Bansilal Ramnath Agarwal Charitable Trust’s
Vishwakarma Institute of Technology
(An Autonomous Institute affiliated to University of Pune)

Structure & Syllabus of

B.Tech. (Chemical Engineering)
Pattern ‘C19’

Effective from Academic Year 2019-20

Prepared by: - Board of Studies in Chemical Engineering
Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by,

Chairman – BOS    Chairman – Academic Board
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## Module V Third Year B. Tech Chemical Engineering

### Title: Course Structure  
**Branch:** Chemical Engineering  
**Year:** Third Year B. Tech.  
**Academic Year:** 2019-20  
**Semester:** V  
**Module:** V  
**Pattern:** C-19

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### Abbreviations Used

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CH3001:: CHEMICAL REACTION ENGINEERING

Credits: 4  Teaching Scheme: 03 (TH) + 02 (LAB) Hours / Week

Section 1:  (20 Hours)

Non-Ideal flow and Heterogeneous processes, catalysis and adsorption

Section 2:  (20 Hours)

Fluid-particle noncatalytic, catalytic and fluid-fluid non-catalytic reactions
Selection of a model for gas-solid non catalytic reaction, Un-reacted core model, Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Application of models to design problems. Various contacting patterns and their performance equations. Introduction to heterogeneous fluid - fluid reactions, Rate equation for instantaneous, Fast and slow reaction, Equipment used in fluid- fluid contacting with reaction, Application of fluid -fluid reaction rate equation to equipment design, Towers for fast reaction, Towers for slow reactions. Introduction of fluid particle catalytic reactions, Rate equation, Pore diffusion controlling, Heat effects during reaction, Various types of catalytic reactors : Fixed bed reactor- construction, operation and design, Isothermal operation, Adiabatic operation, Fluidized bed reactor, Slurry reactor, Trickle bed reactor. Experimental methods for finding rates.

List of labs:
Minimum 6 experiments from the following list to be performed:

1. To calculate the mass-transfer coefficient (KSL) for physical and chemical dissolution and to calculate the enhancement factor for ‘solid-liquid’ systems
2. To calculate the mass-transfer coefficient for physical and chemical dissolution and to calculate the enhancement factor for ‘liquid-liquid’ systems
3. To study residence time distribution (RTD) in a CSTR and to find out peclet No.
4. To determine RTD of a packed bed reactor and to find out Peclet No.
5. To study residence time distribution (RTD) in a plug flow reactor
6. Finding optimum residence time using polymaths for parallel Reactions
7. Finding conversion and rate of heterogeneous reactions.
8. Study reaction in heterogeneous and homogeneous manner
9. Study of a packed bed reactor it’s performance
10. Study of a fluidized bed reactor and its performance
11. Case study of the solid catalyzed reaction mechanisms
12. Case study of three phase reactors

Project areas:
Minimum 1 Project from list to be completed:

1. Synthesizing a rate law, mechanism and rate limiting step for heterogeneous reactions.
2. Design of fluid- fluid reactors
3. Design of fluid- particle reactors
4. Catalyst preparation, adsorption isotherms
5. Conversion prediction by segregation model
6. Conversion prediction by maximum mixedness model
7. Conversion prediction by dispersion model
8. Evaluate different moments of Non ideality
9. Design of a slurry reactor
10. Design of a trickle bed reactor
11. Conversion prediction by tank in series model
12. Conversion prediction by two parameter model

Text Books:

Reference Books:

Course Outcomes:
The student will be able to –

1. Distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information
2. Calculate the global rate of heterogeneous catalytic reactions
3. Determine the characteristics of solid catalyst like porosity, pore volume, etc
4. Select model for fluid-particle reactions and calculate the rate of reactions
5. Select model for fluid-fluid reactions and calculate the rate of reactions
6. Design the various types of rectors depending on the different types of heterogeneous Catalytic and non-catalytic reactions
CH3003:: SEPARATION TECHNIQUES

Credits: 4  
Teaching Scheme: 03(TH) + 02(LAB) Hours / Week

Section 1:  
(20Hours)
Liquid-Liquid Extraction: Ternary liquid-liquid equilibrium, triangular coordinates, single-stage extraction, Multi-stage crosscurrent extraction, continuous countercurrent multistage extraction. Types of extractors.

Section 2:  
(20Hours)
Leaching, Adsorption and Ion Exchange. Solid-Liquid Extraction: Single stage leaching, continuous counter current leaching, ideal stage equilibrium, operating time, constant and variable underflow, number of ideal stages, stage efficiencies, Leaching equipments.
Adsorption: Physical and chemical adsorption, adsorbents, adsorption equilibrium and isotherms, Single-stage, multi-stage cross-current and multi-stage counter current operations, equilibrium and operating lines, Liquid-solid agitated vessel adsorber, packed continuous contactor, breakthrough curves, Rate equations for adsorbents, nonisothermal operation, pressure-swing adsorption, Ion Exchange- Principles of Ion Exchange Equilibria and rate of ion exchange

List of Practicals:

Minimum 6 experiments from the following list to be performed:

1. To generate VLE data for binary ideal/non-ideal systems
2. To study differential distillation and verify Rayleigh equation
3. To carry out steam distillation of substance and determine steam requirement
4. To conduct binary distillation in a packed column at total reflux and to estimate HETP and HTU for column
5. To obtain data for equilibrium distribution of solute in two insoluble solvents for example acetic acid in water and toluene phases and determine percentage extraction
6. To study the (cross current) liquid-liquid extraction for extracting acetic acid from benzene using water as solvent
7. To carry out leaching operation using groundnuts and n-Hexane and find out quantity of oil and to determine the efficiency of single stage leaching operation
8. To verify Freundlich/ Langmuir isotherm equation for batch adsorption
9. To obtain the breakthrough curve for continuous process in adsorption column
10. To study the operation of a batch rectification column under constant or total reflux condition
11. Case study on industrial separation equipments.
12. Case study on separation processes in chemical plant.

List of Project areas:

Minimum 1 Project from list to be completed:

1. Design of distillation column
2. Design and simulation of reactive distillation
3. To prepare the ternary diagram for a system of three liquid one pair partially soluble for example
   acetic acid, benzene and water system
4. Study liquid- liquid extraction in a packed column and determine HTU and HETP for the tower
5. Analysis of ion-exchange equilibria
6. Process Design of Solvent Extractors
7. Design of multi-component distillation system using ASPEN software
8. Design and analysis of Supercritical Extraction
9. Process design of leaching equipment
10. Analysis of Reactive Extraction
11. Process design of adsorbers.
12. Analysis and Design of hybrid separation processes

Text Books:
   Heinemann, 1999
4. Dutta B. K.; Principles of Mass Transfer and Separation Processes; Prentice-Hall of India Private
   Ltd., 2007

Reference Books:
1. McCabe W. L., Smith J. C., Harriett P.; Unit Operations of Chemical Engineering; Fourth
2. Wankat. P.C.; Separations in Chemical Engineering: Equilibrium Staged Separations; Prentice
   Hall, NJ, US, 1988

Course Outcomes:
The student will be able to –
1. generate VLE data for ideal and non-ideal system
2. carry out process design of distillation column
3. analyze implications of factors affecting distillation column operation and design like the
   effect of reflux ratio, feed conditions etc. and also the implications of non-ideal phase
   behavior (e.g., azeotropes) and apply to multicomponent distillation
4. select suitable solvent for liquid-liquid extraction based on properties like selectivity, distribution coefficient etc. and design liquid-liquid extraction column and select equipment required for given separation
5. calculate the number of stages required for a leaching operation
6. draw analogy between adsorption and ion exchange, carry out process design of adsorption column
CH3061:: MECHANICAL OPERATIONS

Credits: 4  
Teaching Scheme: 03 (TH) + 02 (LAB) Hours / Week

Section I:  
(20 Hours)

Relevance of fluid and particle mechanics, Particle size and shape, Mixtures of particles, Characterization of solid particles, Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area, mixing of solids, size reduction, industrial screening equipment, crushing efficiency, open circuit and closed circuit grinding, size reduction equipments, Nucleation and growth of particles, solid storage, characteristics of Bulk solids, different operations for solid separation from gases and liquid- Froth flotation, magnetic separator, fiber and fabric filter, electrostatic precipitators, cyclone separator, hydrocyclone, Mineral jig, scrubbers, centrifuges, centrifugal clarifier, necessity of mixing and agitation in chemical industries, calculation of power requirement of mixing equipment, solid – Solid Mixing, agitator selection, Conveyors: design, calculation of Screw conveyors, Belt Conveyors, Chain and Flight conveyors, bucket elevators, pneumatic conveyors, mixing equipment of pastes and viscous material, mixing equipment of free flowing solids.

Section 2:  
(20 Hours)

Filter media and filter aids, classification of filtration, pressure drop through filter cake, filter medium resistance, specific cake resistance, continuous filtration, washing and dewatering of filter cakes, centrifugal filtration, filtration equipments, motion of particles in liquid, drag force, drag coefficients, gravity settling method, terminal velocity, stoke’s law, free settling, sink and float method, differential settling, Sedimentation and thickening: Batch sedimentation, equipments for sedimentation, kynch theory of sedimentation, calculation of area and depth of continuous thickeners, Flow around immersed bodies: Concept of drag, boundary layer separation, skin and form drag, drag correlations, flow through packed beds, Void fraction, superficial velocity, channeling, Ergun equation and its derivation, Kozeny Carman equation, Darcy’s law and permeability, characteristics of fluidized systems, minimum fluidization velocity, types of fluidization, applications of fluidization technique, spouted beds and fixed bed

List of Practicals:
Minimum 6 experiments from the following list to be performed:

1. Properties of solids: To determine Avg. Particle size, Specific surface of mixture and No. of particles in the mixture.
2. Screening: To determine the effectiveness of screen.
3. Sedimentation: To determine area of thickener by conducting batch sedimentation test.
4. Centrifugal sedimentation of fine particles slurry.
5. Ball mill: To determine crushing law constant (by using Rittingers law, Bonds law and Kicks law).
6. Jaw Crusher: To determine crushing law constant (by using Rittingers law, Bonds law and Kicks law).
7. Vacuum Leaf Filter: To determine filter medium resistance and cake resistance by using vacuum
leaf filter.
8. Cyclone Separator: To determine efficiency of cyclone separator.
10. Fluidization: To determine minimum fluidization velocity and verify with Ergun Equation.
11. Drag Coefficient: To determine terminal settling velocity and compare with theoretical settling velocity.
12. Determination and comparison of solid separation efficiency using gravity and centrifugal sedimentation

List of Project areas:
Minimum 1 Project from list to be completed:

1. Design of filtration process
2. Design of gravity sedimentation process.
3. Design of fluidization process.
4. Design of conveyor belt.
5. Review on recent trends in filtration.
6. Plant design of STP.
7. Plant design of ETP plant.
8. Review on recent trends in gas-solid separation
9. Design of cyclone separator
10. Design of hydro-cyclone separator
11. Design of centrifugal sedimentation process
12. Review on recent trends in solid-solid mixer

Text Books:


Reference Books:


Course Outcomes:
The student will be able to –
1. Recognize basic principle of particle size measurement and select suitable size reduction equipment
2. Select suitable solid-solid, solid-fluid separation technique and storage tank
3. Select suitable solid conveying system and solid-solid mixing process
4. Describe concept of filtration and design filtration unit
5. Describe concept of sedimentation and design sedimentation unit
6. Describe concept of flow through packed bed and design fluidized bed
CH3047 :: OPTIMIZATION TECHNIQUES

Credits: 4  
Teaching Scheme: 03 (TH) + 02 (LAB) Hours / Week

Section 1  
(20 Hours)


Section 2  
(20 Hours)


List of Practical:
Minimum 6 experiments from the following list to be performed:

1. Single variable unconstrained optimization
2. Unconstrained optimization using Newton’s Methods
3. Multivariable unconstrained optimization
4. Random Search Methods
5. Optimization using elimination methods
6. 2-D constrained optimization with Graphical Method
7. Constrained optimization with Simplex method
8. Non Linear Constrained Optimization
9. Software/ packages for optimization
10. Engineering optimization with Spreadsheet applications
11. Duality in Linear Programming
12. Chemical Engineering applications of Optimization

List of Project Areas:
Minimum 1 Project from list to be completed:

1. Least cost design of a Tank
2. Optimal design of a waste water treatment plant
3. Design of a reactor for optimal growth rate of yeast
4. Optimization of multi product facility
5. Design of Zero Effluent Discharge Plant
6. Optimal design of waste stabilization & digestion plant
7. Design of a small heat exchanger network
8. Real time optimization of a distillation column
9. Model predictive control using optimization
10. Maximizing yield or selectivity in a complex chemical reaction
11. Data validation and reconciliation using optimization
12. Synthesis of optimal process system with uncertainty

**Text Books:**

**Reference Books:**

**Course Outcomes:**
The student will be able to –
1. Optimize the process objective function based on different types of constraints.
2. Calculate the search operation of optimization related problem based on different methods.
3. Problem solving using Linear Programming
4. Optimising design of chemical equipments.
5. Solving the problem of unimodal and multimodal function.
CH3075 :: ENGINEERING DESIGN AND INNOVATION 1

Credits: 4  
Teaching Scheme: 01 (TH) + 06 (LAB) Hours / Week

Contents:
This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion. Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.

A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.

The external from Industry/research organization is invited to evaluate the projects done by students.

Course Outcomes:
The student will be able to –
1. Apply chemical engineering knowledge.
2. Learn how to work in team.
3. Define a task (problem) and execute it.
4. Carry out literature search related to topic.
5. Write synopsis and complete literature search related to topic and complete report.
6. Identify the idea and execute it in team.
### Module VI Third Year B. Tech Chemical Engineering

**Title:** Course Structure  
**Branch:** Chemical Engineering  
**Year:** Third Year B. Tech.  
**Academic Year:** 2019-20  
**Semester:** VI  
**Module:** VI  
**Pattern:** C-19

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CH3000::PROCESS EQUIPMENT DESIGN

Credits: 4
Teaching Scheme: 03 (TH) + 02 (PROJ/LAB) Hours / Week

Section 1: (20 Hours)
Heat Exchangers: Introduction, process heat transfer, types of heat exchangers, codes and standards for heat exchangers, materials of construction, API scale, LMTD, countercurrent & concurrent exchangers, temperature approach & cross, counter-flow: double pipe exchangers, baffles and tie rods, design of shell and tube heat exchangers as per IS: 4503 and TEMA standards i.e. shell, tube sheets, channel, channel cover, flanged joints. Design of Double pipe, plate type heat exchangers. Joints, bearings, drives, mechanical seals, fabrication methods. Evaporators & pressure vessels: Classification of vaporizing equipment, evaporators (including different types such as kettle, thermosiphon, vertical, horizontal etc. Chemical evaporators, natural circulation & forced circulation evaporators, the calculation of chemical evaporators. Types of pressure vessels, codes and standards for pressure vessels (ASME Sec VIII Div-1, 2), material of construction, selection of material, selection of corrosion allowance and weld joint efficiency, purging of vessels. selection and design of various heads such as flat, torispherical, elliptical, hemispherical and conical. Opening/ nozzles and manholes, nozzle sizing, calculations etc. Flanged joints: Gasket: types, selection, and design, bolt design and selection, flange dimensions flange rating calculation. Condenser Design and support design: Condenser design for condensation of single vapors, Design of total and partial condenser with pressure balance. Vertical condenser, horizontal condenser. Allowable pressure drop in condensers, condenser-subcooler, condensation of steam- surface condenser. jacket for vessels. Introduction and classification of supports, design of bracket or lug supports, saddle support.

Section 2: (20 Hours)
Mass transfer equipments with storage vessel and mixer consideration: Tray column design and storage vessels: Design of plate column- distillation columns, design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors, plate hydraulic design. Various types of storage vessels and applications, losses in storage vessels, storage of fluids- storage of volatile & non-volatile liquids- fixed roof and variable volume tanks, Various types of roofs used for storage vessels. Storage of gases- spherical vessels. Packed Column Design and mixers: Choices of packing, types of packing, packed bed height (distillation and absorption), HETP, HTU, NTU, Cornell’s method, Onda’s method, column diameter, column internals, column auxiliaries. Mixers- Various types of mechanical mixers- propeller, turbines & paddles their selection, flow patterns in agitated tanks, baffling, design practices, standard geometry tank, power dissipation and discharge flow correlation, mechanical agitator design. Reaction vessels. Filters, Dryers and auxiliary process vessels: Study of various types of filters like vacuum filters, pressure filters, centrifuges and rotary drum filters, design of rotary drum filters including design of drum, shaft, bearing and drive system. Types of dryers, batch type dryers, continuous dryers. Study of auxiliary process vessels such as reflux drum, knockout drum, liquid-liquid and gas-liquid separators, entrainment separators, oil water separator, Decanter, gravity separator, safety devices.

List of Lab experiments:
Minimum 6 experiments from the following list to be performed:
1. Design of Shell and Tube heat exchanger.
2. Design of double pipe heat exchanger.
3. Design of vaporiser
4. Design of condenser
5. Design of distillation column
6. Design of types of supports for vessels
7. Design of various types of heads for vessels
8. Design of agitators for chemical reactors
9. Literature survey on types of safety valves, safety devices for chemical equipments
10. Autocad drawing of tubes sheet for the Shell and tube heat exchanger.
12. Mechanical design details for Shell and tube heat exchanger.

**List of Project areas:**

**Minimum 1 Project from list to be completed:**
1. Optimisation of Shell and Tube heat exchanger considering particular heating or cooling objective
2. Optimisation of Plate type heat exchanger considering particular heating or cooling objective
3. Optimisation of Double pipe heat exchanger considering particular heating or cooling objective
4. Optimisation of Helical tube type heat exchanger considering particular heating or cooling objective
5. Optimisation of evaporator to obtain thick liquor with particular concentration considering various industrial needs
6. Optimisation of tray/packed column for separation by using distillation, absorption, etc operations with an industrial example.
7. Condenser design for multicomponent vapor mixtures.
9. Design of extractive distillation system.
10. Design of rotary dryer.

**Text Books:**

3. V.V. Mahajani, S. B. Umarji; Joshi's Process Equipment Design; 5th Edition; Trinity Press

**Reference Books:**

4. R. K. Sinnott; Coulson and Richardson’s Chemical Engineering Volume 6 - Chemical Engineering Design; 4th Edition; Pergamon Press.

**Course Outcomes:**
The student will be able to –
1. Carry out the detailed thermal design of double pipe and shell and tube heat exchanger for given requirement
2. Design a multiple effect evaporation system for specific requirement of concentration
3. Do hydraulic plate design and tray column design for desired separation needs
4. Select type and size of packing and packed column design with internals for required separation
5. Select and design support for vessels
6. Choose and design auxiliary process equipment required for various simple separation & storage requirements
Section 1: (20 Hours)

Instrumentation: Measurement fundamentals. Temperature, flow, pressure, level and composition measuring instruments. Static and dynamic characteristics. Control valves: sizing and valve characteristics


Section 2: (20 Hours)


List of Practicals:
Minimum 6 experiments from the following list to be performed:
1. Measurements for temperature
2. Measurements for pressure
3. Measurements for flow
4. Measurements for level
5. Process dynamics
6. PID Controlled system: P, I, D modes and controller tuning
7. Feedback control system design using Matlab
8. Dynamic simulation on a chemical engineering simulator such as Aspen
9. Dynamics of distillation column
10. Dynamics of reactor
11. Stability analysis

List of Project areas:
Minimum 1 Project from list to be completed:
1. Controller tuning
2. P&ID diagrams for flow sheets
3. design a control system using time-domain techniques such as root-locus
4. design a control system using frequency-domain techniques such as Bode design
5. Dynamic behaviour of pure capacity process
6. Feedback control system design using Matlab
7. Dynamics of Chemical Engineering Systems
8. Feedforward control system
9. Control valves sizing
10. Cascade control
11. Selective control
12. Multiloop and multivariable control

Text Books:

Reference Books:

Course Outcomes:
At the end of the course the student will be able to
1. carry out selection and performance analysis of measuring instruments
2. write dynamic models of chemical engineering systems
3. carry out process identification and tune a PID controlled system
4. design a control system using time-domain techniques such as root-locus
5. design a control system using frequency-domain techniques such as Bode design
6. carry out preliminary analysis of Advanced Process Control systems
CH3014:: NANOTECHNOLOGY

Credits: 04
Teaching Scheme: 03(TH) + 02(LAB) Hours / Week

Section 1: (20 Hours)

Introduction
Historical development of nanotechnology.
Overview of nanotechnology. Global trends.
Overview of typical products in market utilizing nanotechnology.

Physics of Nanomaterials
Coverage of physics of materials appropriate for applications to nanotechnology

Characterisation of Nanomaterials
Microscopy techniques, spectroscopy techniques, XRD etc

Section 2: (20 Hours)

Synthesis / Fabrication of nanomaterials
Top-down and bottom-up approaches for synthesis of nanomaterials. Industrial scale production of nanomaterials.

Applications of Nanotechnology
Current and potential applications of nanotechnology. Biological nanomaterials. Nanoelectronics. Nanomachines & nanodevices etc.
Research directions. Economic, environmental and societal aspects of nanotechnology.

List of Practicals:
Minimum 6 experiments from the following list to be performed:
1. Copper nanoparticles synthesis
2. Silver nanoparticles synthesis
3. Gold nanoparticles synthesis
4. ZnO nanowires synthesis
5. MEMS/NEMS design and simulation
6. MEMS/NEMS fabrication
7. MEMS/NEMS testing and characterization
8. Nanolithography
9. Biosensing
10. Synthesis of Cu(OH)₂ nanowires
11. Synthesis of CuO nanowires
12. Sol-gel nanosynthesis

List of Project areas:
Minimum 1 Project from list to be completed:
1. Nanoparticle synthesis
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2. Nanowire synthesis
3. Synthesis of quantum dots
4. Thin film synthesis
5. Characterisation of nanomaterials using SEM
6. Characterisation using AFM
7. Characterisation using STM
8. Characterisation using XRD
9. Product design involving some nanotechnology component
10. Analysis of research paper on nanoelectronics
11. Analysis of research paper on nanofabrication
12. MBE

Text Books:

Reference Books:

Course Outcomes:
The students will be able to
1. describe history of nanotechnology
2. understand basics of physics and chemistry involved in nanotechnology
3. explain the major characterization techniques used in nanotechnology
4. classify and describe various nanosynthesis methods
5. analyze any given nanotechnology product / process in terms of characterization techniques, synthesis methods and applications
6. analyse current and future trends
CH3024: ENVIRONMENTAL ENGINEERING

Credits: 4  
Teaching Scheme: 03 (TH) + 02 (LAB) Hours / Week

Section 1  
Pollution Prevention:  
Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules  
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  
Solids waste disposal - composting, landfill, briquetting / gasification and incineration

Section 2  
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  
Water Pollution Control: Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.  
Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying.

List of Practicals:
Minimum 6 experiments from the following list to be performed:

1. Determination of acidity of various water samples.  
2. Determination of the alkalinity of various water samples.  
3. Determination of the chloride content in the given water samples.  
4. Determination of the optimum coagulant dose for the removal of maximum turbidity  
5. Determination of the hardness of the given water sample  
6. Determination of the iron content of water samples  
7. Literature survey on municipal waste management  
8. Literature survey on domestic sewage treatment  
9. Literature survey on air pollution  
10. Literature survey on nuclear waste management  
11. Literature survey on hazardous waste management  
12. Industry visit for study of ETP

List of Project Areas:
Minimum 1 Project from list to be completed:

1. Municipal Solid waste management  
2. Waste to Energy  
3. Electronic waste management
4. Air pollution control - Removal of particulate matter
5. Air pollution control - Removal of SOx
6. Air pollution control - Removal of NOx
7. Water pollution control in Petroleum Industries
8. Water pollution control - Domestic sewage treatment
9. Water pollution control - Petroleum Industries
10. Water pollution control - Fertilizer Industries
11. Water pollution control - Sugar Industries
12. Removal of heavy metal from waste water

Text Books:
3. Eckenfelder W.W; "Industrial Water Pollution Control", 2 Ed; McGraw Hill.

Reference Books:

Course Outcomes:
The student will be able to –
1. Determine type of pollution.
2. Select and use suitable method of gaseous pollution control
3. Select and use suitable method of water pollution control
4. Select and use suitable method of particulate pollution control
5. Select and use suitable method of solid waste management
6. Design the biological water treatment equipment
CH3016:: FERMENTATION TECHNOLOGY

Credits: 4  
Teaching Scheme: 03 (TH) + 02 (LAB) Hours / Week

Section 1  
20 Hours
Manufacturing process for major products produced by biochemical reactions such as vitamins B, alcohol, acetic acid and vinegar, acetone, lactic acid, citric acid, wine, proteins, penicillin. Major components in bioreactor, Types of bioreactor, modern bioreactors types, scale up and its difficulties, considerations on aeration, agitation, and heat transfer, Bioreactor instrumentation and control, Modification in the design and analysis of chemical reactor as biological reactors. Computerized simulation of bioreactor. Fed batch reactor, CSTR, plug flow reactors, Reactor dynamics, reactor with non-ideal mixing, immobilized biocatalyst, Multiphase bioreactors, fermentation technology

Section 2  
20 Hours
Aerobic and anaerobic waste water treatment, Microorganisms used in waste water processes, dissolved oxygen balance, dissolved oxygen model, organic discharge and stream ecology, growth and food utilization, suspended culture system, activated sludge, ponds and lagoons. Attached culture system, refractory chemicals, Product recovery operations:- Dialysis, Reverse osmosis, ultra-filtration, and Micro-filtration, Chromatography, electrophoresis, electro dialysis. Crystallization and drying, Technical aspects:-Bioprocess economics, Genetic information: potential uses and abuses, Biosafety, ideas and research, typical sequence of events, risk and rewards, patents and the protection of ideas.

List of Practicals:
Minimum 6 experiments from the following list to be performed:
1. To prepare culture for fermentation.
2. To carry out cleaning and sterilization by different methods.
3. To evaluate parameter of fermentation process.
4. To determination of kinetics of bioprocess.
5. To determination of growth constant of bioprocess.
6. To study of different types of bioprocesses.
7. To design different components of bioreactor.
8. To design of different types of bioreactor.
9. To estimate economic of bioprocess.
10. To do plant design of bioprocess.
11. To do literature survey of different bioprocesses.
12. To do literature survey of different bioreactors.

List of Project areas:
Minimum 1 Project from list to be completed:
1. Fermentation Technology
2. Enzyme Technology
3. Design of Bioreactors
4. Design of components of bioreactors
5. Design of agitators for Bioreactors
6. Design of sterilization system for Bioreactors
7. Kinetics of bioprocess
8. Different types of bioprocesses
9. Plant Design of bioprocess
10. Biological waste water systems
11. Immobilization of enzymes

Text Books:

Reference Books:

Course Outcomes:
The student will be able to –
1. Describe various bioprocesses in chemical industry
2. Describe various components and type of bioreactors
3. Describe and design bioreactors
4. Describe and design biological waste water treatment processes in chemical industry
5. Describe the separation and recovery operations in biochemical plants
6. Describe bio business and protection of ideas
CH3026: PETROLEUM REFINING

Credits: 4  
Teaching Scheme: 03 (TH) + 02 (PROJ/LAB) Hours / Week

Section 1:  
(20 Hours)

Petroleum composition, specifications of petroleum and some petroleum products such as LPG, Gasoline, Kerosene, Diesel oil and Engine oil.
Pre- refining operations: Settling, Moisture removal, Storage, Heating through exchangers and pipe seal heaters, Atmospheric distillation, Vacuum distillation
Significant conversion units such as, Reforming, Catalytic-Cracking, Hydro-cracking.

Section 2:  
(20 Hours)

Coking and Thermal Processes: Delayed coking, Flexi coking, Fluid coking.
Additives Production such as Ether and Isobutylene production
Refining of petroleum products such as Acid refining, Chemical refining, Hydro-refining, HDS, HDM, HAD.
Blending, Additives, Storage of products, Transportation, Housekeeping, Marketing of petroleum and petroleum products, Safety norms for petroleum products.

List of Lab experiments:
Minimum 6 experiments from the following list to be performed:

1. Study of world oil reservoirs.
2. Study of Indian oil reservoirs.
3. Study of Indian oil refineries.
4. Study of pre-refinery crude oil operations.
5. Study of properties of petroleum products.
6. Study of different additives and blending chemicals.
7. Study of post refinery crude oil operations.
8. Study of recent trends in petrochemicals in terms of packaging materials.
9. Study of recent trends in petrochemicals in terms of catalyst.
10. Study of recent trends in petrochemicals in terms of distillation.
11. Study of recent trends in marketing of petroleum products.
12. Study of safety norms of petroleum product.

List of Project areas:
Minimum 1 Project from list to be completed:

1. A project on design of fire heaters
2. A project on design of multistage atmospheric distillation column
3. A project on design of vacuum distillation column
4. A project on properties of gasoline.
5. A project on properties of diesel.
6. A project on properties of kerosene.
7. A project on properties of lubricating oil.
8. A project on overview of refinery processes.
9. A project on design of pipe still heater.
10. A project on gas to liquid technology.
11. A project on purification of natural gas.
12. A project on liquefaction of natural gas.

Text Books:


Reference Books:


Course Outcomes:
The student will be able to –
1. Find out composition, main characteristics and new trends of petroleum products
2. Select pre-refining operation depending on feed composition
3. Describe cracking and reforming processes
4. Describe coking and additive production processes
5. Select product refining operations and additives to increase quality of petroleum products
6. Develop knowledge of safety during storage, transportation and marketing of petroleum product
CH3076 :: ENGINEERING DESIGN AND INNOVATION 2

Credits: 4  
Teaching Scheme: 01 (TH) + 06 (LAB) Hours / Week

Contents:
This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion. Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.

A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation. The external from Industry/research organization is invited to evaluate the projects done by students.

Course Outcomes:
The student will be able to –
1. Apply chemical engineering knowledge.
2. Learn how to work in team.
3. Define a task (problem) and execute it.
4. Carry out literature search related to topic.
5. Write synopsis and complete literature search related to topic and complete report.
6. Identify the idea and execute it in team.