Petroleum Economics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
UNIT I ALGEBRAIC EQUATIONS 6

UNIT II ORDINARY DIFFERENTIAL EQUATIONS – IVPs 6
Runge Kutta Methods, step size control and estimates of error, numerical stability, solution of stiff ODEs, ODE-IVPs coupled with algebraic equations;

UNIT III ORDINARY DIFFERENTIAL EQUATIONS – BVPs 12
Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method, shooting technique.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS – FINITE DIFFERENCE METHOD 12
Parabolic equations – Different explicit and implicit methods, alternating direction explicit and implicit methods; Elliptic equations – Point iterative methods, line iterative methods, ADI methods; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS – FINITE ELEMENT METHOD 9

TOTAL NUMBER OF PERIODS: 60

REFERENCE:
UNIT I KINETICS OF HETEROGENEOUS REACTIONS 10
Catalytic reactions, rate controlling steps, Langmuir-Hinshelwood model, Rideal-Eiley mechanism, steady state approximation, noncatalytic fluid-solid reactions, shrinking and unreacted core model.

UNIT II EXTERNAL DIFFUSION EFFECTS IN HETEROGENEOUS REACTIONS 10
Mass and heat transfer coefficients in packed beds, quantitative treatment of external transport effects, modeling diffusion with and without reaction.

UNIT III INTERNAL TRANSPORT PROCESSES IN POROUS CATALYSTS 10
Interpellet mass and heat transfer, evaluation of effectiveness factor, mass and heat transfer with reaction.

UNIT IV ANALYSIS AND DESIGN OF HETEROGENEOUS REACTORS 15
Isothermal and adiabatic fixed bed reactors, non-isothermal and non-adiabatic fixed bed reactors. Two-phase fluidized bed model, slurry reactor model, trickle bed reactor model. Experimental determination and evaluation of reaction kinetics for heterogeneous systems

TOTAL NUMBER OF PERIODS: 45

REFERENCE:
UNIT I  BASIC CONCEPTS 6

UNIT II  APPLICATIONS OF DIFFERENTIAL EQUATIONS OF CHANGE 6
Applications in laminar and Turbulent transport in compressible and incompressible fluids. Boundary layer theory.

UNIT III  APPLICATIONS OF INTEGRAL EQUATIONS OF CHANGE 8
Macroscopic balance for isothermal and nonisothermal systems and their applications in Momentum, Heat and Mass transport problems.

UNIT IV  INTERPHASE AND MULTIPHASE MOMENTUM TRANSFER 10

UNIT V  INTERPHASE TRANSPORT IN NON-ISOTHERMAL 8
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.

UNIT VI  INTERPHASE MASS TRANSFER AND MACROSCOPIC BALANCES FOR MULTICOMPONENT SYSTEM 7
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 NUMBER OF PERIODS: 45

REFERENCES
UNIT I BASIC CONCEPTS
Energy and first Law; Reversibility and second Law; Review of Basic Postulates, equilibrium criteria, Legendre Transformation and Maxwell’s relations

UNIT II STABILITY AND PHASE TRANSITION
Stability of thermodynamic systems, first order phase transitions and critical phenomenon, phase rule, single component phase diagrams, thermodynamic properties from volumetric and thermal data

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

UNIT IV PHASE EQUILIBRIUM
VLE - Equations of state, corresponding states, Henry’s Law, lattice theory, criticality, high pressure VLE. Other phase equilibriums- SLE/LLE/VLLE

UNIT V CHEMICAL EQUILIBRIUM
Homogeneous gas and liquid phase reactions, heterogeneous reactions – phase and chemical equilibrium

TOTAL NUMBER OF PERIODS: 45

REFERENCES
1. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad, 2005
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.

Unit V

Total number of periods: 45

References
LIST OF EXPERIMENTS

1. UV-Visible spectrophotometer
2. Infrared spectrophotometer
4. High performance liquid chromatograph
5. Atomic absorption spectrophotometer.
6. Flame photometer
7. Thermo gravimetric analyzer
8. Differential scanning calorimeter
9. Differential thermal analyzer

Total number of periods: 30
SEMESTER II

CL9121 ADVANCED SEPARATION PROCESSES 3 0 0 3

1. 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 electrofiltration, dual functional filter, surface based solid-liquid separations involving a second liquid, sirofloc filter.

2. 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 pemeators involving dialysis, reverse osmosis, nanofiltration, ultrafiltration, microfiltration and Donnan dialysis, economics of membrane operations, ceramic membranes.

3. 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

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

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

Total number of periods: 45

References

Curriculum
1. Advanced Control Strategies
Feed forward, cascade, dead time compensation, split range, selective and override control; automatic tuning and gain scheduling

2. Internal Model Control
Model based control – IMC structure – development and design; IMC based PID control

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

4. Discrete Systems

5. Digital Feedback Controllers

Total number of periods: 45

References
Unit I
Availability of natural gas, Properties and composition, Exploration and control of gas, output, Estimation of availability quantity.

Unit II
Natural gas application in Chemical Process and transportation industry LNG technology, Natural gas storage and transport, Economics of natural gas utilization.

Unit III
General Hydrodynamic equations for flow of fluids through porous media, two dimensional flow problems and potential theory methods, gravity flow systems, systems of non uniform permeability, multiple well systems using computerized streamline tracking methods.

Unit IV
Use of multiphase flow correlations to determine flow ratio and pressure traverse in flowing oil wells, gas condensate wells, gathering systems and pipe lines, application of correlations to the design of gas system

Unit V
Reservoir fluid properties – PVT properties for oil gas systems, phase Behavior of complex hydrocarbon mixtures at high temperature and pressure - thermodynamic property evaluation, packages used in petroleum industry.

Total Number of periods: 45

References
PP 9122  PETROCHEMICALS  3 0 0 3

Unit I  9
Overview of petrochemical industrial Growth in India, Economics, Feedstock Selection for Petrochemicals

Unit II  9
Steam reforming, Hydrogen, Synthesis gas, cracking of gaseous and liquid for stocks, Olefins, Diolifins, Acetylene and Aromatics and their separation.

Unit III  9
Alkylation, Oxidation, Dehydrogenation, Nitration, Chlorination, Sulphonation and Isomerization

Unit IV  9
Chemicals from synthesis gas, Olefins, Diolifins, Acetylene and Aromatics.

Unit V  9
Modes and techniques, Production of Polyethylene, PVC, Polypropylene, SAN, ABS, SBR, Polyacrylonitrile, Polycarbonates, Polyurethane, Nylon, PET.

Total number of periods: 45

References

LIST OF EXPERIMENTS

1. Determination of flash point
2. Viscosity Determination
3. Aniline point determination
4. API gravity determination
5. Determination of aromatic content
6. Hydrogen sulphide content determination
7. Sulphur content determination
8. Determination of calorific value
9. Bitumen testing
10. Carbon residue determination (Conradson apparatus)
11. Cloud point and pour point estimation
12. Cgealing point of wax
13. Foaming characteristics of lube oil
14. Smoke point estimation
15. Corrosion testing of petroleum oil
16. API distillation apparatus
17. Moisture determination other than Karl-Fischer method

Minimum of 10 experiments
1. Introduction
Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

2. Steady State Lumped Systems
Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flowsheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

3. Unsteady State Lumped Systems
Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

4. Steady State Distributed System
Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

5. Unsteady State Distributed System
Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations.

6. Other Modelling Approaches
Empirical modeling, parameter estimation, population balance and stochastic modeling.

Total number of periods: 45

References

1. Catalysis and Catalytic Kinetics

General definition of catalysts, illustration of a catalytic a process, Design for catalysts – Primary constituents, secondary constituents; Catalyst supports-choice of support material, texture and strength of support materials; Chemical interaction, Deactivation steps involved in global catalytic rate.

2. Adsorption-Diffusion and Heterogeneous Catalysis

Adsorption and Heterogeneous Catalysis – the geometrical factor in Catalysis; Electron structure of catalysts; Chemical properties of surfaces; Theories and Adsorption; Semiconduction and catalysts; Defect structure in crystal lattices, Thermodynamics abasics of catalysis; Adsorption studies – Fischer – Tropsh catalysts, synthetic ammonia catalysts, methanol synthesis catalyst. Diffusion and Heterogeneous Catalysis

3. Production of some catalysts:

Precipitation method – Alumino silicate catalyst, Barium alumino vanadium contact mass, production of tabletedd chromium catalysts for the conversion of CO., Production of Cadmium – Calcium Phosphate catalysts for the synthesis of acetaldehyde from acetylene. Mechanical mixing method. Fused-skeleton contact masses – Platinum network catalysts of Ammonia oxidation, iron catalysts of Ammonia synthesis, fused vanadium pentoxide, catalysts of natural clays, zeolites and iron exchange resins, natural catalysts and their activation, zeolite catalysts.

4. Methods of studying catalysts

Methods of determining catalysts activity – static methods, flow (dynamic) method; Study of structure – adsorption for determining catalysyt surface and pore radii; Mercury porosimetry, determination of true and apparent densities of catalysts; Structural study of electron microscopy, determination of mechanical strength of catalysts-static methods, dynamic methods; Methods of thermal analysis.

5. Analysis and Design of Heterogeneous Catalytic Reactors

Fixed bed reaction, continuity equations, reactor parameters. Reaction significance of dimensionless parameters, Chemical dimensionless parameters, physical dimensionless parameters, radial pecket number for heat and mass transfer, Biot numbers. Adiabatic fixed bed reactor .Reactor yield, non isothermal, non adiabatic fixed bed. Fluidixed bed catalytic reactor; slurry reactors – Analysis of first order slurry reaction systems; Selectivity in slurry reactors; catalytic – gaue reactor, trickle bed reactors, batch fluid bed reactor, moving bed continuous fluid bed reactor.

Total Number of Periods : 45

References:


Curriculum

**PP9133**  PROJECT WORK (PHASE I)  0 0 12 6

Students have to do a research-based project in the department or in an industry and submit a report at the end of Phase I

Curriculum

**SEMESTER IV**

**PP9141**  PROJECT WORK (PHASE II)  0 0 24 12

Phase II of Project Work is a continuation of Phase I of Project. Students submit a report at the end of Phase II.
1. **Equilibrium In Liquid-Liquid System**


2. **Differential / Stage-Wise Equilibrium Contact Operations**

   Equilibrium stage-wise contact, Single and multiple contacts with co-current and counter current flow of phases for immiscible and partially miscible solvent phases, Calculation methods, Fractional extraction with reflux of raffinate and extract. Differential contact, HETS, NETS, HTU, NTU concepts and Estimation of these parameters, Mass transfer efficiency, Axial mixing and Residence time distribution in extractors and their estimation.

3. **Dispersion and Coalescence in Extractors**

   Characteristics of dispersion involving single and multiple nozzle distributors, Drop size and formation and coalescence, Mean drop size at dispersion and their settling velocities/relative characteristics velocities. Effect of drop oscillation, wobbling and Internal circulation, Effect of surface active agents, Prediction of drop size and characteristics velocity in spray, packed and mechanically agitated contactors as in RDC, pulsed columns, solute transfer effects on drop dynamics.

4. **Design Of Liquid Extraction Columns**

   Design of extractor height and diameter, Prediction of flow capacities in terms of flooding rates, Regime of operating envelops, Hydrodynamic design variables such as hold up, characteristic velocities, pressure drop, Effect of direction of solute transfer on these variables and their prediction methods, Correction of mass transfer data, Axial mixing correction for column height, Interfacial area estimations, using slow, fast and instantaneous reactions and their application with models for mass transfer coefficients.

   **Total number of periods: 45**

**References:**

1. Environment awareness
   Environment – friendly chemical Process; Hazard and risk analysis; Environmental Audit,

2. Chemical Engineering Processes
   Unit Operations – application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes

3. Recycling Methodology
   Economic recovery and recycling of waste; Transport fuel- Bio-diesel for a cleaner environment.

4. Clean Technology
   Towards Eco-friendly products of chemical industry; Pesticides –Their transfer and Transformation in the environment, Biological and electrochemical technology for effluent treatments

5. Pollution Prevention
   Mass exchange network synthesis for pollution control and minimization Implications of environmental constraints for process design, policies for regulation of environmental impacts, Concept of common effluent treatment; Environmental legislations, Role of Government and Industries

Total Number of periods : 45

References

PP9153        SAFETY AND HAZARD CONTROL         3 0 0 3

Unit I         9
Conventional and modern concepts of safety, Basic Principles and concepts in
hazard identification, Chemical hazards, Process and operation hazard, Hazards
from utilities like air, water, steam etc., Occupational health hazards, Hazard and
operability Studies, Safety Audits.

Unit II        9
Past Accident Analysis, Consequence Analysis of fire, gas/vapour, Dispersions and
explosion, Vulnerability models, Fault and Event Tree Analysis.

Unit III       9
Safety in plant design and layout. Risk Assessment

Unit IV        9
Safety measures in handling and storage of chemicals, Process plant, personnel
Protection, First Aid.

Unit V         9
Disaster mitigation, Emergency Preparedness plans.

Total Number of periods: 45

References

   Wilelys and Sons, New York, 1980.
2. Safety in Chemical and Petrochemical Industries, Report of the Inter Ministry
   Group, Dept. of Chemicals and Petrochemicals, Govt.of India, ICMA
   Publications. 1986.
3. Major Hazard Control, Manual by International Labour Organization, Geneva,
   1990.
5. Marshal, V.C Major Chemical Hazards, Ellis Harwood Ltd. Chichester, U.K.
   1987.
6. Guidelines for Chemical Process Quantitative Risk Analysis, Published by Centre
7. Raghavan, K.V and A.A Khan, Methodologies in Hazard Identification and Risk
8. R.K.Sinnott, Coulson & Richardson’s Chemical Engineering, Vol.6 Butterworth –
Unit I
9
Energy Resources – Conventional – Non conventional, Energy Reserves and Depletion, Non renewable energy sources.

Unit II
9
Power generation by steam, Hydroelectric, Diesel oil, Nuclear fission and Natural gas, Co-generation of power. Selection of power generation process, Economical and technical efficiency of power generation, Socio economic factor affecting consumption of power by various methods, Design and safety equipments

Unit III
9
Renewable sources of energy, Thermal and power generation using water, wind, seawave, Solar energy, Geothermal and biomass utilization.

Unit IV
9
Energy consumption, Demand pattern, energy planning – Short term and long term, Energy conservation – need for, Energy recovery, various types of Energy audit – advantages

Unit V
9
Recovery of waste heat, optimum shell and tube heat exchanger, heat exchanger network, evaporator systems, boiler, turbo generator system

Total Number of periods : 45

References:
Unit I
Introduction to various Polymer Processing methods & Machinery Morphology and structure of Polymers

Unit II
Screw Extrusion – Geometry of screw – Simplified Flat plate Model; rectangular channel model; cylindrical Channel Model; Helical Channel Model; Newtonian and Non-Newtonian flows; isothermal, non-isothermal and adiabatic Models

Unit III
Injection Moulding Various parts of the moulds; Analysis of flow through mould Cavity; various Models; Balancing of runners

Unit IV
Newtonian and non-Newtonian models; Calendar fed with finite sheet; normal stress and viscosity effects, coating – Mixing operations

Unit V
Knowledge based expert systems for modeling of polymer processing

Total Number of periods : 45

References
Unit I

Unit II
Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open – channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

Unit III
Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra red process analyzers, Photometric reaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer, Chromatography.

Unit IV

Unit V
Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

Total Number of periods: 45

References:
UNIT I
Introduction, widespread use, the various types, the advantages and the special features of pipelines.

UNIT II
The fluid mechanics of various types of pipe flow including incompressible and compressible flows of Newtonian fluids, non-Newtonian fluids, flow of solid/liquid mixture (slurry), flow of solid/air mixture (pneumatic transport), and flow of capsules (capsule pipelines).

UNIT III
Various types of pipes (steel, concrete, PE, PVC, etc.), valves (gate, globe, ball, butterfly, etc.) and pressure regulators in pipelines. Blowers and compressors (for gases). Various kinds of flowmeters, sensors, pigs (scrapers) and automatic control systems used in pipelines.

UNIT IV
Various means to protect pipelines against freezing, abrasion and corrosion, such as cathodic protection, Planning, construction and operation of pipelines, including modern use of advanced technologies such as global positioning systems (GPS), directional drillings, automatic control using computers, and pipeline integrity monitoring such as leak detection.

UNIT V
Structural design of pipelines —load considerations and pipe deformation and failure. Economics of pipelines including life-cycle, Cost analysis and comparison of the cost-effectiveness of pipelines with alternative modes of transport such as truck or railroad. Legal, safety and environmental issues about pipelines.

References

UNIT I
Introduction to upstream economics analysis, energy overview of India – Time value of money, cash flow analysis, capital budgeting techniques, general probability, elements of oil and gas project cash flows.

UNIT II
Reserves classification methods, quantification, assessment of geoscience and reservoir engineering uncertainties – Assessment of reserves, production and demand in international market.

UNIT III
Inflation and cost escalation, oil market and OPEC, share of non OPEC countries in oil production – International oil and gas pricing mechanism – Geopolitics.

UNIT IV
Petroleum Fiscal system, classification and analysis – Reserves Auditing – Accounting systems for oil and gas.

UNIT V
Project Economic Evaluation and petroleum economic models – Decision analysis – Valuation of petroleum properties.

References
2. Cronquist, C., Estimation and classification of Reserves of Crude oil, Natural Gas, and Condensate, SPE (2001)