Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. V Semester

Chemical Engineering

Rajasthan Technical University, Kota

Effective from session: 2019 – 2020

5CH3-01: Environmental Pollution Control
(Common with Petrochemical Engineering 5PC3-01)

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Atmosphere:** Structure of the atmosphere, chemical and photochemical reaction in the atmosphere, primary air pollutants-sources. Carbon, Nitrogen & Sulphur Cycle.	3
3	**Wastewater Treatment:** Characterization of industrial wastewater, primary, secondary and tertiary treatment. Segregation, screening, equalization, coagulation, flocculation, precipitation, flotation, sedimentation, aerobic treatment, anaerobic treatment, absorption, ion exchange, membrane filtration, electrodialysis, sludge dewatering and disposal methods.	6
4	**Air Pollution Control:** Sources and classification of air pollutants, nature andcharacteristics of gaseous and particulate pollutants, from automobiles. Air pollutionmeteorology, plume and its behaviour and atmospheric dispersion, control ofparticulate emission by gravity settling chamber, cyclones , wet scrubbers, bagfilters and electrostatic precipitators(General Explanation). Control of gaseousemission by absorption, adsorption, chemical transformation and combustion.	8
5	**Solid Waste Management:** solid waste, waste disposal methods, recycling of solid waste and its management. Hazardous and non-hazardous waste, methods of treatment and disposal, land filling, leachate treatment and incineration of solid wastes. Environmentally Pollution MonitoringLegislation, standards for water and air, Effects of air pollutants on human health, vegetation and materials**,** Air pollution monitoring instruments COx, NOx, SOx, Hydrocarbon and Ozone. Hydrocarbons particulates, sampling techniques. Global warming, Greenhouse effect, depletion of ozone layer, human activity and meteorology	10
	Total	**28**

5CH4-02: Chemical Reaction Engineering –I
(Common with Petrochemical Engineering 5PC4-02)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Mole Balance, Industrial Reactor Batch Reactor, CSTR,PFR **Classification of reactions:** Definition of reaction rate, Variables affecting the rate, concept of reaction equilibrium. Order of reaction and its determination, theoretical study of reaction rates, collision and activated complex theory. Mechanism of reaction series, Parallel and consecutive reaction, autocatalytic reactions, chain reaction, polymerization reaction	10
3	**Interpretation of kinetic data:** Integral and differential method of analysis, Variable volume reactions, total pressure method of kinetic analysis. **Classification of Reactors:** Concept of ideality, Development of design equations for batch, semi batch, tubular and stirred tank reactor .Design of Isothermal and non-isothermal batch, CSTR, PFR, reactors. Combination of reactors, Reactors with recycles.	10
4	**MultipleReactions:** yield and selectivity in multiple reactions. Continuous stirred tank and Plug flow reactors uniqueness of steady state in continuous stirred tank reactor. Optimum temperature progression, thermal characteristics of reactors. Thiele modulus.	10
5	**RTD and Models:** RTD dispersion model, Tank and series model recycle model, segregated flow in mixed models. Residence time Distribution, evaluation of RTD characteristics.	9
	Total	40

5CH4-03: Mass Transfer –II

(Common with Petrochemical Engineering 5PC4-03)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Adsorption:** Adsorption theories, types of adsorbent; activated carbon, silica and molecular sieves. Batch and column, adsorption; Break through curves, Liquid percolation and gas adsorption, Absorption models for adsorption calculation.	9
3	**Distillation:** Vapour liquid Equilibrium, Boiling point diagram, Relative volatility, flash Distillation. Differential distillation for two component mixture, steam distillation, azeotropic distillation, Extractive distillation. Continuous and differential contact Distillation Rectification, reflux ratio, calculation of numbers of plates by NTU. Optimum reflux ratio, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram. MecabTheile and Panchon-Savarit method for calculation of number of theoretical plates. Approximate equation; Fensky equation for minimum numbers of plate calculation. Batch distillation.	10
4	**Liquid –Liquid extraction:** Liquid equilibrium & Ponchon – Savarit method, Mc-Cabe- Thiele method, packed & spray column, Conjugate curve and tie line data, plait point, ternary liquid – liquid extraction. Operation and design of extraction towers analytical & graphical solution of single and multistage operation in extraction -Co-current, counter current and parallel current system	10
5	**Leaching and Crystallization:** Leaching: solid liquid equilibrium, Equipment, principles of leaching. cocurrent and counter current systems and calculation of number of stage required. Crystallization: Factors governing nucleation and crystal growth rates, controlled – growth of crystals, super saturation curve, principle and design of batch and continuous type equipment.	10
	Total	40

5CH4-04: Process Equipment Design –I
Common with Petrochemical Engineering 5PC4-04)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Mechanics of Materials**: Stress, Strain, Stress- Strain relationships of elastic materials subjected to tensile force, Elastic and plastic deformation, Factor of safety. **Pressure Vessel:** Pressure Vessel, Classification of Pressure Vessels, Pressure vessel codes, General design considerations, Materials of construction. **Components of pressure vessel:** Head, Shell, Supports, Bolted flanges, roofs, wind girder, nozzles andother accessories.	10
3	**Design of thin wall vessel under internal and external pressures**: Design of Shell, Design of Head**,** Design of Supports**,** Design of bottom plates. Compensations of openings. **Design of Tall Vertical Vessels:** Pressure, dead weight, wind, earthquake and eccentric loads; combined stresses and induced stresses.	10
4	**Design of High Pressure Vessels:** Stress analysis of thick walled cylindrical shell, Design of Monobloc and multiplayer vessels. **Fabrication of Vessel:** Major fabrication steps; Welding, Welding Joints, Types of welding.	10
5	**Inspection and testing**: Inspection during Manufacture, Inspection of Completed Pressure Vessels, Pressure Tests, Nondestructive tests of welded joints.	9
	Total	40

5CH4-05: Inorganic Chemical Technology

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Study of the following chemical industries/processes involving processes details, production trend, thermodynamic construction, waste regeneration/recycling and safety, environmental and energy conservation measures: Salts Sodium compounds, soda ash, Caustic soda, Chlorine and potassium salts. Hydrochloric acid, sulphur and sulfuric acid, Phosphoric acid and phosphates. Nitrogenous Industries, Ammonia and Nitric acid, Nitrogenous Fertilizer, mixed fertilizers, N-P-K Fertilizers and micronutrients.	20
3	Study of the following chemical industries/processes involving processes details, production trend, thermodynamic construction, waste regeneration/recycling and safety, environmental and energy conservation measures: Cement, Ceramic and Glass industries Industrial gases: Nitrogen, Oxygen, Hydrogen, Helium and Argon. Inorganic chemicals namely Bromine, Iodine and Fluorine, Alumina and Aluminium chloride, Inorganic pigments.	19
	Total	40

5CH5-11: Natural Gas Engineering
(Common with Petrochemical/Petroleum Engineering 5PC5-11/5PE3-01)

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Properties and Measurement of Natural Gas**: Introduction to Natural Gas, origin of natural gas, other sources of gaseous fluids. Phase behaviour fundamentals, qualitative and quantitative phase behaviour, vapour liquid equilibrium. Equation of state, critical pressure and temperature determination. Gas compressibility, viscosity and thermal conductivity, formation volume factor. **Gas Reservoir Performance:** Fundamentals of gas flow in conduits, fundamentals of fluid flow in porous media, inflow performance curves, outflow performance.	8
3	**Gas flow measurement**: Fundamentals, Methods of measurements, Orifice meters equation, turbine meters. **Flow of Gas in Production Tubing**: Introduction, gas flow fundamentals, vertical and inclined single phase flow of gas. Calculating flow and static bottom hole pressure, gas flow through restrictions. Temperatures profiling in flowing gas systems.	6
4	**Natural gas Processing**: Gas liquid separations, dehydration processes, absorption and adsorption by gas permeation. Desulfurization processes, solid bed sweetening process, physical and chemical absorption processes, Acid gas removal. Integrating natural gas processing **Gas Compression:** Introduction, types of compressors, Selection, Thermodynamics of compressors, Design fundamentals for reciprocating, centrifugal and rotary compressors (single and multistage)	8
5	**Gas Gathering and Transport**: Gas gathering system, steady state flow in simple pipeline system, steady state and non-steady state flow in pipelines, solution for transient flow. Installation, operation and troubleshooting of natural gas pipelines.	5
	Total	28

5CH5-12: Process Instrumentation
(Common with Petrochemical Engineering 5PC5-12)

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Introduction to chemical process instrumentation, Process variables, Static and dynamic characteristics of instruments; General classification of instruments, Principles, Construction and operation of Instruments for measurement. Elements of measuring systems & their functions.	8
3	**Temperature measurement:** Classification of thermometers and pyrometers, response of thermometers, protecting wells. Fluid filled expansion thermometers. Thermocouples: Resistance thermometers. Radiation and optical pyrometers.	8
4	**Pressure and vacuum measurement:** Classification, Manometers-Inverted well pressure gauges. Bourdon tube pressure gauges, diagram of pressure gauges. McLeod gauge. Classification of sensors and transducers. **Other Measurement Instruments:-**Measurement of flow, Fluid level, pH, Conductivity, humidity and composition.	8
5	Process instrumentation diagram and symbols, process instrumentation for Process equipment such as distillation column, Heat exchanger, fluid storage vessel. Classification of sensors and transducers.	3
	Total	28

5CH5-13: Energy Resource and Utilization
(Common with Petrochemical Engineering 5PC5-13)

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Synthetic fuels and their manufacture introduction and classification of fuels, Fundamentals, Units and their conversions, Properties of coal, oil shale, and Tar Sands. **Solid Fuels:** Wood, Wood charcoal and Peat. Origin, Composition, Characteristics, and Significance of constituents of coal, Petrography of coal, washing of coal, storage of coal. Pulverised fuel/coal, Uses of coal, comparison of Solid, Liquid, and Gaseous fuels. Selection of coal, Mineral matters in coal ash, and clinker formation; Properties and testing of coal, Classification of coal, Carbonization of coal – coke making and byproducts recovery, Characteristics and distribution of Indian coals, Briqueting of Solid fuel/coal.	10
3	**Liquid Fuels:** Liquid fuels from coal by hydrogenation/ liquefaction, other liquid fuels- Benzol, shale oil, alcohol, and colloidal fuels, Storage and Handling of Liquid fuels/Fuel oils.	8
4	**Gaseous Fuels:** Methane, Wood Gas, Gobar gas, Sewage gas, Gas from underground gasification of coal, Natural gas, LPG, Refinery gases, Producer gas, and Water gas.	3
5	**Furnaces:** Introduction, Waste heat recovery in furnaces, Classification of furnaces. **Nuclear Fuels and their Utilization:** Introduction, nuclear fuel resources in India, Nuclear reactors – introduction, Classification of nuclear reactors, Types of nuclear reactors.	6
	Total	28

5CH4-21: Chemical Reaction Engineering Lab-I

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P **End Term Exam: 3 Hours**

List of Experiment

1. Determine the rate constant and order of reaction in Batch reactor
2. To study temperature dependency of rate constant, evaluation of activation energy and
3. Verification of Arrhenius law in plug Flow Reactor
4. To study a parallel reaction system in cascade CSTR.
5. To study a homogeneous reaction in a semi-Batch reactor under isothermal conditions.
6. Study of non-catalytic homogeneous saponification reaction in CSTR.
7. To study a non-catalytic homogeneous reaction in a plug flow reactor.
8. To study the residence time distribution behaviour of a Packed bed reactor.
9. To study the RTD behaviour of a tubular reactor.
10. To study rate constant in Adiabatic batch Reactor.

5CH4-22: Mass Transfer Lab – II

Credit: 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

List of Experiment

1. Studies on solid-liquid extraction column.
2. Study of the Swenson walker Crystallizer
3. To investigate the characteristics of cooling tower.
4. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer
5. To study vapour Liquid equilibrium set up
6. Column for co-current and counter current flow of binary systems.

5CH4-23: Environmental Engineering Lab

Credit: 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

List of Experiment

1. Physical Characterization of water: Turbidity, Electrical Conductivity, pH
2. Analysis of solids content of water: Dissolved, Settleable, suspended, total, volatile, inorganic etc.
3. Alkalinity and acidity, Hardness: total hardness, calcium and magnesium hardness
4. Analysis of ions: copper, chloride and sulphate
5. Optimum coagulant dose
6. Chemical Oxygen Demand (COD)
7. Dissolved Oxygen (D.O) and Biochemical Oxygen Demand (BOD)
8. Break point Chlorination
9. Ambient Air quality monitoring (TSP, RSPM, SOx, NOx)

5CH7-30: Industrial Training

Credit: 2.5 **Max. Marks: 125(IA:75, ETE:50)**
0L+0T+1P

Student had undergo mandatory 45 days in-house/industrial training after IV semester. Training Examination will be held in V Semester.

5CH8-00: Social Outreach, Discipline & Extra Curricular Activities (SODECA)

Credit: 0.5 **Max. Marks: 25**

Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. VI Semester

Chemical Engineering

Rajasthan Technical University, Kota

Effective from session: 2019 – 2020

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Chemical Engineering)

6CH3-01: Plant Design and Economics

(Common with Petrochemical Engineering 6PC3-01)

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction:** Process Design development, General design considerations, Cost and asset accounting, Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment.	6
3	Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing. Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.	8
4	**Taxes and insurances:** type of taxes: federal income taxes, Insurance-types of insurance, self-insurance. Depreciation: types of depreciation, services life, salvage value, present value, Methods for determining depreciation, single unit and group depreciation.	8
5	**Profitability:** alternative investments and replacements, profitability standards, discounted cash flow Capitalized cost, pay out period, alternative investments, analysis with small investments, increments and replacements.	5
	Total	28

6CH4-02: Chemical Reaction Engineering-II
(Common with Petrochemical Engineering 6PC4-02)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Heterogeneous processes**: Catalysis and adsorption; Classification of catalysts, Preparation of catalysts, Promoters and Inhibitors. General mechanism of catalytic reactions surface area and pore size distribution Rate.	10
3	**Catalyst Deactivation**: Types of catalyst deactivation, kinetics of catalyst deactivation. Pseudo steady state hypothesis. Michaelis-Menten kinetics.	8
4	**Design of catalytic reactors** Steady State Non Isothermal reactor Design, energy Balance, Non Isothermal Continuous Flow reactor, Non Adiabatic Reactor Operation, Adiabatic tubular reactor. Isothermal and non-isothermal effectiveness factors. **Kinetics of Fluid Particle Reaction:-**Progressive Conversation models, Shrinking Core Models, Models for fluid - solid non-catalytic reactions, controlling mechanisms, Diffusion through gas film controls. Diffusion through ash layer controls, Chemical reaction controls. Global reaction rate	12
5	**Multiphase Reactor:** Fluidized bed reactors, Slurry reactors, Trickle bed reactors and its applications. Fluidized bed reactors with and without elutriation. Gas Liquid reaction on solid Catalyst.	9
	Total	40

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Chemical Engineering)

6CH4-03: Process Equipment Design-II

(Common with Petrochemical Engineering 6PC4-03)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Heat Exchanger Design:** **Introduction:** Heat Exchanger, Classification and Application of heat exchanger, Heat exchanger analysis, Overall heat transfer coefficient, Fouling factor, Heat exchanger design procedure, Heat-exchanger standards and codes, General design considerations for heat exchangers, Shell and Tube heat exchanger, Components of Shell & Tube heat exchanger, Types of Shell & Tube heat exchangers . **Design Calculations:** Tube: Dimensions, Tube arrangements, Tube-side passes; Shell: Dimensions, Shell passes; Baffles: Types; Support plates and tie rods, Tube sheets, Tube-sheet layout, Shell and header nozzles, Flow-induced tube vibrations, Mean Temperature Difference, Tube side calculations: Heat transfer coefficients and pressure drop; Shell side calculations: Heat transfer coefficients and pressure by Kern's & Bell's Methods.	19
3	**Condensers Design:** **Introduction:** Condensation, Film-wise and dropwise condensation, Types of condensers: Vertical condenser and Horizontal condenser, De-superheating and sub-cooling. **Design Calculations:** Mean temperature difference, Tube side calculations: Heat transfer coefficients and pressure drop; Shell side calculations: Heat transfer coefficients and pressure.	10
4	**Reboiler Design:** **Introduction:** Boiling, Pool boiling, Convection boiling**,** Reboiler, Classification of reboilers **Design of kettle reboiler**: Design considerations, Individual heat transfer co-efficient hot fluid and boiling liquid, allowable vapor velocity, Tube side and shell side pressure drop.	10
	Total	40

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Rajasthan Technical University, Kota

6CH4-04: Process Dynamics and Control
(Common with Petrochemical/Petroleum Engineering 6PC4-04/6PE5-12)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**First–order Systems**: Introduction, Transfer Function, Linear Open-Loop Systems, Transient response (step response, impulse response, and sinusoidal response), response of first order systems in series. Non-interacting systems and interacting systems. **Second-order systems**: Transfer function, step response, impulse response, k sinusoidal response, transportation lag.	10
3	**Linear closed-loop Systems:** Control System: components of a control system block diagram. Negative feedback and positive feedback, servo problem and regulator problem. **Closed-Loop Transfer functions:** Overall transfer function for single loop systems, overall transfer function for set-point change and load change, multi-loop control systems. Transient Response of simple control systems: P and PI control for set point change and for load change.	10
4	**Controller and final control element**: Mechanism of control valve and controller, transfer functions of control valve and controllers (P, PI, PD, and PID). Examples of a chemical reactor control system. **Stability**: Concept of Stability, Stability criteria, Routh test for stability, Root Locus.	10
5	**Frequency Response**: Introduction to Frequency Response, Bode Diagrams for First and second order systems, Bode stability Criteria, Ziegler-Nichols and Cohen-coon Tuning rules.	9
	Total	40

6CH4-05: Petroleum Refinery Engineering
(Common with Petrochemical/Petroleum Engineering 6PC4-05/6PE5-11)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Separation Processes:** Atmospheric Distillation, Vacuum Distillation. **Cracking Process:** Thermal conversion processes. Conventional thermal cracking process. Visbreaking, Coking – Fluid coking, Flexicoking, delayed coking etc.	15
3	**Reforming:** Catalytic conversion processes – fluid catalytic cracking, Hydrocracking, hydrogen production, Reforming. **Purification process** Alkylation, Polymerization process of crude oil. Isomerisation and Hydrotreating processes crude oil.	14
4	**Crude oil Evaluation:** Evaluation of crude oil for LOBS (Lube oil base Stock). Steps in preparation of LOBS, Deasphalting. **Solvent Extraction**: Types of solvents available and their comparison, dewaxing. Hydro finishing of LOBS Hydrogenation processes for LOBS production.	10
	Total	40

6CH5-11: Organic Chemical Technology

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Study of organic process industries/processes involving, Process details, production trend, thermodynamics consideration, flowsheets, engineering problems pertaining to material of construction, waste regeneration/ recycling and safety, environmental and energy conservation measures: Pulp and paper industry, soaps, detergents, dyes and dyes intermediates. Agro based alcohol industries, production of cane sugar, molasses, formation of alcohol,alcohol derivatives like acetic acid, acetic anhydride, vinyl acetate, ethylene glycol,pyridine.	19
3	Study of organic process industries/processes involving, Process details, production trend,thermodynamics consideration, flowsheets, engineering problems pertaining to material of construction,waste regeneration/ recycling and safety, environmental and energy conservation measures: Carbohydrates and sugar, insecticides and pesticides. Manmade fibers, rayon, polyester, polyamides and acrylics, cellulose and acetate. Intermediates for petrochemical from petroleum based feed stocks, phenol, methanol, ethylene, propylene, aromatic benzene, toluene and xylene acrylonitrile, styrene, butadiene.	20
	Total	40

6CH5-12: Advanced Separation Process
(Common with Petrochemical Engineering 6PC5-12)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basics of Separation Process:** Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances. Processconcept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.	10
3	**Membrane Separations:** Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial. Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nano-filtration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.	9
4	**Separation by Adsorption:** Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity. Chromatography and Immuno Chromatography, Recent Trends in Adsorption.	6
5	**Inorganic Separations:** Controlling factors, Applications, Types of Equipment employed for Electrophoresis. Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.	6
6	Other Techniques: Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting. Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.	8
	Total	**40**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Chemical Engineering)

6CH5-13: Polymer Science & Technology

(Common with Petrochemical/Petroleum Engineering 6PC5-13/6PE5-13)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Classification of polymers, Linear branched and cross-linked polymers, Molecular weights of polymers.Polydispersity and Mol. Wt. distribution in polymers. Random, alternate, block and graft co-polymers, polymer characterization techniques, polymer degradation. Kinetics of chain & Step polymerization, techniques of molecular weight control. Initiators, Chain transfer agents, Inhibitors. Techniques of polymerization.	20
3	Bulk, Solution, Suspension & Emulsion polymerization. Introduction to polymer rheology, Newtons law of viscosity, viscometris plots, rheometers. Rheological models, theory of viscoelasticity, Heat distortion temperature. Basic concept of polymer processing: Compounding methods, Extrusion moulding, Injection moulding. Blow moulding, Rotational moulding. Introduction to fibre reinforced plastics.	19
	Total	40

6CH4-21: Petroleum Product Testing Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P **End Term Exam: 3 Hours**

List of Experiment

1. Measurement of fire point- Flash point
2. Measurement of Cloud point and pour point.
3. Measurement of Aniline point & Bromine number
4. Measurement of Reid Vapour Pressure
5. Measurement of Sulphur Content
6. Measurement of Carbon Residue.
7. ASTM Distillation of Petroleum Products.
8. Measurement of surface tension by Tensiometer.
9. Measurement of surface tension by Platinum ring method.
10. Determination of smoke point.

6CH4-22: Process Dynamics and Control Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+4P **End Term Exam: 3 Hours**

List of Experiment

1. To determine the time constant of a given thermometer and thermocouple
2. To study the open loop, three mode PID and two mode PD control
3. To study the working principal and calibration procedure of capacitance type level transmitter.
4. To obtain the step response of a single tank liquid level system to a step change in input flow and compare it with the theoretical response.
5. To study the inherent characteristics of control valve.
6. To study the theoretical time constant and damping coefficient of the manometer.
7. To study the interacting and non-interacting mode of system.
8. To study the behavior of a PID controller.

6CH4-23: Chemical Reaction Engineering Lab-II

Credit: 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

List of Experiment

1. Preparation of catalysts
2. Design of Steady State Non Isothermal reactor
3. Design of Non Isothermal Continuous Flow reactor,
4. Design of Non Adiabatic Reactor
5. Design of Adiabatic tubular reactor
6. Design of Fluidized bed reactors
7. Design of Slurry reactors
8. Design of Trickle bed reactors

6CH4-24: Plant Design and Economics Sessional

Credit: 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

List of Experiment

1. Calculations of Interest and Investment costs
2. Calculations of Taxes and insurances
3. Calculations of Depreciation
4. Study of Profitability
5. Study of Cash flow

6CH8-00: Social Outreach, Discipline & Extra Curricular Activities

Credit: 0.5 **Max. Marks: 25**