SGGS INSTITUTE OF ENGINEERING & TECHNOLOGY, NANDED

(An Autonomous Institute of Government of Maharashtra)

Final Year B. Tech. (Chemical Engineering) Curriculum Structure: Academic year 2017-18 onwards

Choice Based Credit System: A

Semester VII								
Course Code	Course Title	Cat Code	Lectures (L)	Tutorials (T)	Practical (P)	Credits		Total
						Th.	Pr.	
CH421	Process Modeling & Simulation	PC	03	01	02	04	01	05
CH422	Transport Phenomena	PC	03	01	--	04		04
CH423	Industrial Organization & Management	PC	03	--	--	03		03
CH424	Optimization Techniques	PC	03	01	--	04	--	04
CH425	EL-III /open EL	PE/OE	03	--	--	03	--	03
CH426	Seminar	FC	--	--	02	--	01	01
CH427	Minor Project	FC	--	--	08	--	04	04
Total			15	03	12	18	06	24
Sub Total			30			24		**24**
Semester VIII								
Course Code	Course Title	Cat Code	Lectures (L)	Tutorials (T)	Practical (P)	Credits		Total
						Th.	Pr.	
CH428	EL-IV/open EL	PE/OE	03	--	--	03	--	3
CH429	EL-V/open EL	PE/OE	03	--	--	03		3
CH430	El-VI/ open EL	PE/OE	04	--	--	04	--	4
CH431	Major Project	FC	--	--	16	--	08	08
Total			10	--	16	10	08	18
Sub Total			26			18		**18**
Total Credits			**24+18=42**					

OR

Choice Based Credit System: B (Optional Scheme)

Semester VII								
Course Code	**Course Title**	**Cat Code**	**Lectures (L)**	**Tutorials (T)**	**Practical (P)**	**Credits**		**Total**
						Th.	**Pr.**	
CH421	Process Modeling & Simulation	PC	03	01	02	04	01	05
CH422	Transport Phenomena	PC	03	01	--	04		04
CH423	Industrial Organization & Management	PC	03	--	--	03	--	03
CH424	Optimization Techniques	PC	03	01	--	04	--	04
CH425	EL-III /open EL	PE/OE	03	--	--	03	--	03
CH426	Seminar	FC	--	--	02	--	01	01
CH427	Minor Project	FC	--	--	08	--	04	04
*CH430	EL-VI/open EL	PE/OE	04	--	--	04	--	04
Total			19	03	12	22	06	28
Sub Total			34			28		**28**

Semester VIII*								
Course Code	Course Title	Cat Code	Lectures (L)	Tutorials (T)	Practical (P)	Credits		Total
						Th.	Pr.	
CH431	Major Project	FC	--	--	28	--	14	14
Total			--	--	28	--	14	14
Sub Total			28			14		**14**
Total Credits			**28+14=42**					

*Sem VIII is Industrial Project based. If the students want to adopt Choice Based Credit System: B then they has to inform for their choices in the month of August.

List of Electives

EL III/Open	**EL-IV**	**EL-V**	**EL-VI**
Energy Management	Safety and Risk Analysis [OE]	Petrochemical Technology	Green Process Engineering
Renewable Energy Resources	Polymer Processing	Biotechnology	Green Chemistry
Piping Engineering [OE]	Catalytic Green Science & Technology	Nanotechnology [OE]	Waste Water Treatment [OE]
Computational Fluid Dynamics (CFD) [OE]	Catalytic Science and Engineering	Refinery Science and Engineering	Solid Waste Management[OE]
Food Technology	Chemical Analytical Instrumentation	Sustainable Chemical Technology	Air Pollution and control[OE]

CH421	PROCESS MODELING AND SIMULATION; Credits: 05 (L-3, T-1, P-2)

Course Objectives: Students undergoing this course will be able to-

- Understand fundamental principles of process modeling and simulation.
- Learn to develop mathematical models of phenomena involved in chemical engineering processes.
- Solve mathematical models with different simulation tools.
- Optimize the operating conditions by simulating mathematical models for process intensification.

Course Outcomes: Students who have succeeded in this course can-

- Apply fundamental laws to formulate mathematical process models.
- Develop model equations for steady state processes.
- Develop model equations for dynamic processes
- Simulate and optimize various chemical engineering processes.

Course Contents:

Introduction to Process Modeling and Simulation Fundamentals

Uses of Mathematical Models, Scope of coverage, principles of formulation Fundamental laws: Continuity equation, Energy equation and Information flow diagrams, Equations of motion, Transport equations, Equations of state, Phase and Chemical Equilibrium, Chemical kinetics, Classification of process models, Dimensionless modeling approach.

Modeling of Chemical Engineering System –I

Two heated tanks, Batch Reactor, Series of isothermal constant holdup Continuous Stirred Tank Reactor (CSTR), CSTR with variable holdup, Gas phase pressurized CSTR, Non-isothermal CSTR, Reactor with mass transfer, Models in reaction kinetics schemes for various reaction schemes: Series parallel, combination, etc.

Modeling of Chemical Engineering System – II

Single component vaporizer, Multi-component flash drum, Ideal binary distillation column, Batch distillation with holdup, pH Systems, steady state modeling of Solvent Extraction, two stage extraction, models in heat transfer operation, etc.

Dynamic Simulations

Batch reactor, Gravity flow tank, Three CSTR in series, Non-isothermal CSTR, etc. Binary distillation column, Multi-component distillation column, Variable pressure distillation column, Ternary batch distillation with holdup, etc.

Text Book:

1. William L. Luyben, "Process Modeling, Simulation An Control For Chemical Engineers", McGraw-Hill Publishing Company

References:

1. B.V.Babu, "Process Plant Simulation", Oxford publications.
2. V.G.Jenson,and G.V.Jefree, "Mathematical methods in Chemical Engineering", Academic Press
3. John Ingham, et al., "Chemical Engineering Dynamics-An introduction to modeling & computer simulation", John Willey Publications, 2nd completely revised edition.

CH421	Chemical Process Modeling and Simulation Lab [(0-0-2); credits: 02]

Course Objectives: Students undergoing this course will be able to-

- Introduction to different commercial software packages.
- Construct the code for simulating process models.
- Design, control and optimize process models by simulators.

Course Outcomes: Students who have succeeded in this course can-

- Demonstrate the ability to use a process simulator.
- Formulate the algorithm for simulating chemical processes.
- Analysis of design, control and optimization of chemical processes.

Syllabus:

The following experiments have to be conducted using any commercial software package available like Polymath/MATLAB /CHEMCAD/Aspen Plus/Hysys /Unisim , etc. (Any 08 out of 13 listed below).

1. Gravity Flow tank.
2. Three CSTR's in series – open loop.
3. Three CSTR's in series – closed loop.
4. Non-isothermal CSTR.
5. Complex reaction scheme (Batch Reactor)
6. Second order complex batch reactor
7. Series parallel reaction scheme
8. Semi-batch reactor model
9. Complex reaction model
10. Parallel second order reaction scheme
11. Reversible and irreversible 1^{st} order reactions
12. 2nd order series reactions
13. Complex set of series parallel reactions

***Additional experiments can be added as per the course content.**

CH422	Transport Phenomena: Credits: 04 (L-3, T-1, P-0)

Course Objectives: Students undergoing this course will be able to-

- Learn the fundamentals of transport phenomena.
- Identify transport properties of molecular momentum, energy and mass transport.
- Adopt the shell balance approach to transport processes.
- Familiarize the equations of change.
- Recognize analogies among momentum, heat and mass transfer.

Course Outcomes: Students who have succeeded in this course can-

- Interpret the chemical and physical transport processes with mechanisms.
- Formulate heat, mass and momentum transfer analysis by setting up shell balances for desired profiles of process variables.
- Develop steady and time dependent solutions along with their limitations.
- Apply equations of change to obtain engineering quantities of interest.
- Compare the analogies amongst momentum, heat and mass transfer.

Course Contents:

Definition of transport properties, their measurement and estimation, flow of Newtonian & non-Newtonian fluids, development of boundary layer, Shell balance approach for developing momentum balance, velocity distribution in laminar and turbulent flow, Flow in some simple cases - Flow over an inclined plane, Flow between two parallel plates, flow between two concentric rotating cylinders, steady flow around a sphere (theory of very slow motion), etc.

Equations of Continuity, Euler, Motion and Navier–stokes (Cartesian, cylindrical, and spherical coordinates) in laminar flows and its applications for the calculation of velocity profiles, shear stresses, power, etc. in various engineering applications, dimensional analysis of equation change.

Shell balance approach for developing equations for heat transport, development of thermal boundary layer, Temperature distribution in solids and fluids in laminar flow. Heat conduction with electrical heat source, Heat conduction with a nuclear heat source, Heat conduction with a viscous heat source, Heat conduction with a chemical heat source, Heat conduction with variable thermal conductivity, Forced and free convection, Heat conduction in a cooling fin, etc.

Shell balance approach for developing equations for mass transport, Concentration distribution in solids and in fluids in laminar flow- Diffusion through stagnant gas film, Diffusion with heterogeneous chemical reaction, Diffusion with homogeneous chemical reaction , Diffusion through Pyrex tube, etc.

Analogies between heat, momentum and mass transport. Applications of heat, momentum and mass transport concepts to various disciplines of engineering and technology.

Text Books:

1. Bird R.B., Stewart W.E., Lightfoot E.N, “Transport Phenomena”, John Wiley & Sons, Singapore, 1960 & 2002.

References:

1. Thomson, W.J. “Introduction to Transport Phenomena”, Pearson Education Asia, Singapore, 2000.
2. Brodkey R.S. and Hershey H.C, Transport Phenomena: A Unified Approach, McGraw-Hill, New York,1988.
3. Plawsky J.L, “Transport Phenomena Fundamentals”, Marcel Dekker, New York, 2001.
4. Slattery J.C., Sagis L., Oh E-S. “Interfacial Transport Phenomena”, Springer, New York, 2007.

CH423	Industrial Organization & Management; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Study the management concept, its functions and responsibility.
- Understand the human resource management in industry.
- Understand the store and purchase management.
- Study the management laws.

Course Outcomes: Students who have succeeded in this course can-

- Understand the management process and structure in the industry so that it will help them to work in a better way.
- Develop an efficient methodology for industrial management.
- Cater the issues related to current industrial amendments.

Course Contents:

Management Science: Management, its growth, concepts of administration and management of organization. Definition of management, functions, authority and responsibility. Unity of command and direction. Decision making in management by objectives.

Business Organization: Different forms of organization, their formation and working, Different organization structure-line organization, functional organization, line and staff organization.

Personnel Management: Man power planning, sources of recruitment, selection and training of staff. Job evaluation, merit rating, performance appraisal, wage administration and system, of wage payment, incentive, motivations, industrial fatigue, Trade unions– industrial relations.

Purchase and stores management: Concepts of quotation, tenders and comparative statement, inspection and quality control, Inventory, carrying cost and fixed cost of inventory, examples of cost of Inventory, Stores management, functions of storekeeper, methods of inventory: LIFO, FIFO.

Export and import management: Concepts of international trade, duties, antidumping duty, cost involved in exporting a product, pricing of export product. Government aids for export promotion, export houses, export promotion counsel, MODVAT, patent and patent rights.

Management Laws: Concepts of contract act, offer, and acceptance, types of contracts, Void contract, concept of guarantee and warranty. Introduction of MRTP and FERA.

Textbook:

1. Industrial Engineering and Management-O. P. Khanna

References:

1. Management for Business andIndustry-C.S. GeorgeJr.
2. Principles of management-Knootsand O.Donnell.
3. Business Organization and management-M.C. Shulka.

CH424	Optimization Techniques; Credits: 04 (L-3, T-1, P-0)

Course Objectives: Students undergoing this course will be able to-

- Introduce the fundamental concepts of Optimization Techniques;
- Create awareness of the importance of optimizations in real scenarios;
- Provide the concepts of various classical and modern methods of constrained and unconstrained problems in both single and multivariable.

Course Outcomes: Students who have succeeded in this course can-

- Formulate optimization problems;
- Understand and apply the concept of optimality criteria for various types of optimization problems;
- Solve various constrained and unconstrained problems in single variable as well as multivariable;
- Apply the methods of optimization in real life situation.

Course Contents:

Introduction to optimization; Formulation of objective function; Basic concepts-functions, regions, necessary and sufficient conditions for an extremum of an unconstrained function.

One dimensional Search: Scanning and bracketing; Newton, quasi-Newton and secant methods; Region elimination method; Polynomial approximation methods.

Unconstrained multivariable optimization: Direct methods-random searches, grid search, univariate search, simplex method, conjugate search direction and Powell's method; indirect method-gradient and conjugate gradient methods, Newton's method, movement in search direction, secant method.

Linear programming: Basic concepts in linear programming; Graphical solution; Simplex method; Standard LP from; Obtaining first feasible solution; Sensitivity analysis. Non linear programming: Lagrange multiplier method;

Quadratic programming; Penalty function and augmented Lagrangian methods; Successive quadratic programming; Optimization of dynamic processes. Optimization of staged and discrete processes: Dynamic programming; Integer and mixed integer programming.

Nontraditional optimization techniques: Simulated anneling; Genetic algorithms; Differential evolution. Application of optimization in the design of separation process, chemical reactor and large scale process plant.

Textbook:

1. Engineering Optimization Theory & Practice, S. S. Rao,

References:

1. Multi-Objective Optimization Using Evolutionary Algorithms K. Deb,
2. Process Plant Simulation, B.V. Babu
3. Optimization of Chemical Processes, T. F. Edgar, D. M. Himmelblau

CH425	El-III: Energy Management ; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Describe the general aspects of energy management.
- Understand the principles and techniques used in energy conservation.
- Exercise the methodology of energy auditing and its economics.
- Impart the concept of energy cogeneration and waste heat recovery.

Course Outcomes: Students who have succeeded in this course can-

- Explain the principles and techniques used in energy conservation and management.
- Know the techniques of cogeneration and waste heat recovery in chemical processes.
- Perform energy auditing and its economic analysis.
- Evaluate the performance of industrial boilers, furnaces etc. by direct and indirect methods

Course Contents:

General aspects of energy management: Current energy scenario-India and world, current energy consumption pattern in global and Indian industry, Principles of energy management, energy security and reliability, energy and environment, Concept of energy conservation, Energy Conservation Act of India (2001),

Energy efficiency in thermal utilities: Thermodynamic energy indices & Bureau, Indian Boiler Act (1923) Boiler-efficiency testing, excess air control, Steam distribution and use, steam traps, condensate recovery, flash steam utilization, heat pipes, heat integration and networking.

Cogeneration and waste heat recovery: Waste heat recovery, Need, applications, advantages, classification, of cogeneration. Waste heat recovery classification and applications, Potential for waste heat recovery in industry.

Energy auditing: Methodology, analysis of past data, measurements of various parameters, portable and on line instruments.

Energy economics: Payback period, Rate of Return, life cycle costing. Concept of comprehensive Energy Conservation and Planning.

Textbooks:

1. Vijay Navale & Mahesh Nayvale," Energy Audit & Management",Tech Easy Publication Pune ,2008.
2. Murphy W.R., McKay G.A, "Energy Management", Murphy Butterworth-Heinemann Ltd., 2001.

References:

1. Turner W.C,"Energy Management Handbook", Fairmont Press, Lilburn, Georgia, 1993.
2. Energy Conservation Handbook, C Douglas, McGraw Hill Publications.

CH425	El-III: Renewable Energy Resources; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Study various types of conventional and non-conventional energy resources.
- Describe new and renewable energy sources like solar energy, wind energy, geo-thermal energy, tidal energy, ocean thermal energy.
- Describe the application and uses of above energy sources in various industries.
- Describe the principles and techniques used in energy conservation and management.

Course Outcomes: Students who have succeeded in this course can-

- Understand and analyze the present and future energy demand of world and nation,
- Understand the techniques to exploit the available renewable energy resources such as solar, bio-fuels, wind power, tidal and geothermal effectively.
- Know about the exploration of nonconventional energy resources and their effective tapping technologies.
- Understand the effective utilization of available renewable energy resources.
- Acquire the knowledge of modern energy conversion technologies.

Course Contents:

Introduction -: Energy scene of supply and demand in India and the world, Energy consumption in various sectors, potential of non-conventional energy resources, energy needs and energy supply, sources, contribution of non-conventional energy.

Solar Energy -: Solar radiation and its measurement, characteristics and estimation, limitations in the applications of Solar Energy, Collectors: flat plate and concentrating types, their comparative study; design and material selection, efficiency, selective paints and surfaces. Solar water heater, applications of Solar Energy for heating, drying, water desalination, solar concentrators, photovoltaic power generation using silicon cells. Thermal storages, Solar ponds, Solar pumps, Solar power, Solar cookers. Direct conversion of solar energy to electricity and its various uses, materials, limitations and costs.

Bio- Fuels -: Photosynthesis and generation of bio-gas, digesters and their design, selection of material; feed to digester, pyrolytic gasification, production of hydrogen, algae production and their uses. Wind Energy -: Principle of energy from wind, availability, site selection, different types of wind turbines, design criteria and material selection, economics. Geo-Thermal Energy- : Geo-technical wells and other resources dry rock and hot aquifer analysis, harnessing geothermal energy resources. Tidal Energy- : Its meaning, causes of tides and their energy 31 potential, enhancement of tides, limitations, different methods of using tidal power.

Ocean Thermal Energy -: Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC. Principle of utilization and its limitations, description of few systems. Other Non-conventional Energy Sources, fluidized bed combustion, heat from waste and other sources. Energy Conservation: Principles of energy conservation. Familiarization with the different energy conservation appliances and practices, improved cooking stoves, benefits of improved cooking stoves over the traditional cooking stoves. Scope of energy conservation in the domestic, commercial and agricultural sector.

Textbook:

1. Kothari D.P., “Renewable Energy Sources and Emeriging Technologies”,PHI,2008

References:

1. Khan B.H., “Non-Conventional Energy Sources”,2nd edition, McGraw-Hill,2009
2. Solanki C.S., “Renewable Energy Technologies”,PHI,2009
3. Rai G.D, “Non-Conventional Energy Sources”, Khanna Publishers, Delhi.
4. Twiddle J., Weir T., “Renewable Energy Resources”, Cambridge University Press, 1986

CH425	Elective-III: Piping Engineering; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- To study the basics of Piping Engineering.
- Explain concepts related to Piping Engineering.
- Use information of what Piping Engineer should know to implement in new situation.
- To understand the fundamentals about pipes and tubes
- To understand the role, responsibilities of Piping Engineering.

Course Outcomes: Students who have succeeded in this course can-

- Capable to understand the concepts of the nature of fluid flow.
- Ability to analyze Flow of liquid in Pipe.
- Should understand the concept of Pipe surface roughness effects.
- Get familiar with phenomenon of pipe networking.
- Understand the difference between pipes and tubes.
- Understand the Apparent Reynolds.

Course Contents:

What is Piping Engineering, role, responsibilities of Piping Engineering, what Piping Engineer should know, Classification of pipes and tubes, IS & BS codes for pipes used in chemical process industries and utilities. Pipes and tubes, difference between pipes and tubes.

Flow of liquid in Pipe, Newtonian fluids, the nature of fluid flow, flow over a surface, Pipes for Newtonian and non-Newtonian fluids, sudden expansion, derivation, and contraction effects, derivation, Pipe surface roughness effects, pipe bends, derivation, shear stress in fluid, Shearing characteristics. Force exerted by flowing fluid on pipe bends Derivation.

Pressure drop for flow Newtonian and non-Newtonian fluids through pipes. Derivation, Resistance to flow and pressure drop. Apparent Reynolds number, Reynolds no. & shear stress Effect of Reynolds and apparent Reynolds number. Derivation, stress strain, yield.

Pipes of circular and non-circular cross section – velocity distribution, average velocity and volumetric rate of flow. Derivation, Flow through curved pipes (Variable cross sections). Effect of pipe-fittings on pressure losses. Flow through annulus, Derivation, flow between two parallel plates – velocity distribution, average velocity and volumetric rate of flow. Derivation.

Non-Newtonian fluid flow through process pipes, Shear stress, Shear rates behavior, apparent viscosity and its shear dependence, Power law index, Yield Stress in fluids, Time dependent behavior, Thixotropic and rheopetic behavior, mechanical analogues, velocity pressure relationships for fluids, line. elasticity ,viscosity, dilatant, viscoelastic, strain. Pipe line design and power losses in compressible fluid flow, Derivation, Multiphase flow, gas-liquid, solid-fluid, flows in vertical and horizontal pipelines, Lockhart Martinelli relations, Flow pattern regimes. hardy cross method, rules, process.

Textbook:

1. Coulson JM and Richardson J.F. – Chemical Engineering – VolI, VI Edition, Butterworth Heinemann, British Library, Publications, Oxford, 1999.

References:

1. Govier, G.W. and Aziz K. – The flow of Complex Mixtures in Pipe – Krieger Publication, Florida, 1982.
2. Green DW and Malony, perrys – Chemical Engineers Handbook – VII Edition McGraw Hill, Bew York, 1997.

CH425	Elective-III: Computational Fluid Dynamics; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Introduce computational methods to study fluid dynamics.
- Learn how to formulate and solve computational problems arising in the flow of fluids.
- Assess the accuracy of numerical solutions by comparing with known solutions of simple test problems and by mesh refinement studies.
- Use CFD to predict forces on transport systems.

Course Outcomes: Students who have succeeded in this course can-

- Construct the differential equations for flow phenomena and apply numerical methods for their solution.
- Use and develop flow simulation software for the most important classes of flows in engineering and science.
- Critically analyze different mathematical models and computational methods for flow simulations
- Undertake flow computations using current best practice for model and method selection, and assessment of the quality of results obtained.

Course Contents:

Conservation equations for mass, momentum and energy; Comparison of various numerical techniques for CFD; Review of finite difference and finite element methods; Solution to discretised algebraic equation; Finite volume method for diffusion problems; Finite-volume method for convection and diffusion problems – pressure velocity coupling; Construction of geometry and discretion using Gambit-Fluent‘s manuals; Commercial CFD solvers; Turbulence modeling; Implementation of boundary conditions; Introduction to multiphase flow; Customizing commercial CFD solver; Unsteady state simulations.

Textbook:

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method H.K. & Malalasekera W.

References:

1. Computational Fluid Dynamics: The Basics with Application Anderson, J.D.
2. Computational Methods for Fluid Dynamics Ferziger J.H. and Peric M.

CH425	Elective-III: Food Technology; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Introduce food preservation processes.
- Understand harvesting processes.
- Learn & implement post processing operations.

Course Outcomes: Students who have succeeded in this course can-

- Understand food preservation processes.
- Use and develop flow of post harvesting operations.
- Analyze different food processes.
- Design, develop and apply the knowledge to food process operations.
- Implement & develop post harvesting processing operation.

Course Contents:

Introduction and Basic Principles: Importance of food Industry in India, Current status of various food products from cereals, dairy, edible oil, fruits, vegetables and beverages. Physical, chemical, biological, nutritional, sensory characteristics of food.

Post Harvesting operations and storage: Storage of solid foods, Cleaning (wet and dry), sorting by shape, size, color, weight, grading and peeling, Equipment for storage of solids, bins, silos, controlled atmosphere storage for food grains and vegetables and fruits. Principals involved in degradation and prevention

Treatment of milk before storage, effect of pasteurization, heat sterilization, In-container sterilization, storage of oils, filtration, free fatty acids removal, foots and other impurities.

Processing of fruits for manufacture of Jams, Jellies, operations and equipments involved. Manufacture of Pickles, Squashes, and beverages, preservatives used in food processing.

Processing of food grains, Theory of size reduction equipments and effect of size reduction on foods, evaporation extrusion, hot air dehydration, baking, roasting and hot oil frying Theory, equipments, applications and effect on food materials for Freezing / Freeze drying and Freeze concentration

Post Processing operations: Coating or enrobing operations, equipment and applications, theory of food packaging, types of packaging materials and packaging operations, filing and sealing of rigid and semi-rigid containers. Materials for handling the food items. Temper evident containers.

Textbooks:

1. Fellows P. , Ellis H., 1990 – Food Processing Technology Principles and Practice –New York
2. Considine D. M., Food and Food Production Encyclopedia, VNR New York 1982.

References:

1. Matz S. A. : Bakery Technology & Engineering, AVI Publishing, 1960.
2. Shapton & Shapton, Safe Processing of Foods.
3. Weiser, Mountney, Gould, Practical Food Microbiology and Technology.
4. Charm S. E. Fundamentals of food Engineering, AVI, 1963.
5. Hall, Farral, Rippen, Encyclopedia of food Engineering, AVI, 1970.
6. Mirajkar M, Menon- Food Science and Processing Technology Vol I & II New Delhi, Kanishka Publishers.

CH426	Seminar; Credits: 01 (L-0, T-0, P-2)

Course Objectives:

- This memorandum provides each student the administrative details and guidance necessary to successfully completion of seminar
- This course is intended to enhance students' effectiveness. Topics covered include: fundamentals of chemical engineering, professional development, academic development, personal development and orientation to the field of engineering.

Course Outcomes: Students who have succeeded in this course can-

- Collect literature on a given topic
- Classify the collected literature into various categories.
- Summarize and write a few paragraph on each paper
- Compare the information content given in different papers
- Analyze a particular paper based on principle of Chemical Engineering
- Write a report based on his / her work

Course Contents:

Students will be required to prepare a critical review of selected topics in Chemical Engineering and allied subjects and submit in the form of a standard typed report. Typically, the report should contain and will be evaluated based on the following points:

(i) Introduction: 2 pages maximum,

(ii) Exhaustive review of literature (including figures): 10 – 12 pages: 50% weightage

(iii) Critical analysis of the literature and comments on the analysis (including figures): 10 – 12 pages: 50% weight age.

The critical analysis of literature should include the following points: are the papers technically correct? Are assumptions reasonable; is the reasoning logical? If you think it is not, specify what you think is incorrect and suggest the correct approach. Are the methods used in the literature appropriate? Are there any internal contradictions or computational errors and are there any loopholes in the observations? If so, please explain. Critical analysis of papers should also contain quantitative comparison of observations, results and conclusion amongst the various papers. Each student will also be required to make an oral presentation of the review. Weight age would be 40% for the presentation and 60% for the report. Additional details and requirements are given to the Students every year by the coordinator of this activity.

CH427	Minor Project; Credits: 04 (L-0, T-0, P-8)

Course Objectives:

Introduce student to Principles of project management for efficient completion of the project in optimum duration with efficient use of available resources.

Course Outcomes: Students who have succeeded in this course can-

1. Apply basic fundamentals of chemical engineering for execution of process design.
2. Identify needs for further and continuous development in area selected for project work.
3. Apply the relevant knowledge and skills with area of project work
4. Do critical assessment of own results obtained based on experimental findings.
5. Analysis of economical feasibility bases on detailed project report.

Course Contents:

Students will be allotted project either individually or in groups. Each project will have one guide from the faculty. Students may be encouraged to choose co-guide from the industry, wherever possible. The aim of the project work is to evaluate the quality and competence developed by the students implementing theoretical concepts learned, in terms of technical report / presentation. The students may encourage doing Plant Design Project.

In case of Plant Design Project, the report must consist of the following chapters:

1. Introduction (including market report)
2. Process Selection
3. Material and Energy Balance
4. Sizing and detailed design of major equipment/s
5. Thermodynamics and Kinetics
6. Instrumentation & Process Control
7. Plant Layout
8. Waste Treatment & Safety aspects
9. Cost Analysis

References

Appendices

In case of strictly research or more practical project, the report must consist of the following chapters:

1. Abstract
2. Aim and Objectives
3. Introduction/background
4. Literature Review
5. Methodology
6. Results
7. Discussion
8. Conclusion and recommendations

References

Appendices

In case of Modeling and Simulation Project, for example "Modeling and Simulation of Trickle Bed Reactor", the report may consist of the following chapters:

1. Introduction
2. Literature Review

3. Trickle Bed Reactor
4. Hydrodesulphurization
5. Modeling of Trickle Bed Reactor
6. Simulation of Trickle Bed Reactor
7. Sensitivity Analysis
8. Conclusion & recommendations
Nomenclature
References
Appendices

The actual contents of the project report may be decided by the faculty guide. Students should guide to refer chemical abstracts/engineering abstracts, national/international journals to know about the latest field.

Semester –II

CH428	El-IV: Safety & Risk Analysis; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- To understand Basics of Industrial Safety Management.
- Know various aspects of Chemical plant safety
- Ought to know the various aspects of Industrial accidents and Fire safety
- Know Hazard identification techniques
- Various aspect of industrial hygiene and Occupational Health hazards, Safety legislation in Chemical industries
- Be aware of the legal requirements governing risk assessments.

Course Outcomes: At the end of this course, the students would be able to-

- Identify, Explain and Handle Different safety principles
- Identify Different Hazards And their Fire protection agency's
- Analyze various health hazards & apply Hazards Safety in operations and processes
- Identify Safety aspects of reactive chemicals
- Compose and perform accident analysis from accident documentation to analytical explanation of possible causation processes, and document into an accident report.
- Explain the legal and specified requirements for conducting continuous risk assessments.

Course Contents:

Industrial Safety Management:- Importance of Safety consciousness in Indian Chemical Industries – Development of Industrial Health and Safety, Safety Organization –Polices-Culture - Planning- Promotion – Inspection –Rules- Responsibility – Supervision, Safety Committee – role of safety functionaries, Elements of work place Safety Program, Economic and Social Benefits from Safety Program- Effective Safety Education and Training – Communication at various levels of production and operation, Safety slogans

Chemical Plant Safety:- Chemical process Industries - Sitting and Layout of a Chemical plant, Safety in transportation, storage and handling of hazardous chemicals, Chemical process hazards and their control - First degree and second degree hazards. Lines of defense - High pressure - High temperature operations – Case studies, Emergency preparation: On-site and Offsite , Safety aspects of maintenance in chemical plant -Effective steps to implement safety procedures- Periodic Advice and checking to follow safety procedures and rules- Safe guarding of Machines – Ergonomics -Proper selection and replacement of handling equipment –Safe handling and operation of materials and machineries

Accident And Their Prevention:- Definitions, H.W.Henrich, Frank bird & Multiple Causation theories of accident occurrences, Classification, Causes, Costs -Industrial accidents, Principles of Accident prevention, Accident prevention technique – Plant and Chemical job safety analysis, Accident proneness-vocational guidance, Safety performance measurement tools - FR. SR, (FSI), Safe-T-Score, Accident rate per 1000 workers, Disabling injury index, Accident Compensation Statutes, Accident Investigation reporting and Analysis - Case studies. Conditions -Fire triangle-Classification of fires, Common causes of industrial fires, Fire protection systems prevention-Case studies, Safety in Explosive

Hazard Identification Techniques:- Safety Appraisal - Risk Assessment -Hazard identification techniques with examples such as FMEA, CMA, Fault Tree Analysis, Preliminary Hazard Analysis (PHA), Hazard and operability (HAZOP) study, Quantitative risk analysis-Out line of methodology, Consequences analysis (Calculation of release rates of liquids under ambient pressure and liquids under pressure, Calculation of dispersion of released gases and vapors and

platting of equal concentration contours), Dow (Index) Fire and Explosion Index System of Risk Analysis, Safety Audit. Industrial Hygiene And Occupational Health Hazards:- Concepts - Industrial and Occupational health hazards, Housekeeping, human factors and error, stress at work, Personnel protective equipments, Role of trade unions in Industrial safety and health.
Safety And Law:- Introduction to ILO, Safety legislation in India, Factories act 1948, Employees welfare and legislation, Provisions relating to safety , health & environment in other important legislations - Indian boilers act and regulations, Indian electricity act and rules, Indian explosives act and rules, Mines act, Petroleum act and rules. Environmental protection act.

TEXT BOOK:

1. Daniel A. Crowl and Joseph F. Louvar, "Chemical Process Safety: Fundamentals with Applications" Prentice Hall International Sereis

REFERENCES:

1. Greene R. "Safe and Efficient Plant Operation and Maintenance", McGraw Hill Book Co., New York.
2. Dixit, "Safety Evaluation of Environmental Chemicals", PHI.
3. Dekkar Marcel, "Safety Management and Practices for Hazardous Units", McGraw Hill Book Co., New York, 1995
4. Saxena, "Safety and Good House Keeping", National Productivity Council, New Delhi (1976)
5. Wells G.L., "Safety in Process Plant Design", George Godwin Ltd., (1980).

CH428	Elective-IV: Polymer Processing; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- To provide a broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behavior.
- To impart the knowledge of various processing techniques along with the production of polymers.
- The students will be able to correlate structure-processing-properties relationships for polymers, blends and composites including nanocomposites.

Course Outcomes: Students who have succeeded in this course can-

- Apply the techniques and their characteristics/limitations of synthesis of polymers.
- Identify the structure-processing-property relationship of polymers.
- Understand and apply the various processing and manufacturing techniques.
- Understand the basic issues involved in polymer blends, composites and nano-composites.

Course Contents:

Introduction: Comparison of thermoplastics and thermoset plastics; Thermoset plastics - Types of resins, Interpenetrating Polymer Networks (IPN); Thermoplastics - Types of aliphatic and aromatic thermo plastics, copolymers, Blends and alloys; Liquid crystal plastics; cellular plastics; oriented plastic materials.

Processing: Basics of process design, Classification & general aspects of processes - molding & forming operations, Post die processing; Decoration of plastics - Printing, Vacuum Metalizing, In-mold decoration. Additives & Compounding - Different types of additives, Batch mixers, continuous mixers, Dispersive and distributive mixing, Characterization of mixed state.

Fundamentals on Viscous & Viscoelastic behavior of polymer melt, Rheological measurements and Polymer processability. Non isothermal aspects - Temperature effect on rheological properties, Crystallization, Morphology & Orientation, plastic memory, Molecular weight effects on processing and properties.

Properties & Testing of plastics: Basic concepts of testing, National & International standards, Test specimen preparation, Pre conditioning & Test atmosphere. Identification of plastics by simple test - Visual examination, Density, Melting point, Solubility test, Flame test, Chemical tests. Effect of shape & structure on material properties, Long - term & short - term mechanical properties, crazing, Permeability & barrier properties, Environmental-stress cracking, Melt flow index, Heat deflection temperature, Vicat softening temperature, Glass transition temperature, thermal conductivity, Co-efficient of thermal expansion, Shrinkage, Thermal stability, Flammability. Waste management & Recycling: Plastics waste and the associated problems, Integrated waste management - source reduction, recycling & sustainability correlation, energy recovering process. Environmental issues, policies and legislation in India.

Textbook:

1. Gruenwald G, "Plastics - How Structure Determines Properties", Hanser Publishers, 1993

References:

1. Baird D. G. and Collias D. I., "Polymer Processing Principles and Design", Butterworth-Heinemann, 1995
6. Vishu Shah, "Hand Book of Plastics Testing Technology", John Wiley & Sons Inc. New York
7. J.S.Anand, K.Ramamurthy, K.Palanivelu, "How to identify Plastics by Simple Methods". CIPET, Chennai
8. Anthony L. Andrady (Ed.), "Plastics and the Environment", Wiley Interscience, New York

CH428	El-IV: Chemical Analytical Instrumentation; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Understand operation and care of instruments used in the chemical laboratories of industry.
- Introduce the student to principles and theory of instrument analysis.
- Teach the student the correct operation of chemical instruments.
- Introduce the student to the techniques of troubleshooting instruments in the chemical laboratory.
- Emphasize the safe use of chemical instrumentation.

Course Outcomes: Students who have succeeded in this course can-

- Operate various analytical equipments.
- Distinguish analytical instruments for particular characterization of samples.
- Understand the principles behind the working of several analytical instruments
- Work at R&D department of industries and research institutes.

Course Contents:

Introduction: Types of instruments in industries. Classification of Instrumental methods. Basic function of Instrumentation. Difference between analytical and other instruments. Thermal Analysis Technique (DTA, TGA, DSC etc.)

PH measurement: Colorimetric method, potentio-meteric methods, PH meters (Construction, advantages, disadvantages, factors affecting measurement). Applications. Electrical conductivity measurement; Electrical conductivity and molecular conductivity (definitions) Methods of measurement, Conductometric Titrations. Applications.

Chromatography: introduction, definitions, classification, Gas chromatography apparatus, details of different parts, applications, factors affecting separation. HPLC Instrumentation, Sample introduction, Separation Column, Detectors.

An introduction to absorption and emission spectroscopy: The nature of electromagnetic radiation, electromagnetic spectrum, atomic energy levels, Vibrational energy level, Raman effect, nuclear spin behavior, electron spin behavior, X-ray energy levels.5. Basic principle Ultraviolet and Visible Spectrometry: Radiation sources, detectors, Instruments for absorption Photometry. Flame Emission and Atomic Absorption Spectroscopy; Instrumentation, Application Fundamental laws of photometry, Turbidity and Nephelometry.

Introduction to NMR and X-ray Spectroscopy: Quantitative analysis. Instrumental methods, detectors, direct absorption fluorescence methods. X-ray diffraction. Introduction to Mass Spectrometry & Radiochemical Methods

Text Book :

1. Instrumental Methods of Analysis: Willard , Merritt Dean.
1. Instrumental Methods of Chemical analysis-AnandChatwal.

References:

2. Instrumental Methods of chemical analysis-Calen W. Ewing.
9. Instrumental methods of chemical analysis – B.K. Sharma.
10. Basic Instrumentation in Industrial measurements O Higgins P.J Mc Gram – Hill.
11. Principle of Industrial Instrumentation Patranabis-TMH Publication, New Delhi.

CH - 428	Elective-IV: Catalytic Green Science and Engineering; Credits-03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Impart the basic concepts of catalysis
- Develop understanding about catalyst selection for various unit processes.
- Understand the principles of Catalysis and its application in Engineering
- Understand catalytic reactions for the design of processes involving catalytic reactions.
- Utilize the knowledge of catalysis at the molecular level to design new, more efficient catalysts and catalytic processes.

Course Outcomes: Students who have succeeded in this course can-

- Understanding of various catalysts and the role of catalyst in chemical reactions.
- Knowledge of catalyst preparation and characterization methods.
- In-depth understanding of various empirical models in heterogeneous catalysis.
- Knowledge of heat and mass transfer effects on catalytic reactions.
- Ability to design different types of reactors for conducting catalytic reactions.

Course Contents:

Heterogeneous processes. Global rates of reaction. Catalysis. General characteristics of catalysis. Physical adsorption and chemisorption. Adsorption isotherms, Determination of surface area of a catalyst. Classification of catalyst, catalyst preparation. Catalyst deactivation. Langmuir-Himshelwood and Eley – Rideal model. Rate equation when surface reaction, adsorption and desorption control. External Diffusion effects on heterogeneous catalytic reaction. Modeling diffusion without reaction. External resistance to mass transfer. Mass transfer limited reaction in packed beds. Diffusion and reaction in porous catalyst pellets. Effective diffusivity and effective thermal conductivity. Internal effectiveness factor. Thiele modules. Mass transfer and reaction in a packed bed reactor. Gas- solid non catalytic reaction –shrinking core model – Diffusion through ash layer, chemical reaction and gas film controls. Limitation of shrinking core model. Determination of the rate controlling step. Design of gas solid particle reaction. Gas – liquid reaction. Absorption combined with chemical reaction. Mass transfer coefficients and kinetic constants. Application of film penetration and surface renewal theories. Hatta number and enhancement factor for first order reaction. Tower reactor design.

Phenomena of Fluidization, liquid like behavior of fluidized beds, advantages and disadvantages of fluidized beds, different types of fluidized beds and applications of fluidization technique in process industries. Heat and Mass Transfer in Fluidized Beds : Variables affecting heat transfer rate, heat transfer at the wall of containing vessel, heat transfer to immersed tubes. Models proposed by (i) Wicke- Fetting, (ii) Mickley and Fair Banks and (iii) Levenspiel and Walton. Heat transfer in fixed and fluidized beds. Definition and evaluation of mass transfer coefficient.

Text Book:

1. Smith J.M., Chemical Engineering Kinetics, McGraw Hill.

References:

1. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India.
2. Levenspiel O., Chemical Reaction Engineering, John Wiley.
3. Hill C.G., An Introduction to Chemical Engineering Kinetics & Reactor Design, John Wiley.
4. B. Viswanathan, S. Sivasanker, A. V. Ramaswamy, Catalysis: Principles and Applications, Academic Press.

* CH428	El-IV: Catalytic Science & Engineering; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Impart basics of catalysis.
- Understand heterogeneous catalytic processes.
- Understand reaction kinetics and mechanism of heterogeneous catalytic reactions.
- Learn catalytic phenomena with extensions to reactor design.
- Know various catalyst preparation and characterization techniques.
- Understand the techniques involved in enhancing catalyst activity and life time.

Course Outcomes: Students who have succeeded in this course can-

- Apply knowledge of heterogeneous catalytic reactions in industrial applications.
- Find out the mechanism and kinetics of heterogeneous catalytic reactions
- Prepare required catalyst and carry out characterization of the same.
- Predict mass and heat transfer effects on heterogeneous catalytic reactions.
- Design reactors for heterogeneous catalytic reactions.

Course Contents:

Heterogeneous catalytic processes, types of heterogeneous reactions. Absorption, absorption isotherms, rates of absorption, Physisorption and chemisorptions. Solid catalysis, types of catalysts, catalyst formulations and Preparation methods.

Catalysts Characterization methods: Surface area and pore volume determinations, XRD, various Spectroscopic techniques, Temperature programmed reduction & oxidation, Electron microscopy. Testing of catalysts, various types of reactors, activity and selectivity studies. Effect of external transport processes on observed rate of reactions. Effect of internal transport processes: reactions and diffusion in porous catalysts.

Mechanism of catalytic reactions, Rates of adsorption, desorption, surface reactions, rate determining steps. Kinetic modeling and Parameter estimations, model discriminations.

Catalysts promoters, inhibitors, catalyst deactivation, kinetics of catalyst deactivations. Industrial processes involving heterogeneous solid catalysts.

New developments in solid catalysis, monolith catalysts, nanocatalysts, fuel cell catalysts, environmental catalysts, in-situ characterization. Design of catalysts, simulation techniques.

Textbook:

1. J. J. Carberry, "Chemical and catalytic reaction Engineering", Dover Publications.

References:

1. G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis", Vol 1-5, Wiley - VCH.
12. B. Viswanathan, S. Sivasanker, A.V. Ramaswamy", Catalysis: Principles & Applications" CRC Press.
13. J. M. Smith, "Chemical Engineering Kinetics" McGraw-Hill Book Company.
14. J. M. Thomas and W. J. Thomas, "Principles and Practice of Heterogeneous Catalysis", Wiley- VCH.
15. H. S. Fogler, "Elements of Chemical reaction engineering" Prentice – Hall of India.

6. C. H. Bartholomew and R. J. Farrauto "Fundamentals of Industrial catalytic Processes", Wiley- VCH.

CH429	Elective-V: Refining science and engineering ; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Various extraction techniques for the production of oil and gas to meet energy needs.
- Refining operations of crude oil for a wide spectrum of useful products.
- Production processes for various petroleum products from refined crude oil.

Course Outcomes: Students who have succeeded in this course can-

- Develop knowledge of different refining processes
- Develop knowledge of safety and pollution control in the refining industries.
- To find the suitable refining technology for maximizing the gasoline yield

Course Contents:

History of petroleum, types and ages of rocks, Theories and origin and accumulation of oil and gas, Kerogen composition, classification, isolation, Properties of petroleum and gas in rocks, porosity, permeability, connate water, electrical resistivity, compressibility of rocks, phase behavior, shrinkage, viscosity, compressibility, permeability, mobility, interfacial tension, wetting capillary pressure and forces of oil and flows.

Methods of surface and subsurface exploration (geolotical, geophysical and geochemical) cable tool, rotary and turbo drilling, drilling of wells (vertical, deviated and horizontal). Drilling, fluids, composition and functions, rates, coring, cementing, acidization, fracturing, completion and testing of wells, logging, methods of primary recovery. Well testing and control, free flow and gas lifting, mechanical pumping, work over jobs, treatment of water for injection, enhanced oil recovery, secondary and tertiary.

Separation of Oil and Gas, gathering, stabilization, dehydration, desalting, sorting and mixing, transportation and storage of oil and gas, metering systems, group gathering stations and tank firms. Elementary concept of fractionation – Distillation theory (atmospheric pressure, reduced pressure, azeotropic and extractive) solvent treatment, asphaltene separation and fractionation. Absorption, chemical methods like sulphuric acid treatment, molecular complex formation, Extraction and use of data.

Composition of petroleum, natural gas, major petroleum fractions and products (refinery gases, gasoline, naphtha, kerosene, diesel, fuel oil, lubricating oil, other oil products, waxes, asphalt, coke, acid sludge) Hydrocarbons and non hydrocarbons present (Type, name, structure, role) chemical aspects of origin of petroleum and natural gas.

Classification and description of various crudes. General methods of classification and correlations. N-d-M ring analysis method, comparison of structural group analysis by spectroscopic and physical property methods. MW determination, correlation method for structure of solid saturated hydrocarbons.

Textbook:

1. Petroleum Refining Engineering : W L Nelson

References:

1. An introduction to Physics and Chemistry of Petroleum : R R F Kinghorn
16. Composition and properties of Petroleum : H J Neumann, B P Lahme and B Severin
17. Modern Petroleum Technology : G D Hobson and W Pohl
18. Chemical Technology of Petroleum : W A Gruce and Stevens
19. The Chemistry and Technology of Petroleum : James G Speight
20. Petroleum refining, Technology and Economics : J H Gary and G E Handwork.

CH429	Elective-V: Sustainable Chemical Technology; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Have an increased awareness among students on issues in areas of sustainability
- To understand the role of engineering and technology within sustainable development
- To know the methods, tools, and incentives for sustainable product-service system development
- To understand the fundamentals about Sustainable Chemical Engineering
- To establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.

Course Outcomes: Students who have succeeded in this course can-

- Understand the different types of environmental pollution problems and their sustainable solutions
- Analyze the principles of sustainability.
- Work in the area of sustainability for research and education
- Having a broader perspective in thinking for sustainable practices by utilizing the engineering knowledge.
- Produce new ideas from sustainable development.

Course Contents:

Sustainability- need and concept, challenges; Environment acts and protocols, Global, Regional and Local environmental issues Natural resources and their pollution, Carbon credits Zero waste concept ISO 14000, Life Cycle Analysis, Environmental Impact Assessment studies Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Technology and sustainable development, Sustainable urbanization, Industrial Ecology.

Text Book:

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.

References:

1. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning Environment Impact Assessment Guidelines, Notification of Government of India, 2006
2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
3. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
4. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.

CH429	Elective-V: Nanotechnology; Credits: 03 (L-3, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Understand basic concepts of nanotechnology.
- Learn different synthesis methods for nano-materials and characterize those using different techniques.
- Study applications of nanotechnology in interdisciplinary areas such as water treatment, nanobiotechnology, chemical engineering, etc.

Course Outcomes: Students who have succeeded in this course can-

- Understand broad areas of nanotechnology.
- Synthesize different nanomaterials and perform their characterization.
- Apply knowledge in interdisciplinary areas of science and technology.

Course Contents:

Introduction: Introduction to nanotechnology and materials, Nanomaterials, How It All Began: Synthesis of carbon buckyballs, List of stable carbon allotropes, extended, fullerenes, metallofullerenes, solid C 60, bucky onions, nanotubes, nanocones, Properties of Individual nanoparticles. Methods of synthesis. Carbon nanostructures. Synthesis procedures of nanomaterials :Bottom-up vs. top-down , Epitaxial, growth ,Self-assembly, Modeling and Applications Production Techniques of Nano-tubes, Carbon arc bulk synthesis in presence and absence of catalysts High-purity material, (bucky paper) production using Pulsed Laser Vaporization (PLV) of pure and doped, graphite High-pressure CO conversion (HIPCO) nanotube synthesis based on Boudoir, reaction Chemical Vapor Deposition (CVD) Characterizations of nanomaterials: Top down approach Bottom up, approach Optical Microscopy, Electron Microscopy, Secondary electron scattering, back, scattering, Scanning Probe Microscopes, Focussed Ion Beam Technique, X-ray imaging, SPM-AFM, STM, Optical Microscopy, Electron Microscopy, Secondary electron scattering, back scattering, Scanning Probe Microscopes, Intrinsic semiconductors, Band gaps, Law of mass action, Mobility of charge carriers Extrinsic semiconductors The p-n junction, Ferromagnetism Energy gaps; Nano colloids and Chemistry: Surface Tension and Interfacial Tension Surfaces at Equilibrium Surface Tension Measurement, Contact Angles, Colloidal Stability, Electrical Phenomena at Interfaces Van der Waals Forces between Colloidal Particles, photocatalysis Nanostructured materials. Self-assembly and Catalysis. Applications and Safety, Environment: Waste Water Treatment, Nano-biotechnology: Drug Delivery, Nanoclay, Nanocomposites, Surface coatings. Self cleaning Materials, Hydrophobic Nanoparticles. Biological nonmaterials. Nanoelectronics. Nanomachines & nanodevices Societal, Health and Environmental Impacts, Commercial Processes for Nanotechnology and Chemical Engineering Applications Nanohydrogel, Photocatalytic reactors, Nanoclay Synthesis, Polymer nanocomposite, Introduction to industries which produces commercial nonmaterial'

Textbook:

1. Introduction to NanoScience, (CRC Press of Taylor and Francis Group LLC), G. Louis Hornyak, Joydeep Dutta, Harry F. Tibbals and Anil K. Rao, May 2008, 856pp, ISBN-13: 978-142004805

References:

1. Introduction to Nanoscience and Nanotechnology, Chris Binns, 2010, Wiley, ISBN: 978-0471776475
2. Introduction to Nanoscience, Stuart Lindsay, 2009, Oxford University Press,

CH430	Elective –VI: Green Chemistry ; Credits: 04 (L-4, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Introduce the 12 principles of green chemistry as well as the tools of green chemistry including the use of alternative feed stocks or starting materials, reagents, solvents, target molecules, and catalysts.
- Understand the necessity and viability of the methods of green chemistry to the chemical sciences and related disciplines.
- Demonstrate how to evaluate a reaction or process and determine "greener" alternatives.

Course Outcomes: Students who have succeeded in this course can-

- Explain the basics of green chemistry in terms of 12 principles.
- Develop Green synthesis methods and eco-friendly products.
- Design and modify the conventional synthesis routes to greener synthesis routes to improve industrial processes and to produce important products.

Course Contents:

Principles & Concept Of Green Chemistry:- Introduction –Concept and Principles-development of Green Chemistry- Atom economy reactions –rearrangement reactions, addition reactions- atom uneconomic-sublimation-elimination-Wittig reactions-toxicity measures- Need of Green Chemistry in our day to day life. Green tribunal act 2001.

Measuring And Controlling Environmental Performance :- Importance of measurement – lactic acid production-safer Gasoline – introduction to life cycle assessment-four stages of Life Cycle Assessment (LCA) –Carbon foot printing-green process Matrics-eco labels -Integrated Pollution and Prevention and Control(IPPC)-REACH (Registration, Evaluation, Authorization of Chemicals)

Emerging Green Technology And Alternative Energy Sources:- Design for Energy efficiency-Photochemical reactions- Advantages-Challenge faced by hoto-chemical process. Microwave technology on Chemistry- Microwave heating –Microwave assisted reactions-Sono chemistry and Green Chemistry –Electrochemical Synthesis-Examples of Electrochemical synthesis.

Renewable Resources:- Biomass –Renewable energy – Fossil fuels-Energy from Biomass-Solar Power- Other forms of renewable energy-Fuel Cells-Alternative economics-Syngas economy-hydrogen economy-Bio refinery chemicals from fatty acids-Polymer from Renewable Resources – Some other natural chemical resources.

Industrial Case Studies:- Methyl Methacrylate (MMA)-Greening of Acetic acid manufacture-Vitamin C-Leather manufacture –Types of Leather –Difference between Hide and Skin-Tanning –Reverse tanning –Vegetable tanning –Chrome tanning-Fat liquoring –Dyeing –Application-Polyethylene-Ziegler Natta Catalysis-Metallocene Catalysis-Eco friendly Pesticides-Insecticides.

Text Books:

1. Mike Lancaster , Green Chemistry and Introductory text, II Edition
2. P.T.Anastas and J.C Warner,Green Chemistry theory and Practice, Oxford University press, Oxford (1988).

References :

1. P.Tundo*et. al.*, Green Chemistry, Wiley –Blackwell, London (2007).
2. Protti D.Dondi *et.al.*,Green Chemistry
3. T.E Graedel, Streamlined Life cycle Assessment, Prentice Hall, NewJersey (1998).
4. V.K. Ahluwalia,Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry.

CH430	Elective –VI: Green Process Engineering; Credits: 04 (L-4, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Acquire fundamental understanding of basic chemistry and technology behind Green Process Engineering.
- Get acquainted with the development of latest technologies and methodologies for environmentally benign processes currently practiced in various industrial sectors
- Identify the tools of green technology and zero waste systems.
- Understand environmental laws , carbon credit and life cycle assessment methods and tools
- Acquire methods for pollution prevention and learn to design for environment

Course Outcomes: Students who have succeeded in this course can-

- Explicate the importance of green technology in sustainable development.
- Understand the issues and ethics of responsible, safe design
- Apply appropriate technology to match a green engineering problem.
- Understand environment laws, carbon credits, ISO 14000 series
- Understand pollution prevention planning and environment friendly design

Course Contents:

Introduction to Green Technology:- Green chemistry and technology for sustainable development, Waste and its minimization, Green political movement, roles and responsibilities of chemical engineers, Twelve principles of green engineering, carbon credits, environmental management system standards- ISO 14000 series. Green Chemistry and Synthesis :- Green chemistry, Green chemistry methodologies, feed stocks, solvents, synthesis pathways, Functional group approaches to green chemistry, Waste treatment/recycle, Synthetic efficiency, Green chemistry metrics, individual reactions analysis, Atom economy, E-factor and reaction mass efficiency, material efficiency and synthetic elegance ranking, Quantitative/Optimization-based frameworks for the design of green chemical synthesis pathways, Green chemistry expert system, case studies. Evaluation of Environmental Performance During Process Synthesis:- Introduction, Tier-1Environmental performance tools: Economic and environmental criteria, Threshold Limit Values (TLVs), Permissible Exposure Limits (PELs), and Recommended Exposure Limits (RELs), Evaluating alternative synthetic pathways, Tier-2Environmental performance tools: environmental release assessment, Release quantification methods, modeled release estimates, release characterization and documentation, Assessing environmental performance Catalysis for Green Technology:- Role of catalysis, Catalysis and sustainable green chemistry, Heterogeneous catalysis, Solid acids, Solid base catalysis ,Template silica, Polymer-supported reagents, Catalysis in novel reaction media, Homogeneous catalysis, Phase transfer catalysis, Biocatalysis, Photocatalysis, Process integration and cascade catalysis.

Flow sheet Analysis For Pollution Prevention:- Pollution prevention planning, Structure of the pollution prevention process, Pollution prevention in material selection for unit operations, Pollution prevention for chemical reactors, separation devices, Storage tanks and fugitive sources, Integrating risk assessment with process design, Process energy integration, Process mass integration, Case study of process flow sheet. Risk Hazard Minimization:- Overview of risk assessment concepts, Hazard and Exposure assessment, Risk characterization, Design for degradation, Real-time analysis for pollution prevention, inherently safer design for accident prevention, Process safety and thermal hazards, Process control using real-time analysis. Process intensification, Life-Cycle Assessment.

Text Books:

1. Anastas, P.; Warner, J., "Green Chemistry: Theory and Practice", Oxford University Press, London, 1998.
2. David Allen, D and Shonnard, D., "Green *engineering:* Environmentally conscious design ofschemical processes": Prentice-Hall, New Jersey, 2002
3. Albert S. Matlack, "Introduction to Green Chemistry" Marcel Dekker, Inc., New York, 2001.

References :

1. Boyle, Godfrey, Bob Everett, Janet Ramage, "Energy Systems and Sustainability: Power for a Sustainable Future", Oxford University Press, 2004
2. Paul L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill, 2000.
3. Zimmerman, J.B.; Anastas, P.T. "The 12 Principles of Green Engineering as a foundation for
4. Sustainability" in Sustainability Science and Engineering: Principles. Ed. Martin Abraham, Elsevier Science, 2005.

CH430	Elective –VI: Solid Waste Management; Credits: 04 (L-4, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Explain concepts related to solid wastes.
- Know different storage techniques for solid waste, its impact on human health and environment.
- Understand the fundamentals about collection and transfer.
- Learn the efficient management of solid wastes.

Course Outcomes: Students who have succeeded in this course can-

- Capable to understand the concepts of solid waste with methods of handling.
- Use information related to types and composition of solid waste with methods of handling, sampling and storage of solid waste.
- Analyze all methods And Select the appropriate method for solid waste collection, transportation, redistribution and Disposal.
- Describe methods of disposal of hazardous solid waste.

Course Contents:

Sources and types of municipal solid wastes Sources and types of solid waste - Quantity - Factors affecting generation of solid wastes; Characteristics - methods of sampling and characterization; Effects of improper disposal of solid Wastes - public health effects. Principle of solid waste management - social and economic aspects; Public awareness; Role of NGOs; Legislation

On-site storage and processing On-site storage methods - Materials used for containers - on-site segregation of solid wastes - Public health and economic aspects of storage - options under Indian conditions – Critical Evaluation of Options

Collection and transfer Methods of Collection - types of vehicles - Manpower requirement - collection routes; transfer Stations - selection of location, operation and maintenance; options under Indian conditions

Off-site processing Processing techniques and Equipment; Resource recovery from solid wastes - composting, Incineration, Pyrolysis - options under Indian conditions

Disposal Dumping of solid waste; sanitary landfills - site selection, design and operation of sanitary landfills - Leachate collection and treatment

Text Books:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil Integrated SolidWaste Management, McGraw-Hill Publishers, 1993.
2. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste Management”, Springer, 1994

References :

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000
2. R.E.Landreth and P.A.Rebers, Municipal Solid Wastes - problems and Solutions, Lewis Publishers, 1997
3. Bhide A.D. and Sundaresan, B.B., Solid Waste Management in Developing Countries, INSDOC, 1993

CH-430	Elective-VI: Air Pollution And Control; 4 - Credits (L-4, T-0, P-0)

Course Objective: The course objectives has three components i.e., sources of air pollution, pathways (air pollutants transformation and transport) and receptors.

- Students would get an insight into the dispersion of air pollution in the atmosphere.
- Students would understand the control methodologies of several pollutants viz. Sox, NOx CO, HC etc.
- This life cycle of air pollution will enable the student to first identify the pollutants and their sources and then the transport mechanisms of the pollutants followed by the affected population and there control mechanisms.
- To understand the principles of air pollution control equipments.

Course Outcomes: After attending the course the students shall have acquired knowledge and understanding to evaluate air quality management and analyze the causes and effects of air pollution.

- Students would be able to understand the type and nature of air pollutants, the behavior of plumes and relevant meteorological determinants influencing the dispersion of air pollutants.
- Students would get exposure to air pollution engineering problems.
- The basic understanding of methods available for controlling point, line and area sources.
- Know the design characteristics of Electrostatic Presipitators, Fiber Filters, Cyclones, and Gravity Settlers for the removal of fine particulates.

Course Contents:

Air Pollution Definitions, Scope, Significance and Episodes, Air Pollutants Classifications, Natural and Artificial, Primary and Secondary air pollutants, Point, Line and Areal Sources of air pollution, Stationary and mobile sources, Effects of Air pollutants on man, material and vegetation, Global effects of air pollution, Green House effect, Heat Island, Acid rains, Ozone Holes etc.

Meteorology and plume Dispersion, Properties of atmosphere, Heat, Pressure System, Winds and moisture, plume behavior and plume Rise Models, Gaussian Modal for Plume Dispersion.

Control of particulates, Control at Sources, Process Changes, Equipment modifications, Design and operation of control. Equipment's: setting chambers, cyclone separators, filters, Dry and Wet scrubbers, Electrostatic preceptors.

Control of gaseous emissions, General Methods of control of NOx and SOx emissions, In plant Control Measures, process changes, dry and wet methods of removal and recycling, Adsorption, Absorption and Combustion.

Air Quality Management, Monitoring of SPM, SOx; NOx and CO Emission standards, Air sampling, Sampling Techniques, High volume air sampler, stack sampling, Analysis of Air pollutants, Air quality standards, Air pollution control act.

Text Book:

1. Air pollution By M.N.Rao and H.V.N.Rao – Tata Mc Graw Hill Company.

References:

1. Air pollution By Wark and Warner – Harper & Row, New York.
2. An introduction to Air pollution by R.K Trivedy and P.K Goel, B.S.

CH- 430	Elective-VI: Waste Water Treatment; 4 - Credits (L-4, T-0, P-0)

Course Objectives: Students undergoing this course will be able to-

- Learn water quality parameters, policies and norms for waste water.
- Train the students in waste water management techniques.
- Teach the processes for transformation of waste water in potable water
- Impart the knowledge of waste water analysis techniques.
- Understand the designing of industrial waste water treatment equipments.

Course Outcome: Students who have succeeded in this course can-

- Understand the water standards and disposal norms.
- Analyze waste water samples for several parameters.
- Utilize various unit operations for waste water treatment.
- Designing of waste water treatment plant.
- Treat waste water with advanced processes.

Course Contents:

Water Pollutants, Effects, Monitoring and Quality standards: Pollution of water and soil, effect of pollutants on environment and health, monitoring water pollution, water pollution laws and minimum national standards, monitoring, compliance with standards, Latest norms for effluent treatment. Water Pollution Sources, Analysis and Methods of control: Water pollution sources and classification of water pollutants - Wastewater sampling and analysis. Treatment of water-pollution: BOD, COD of wastewater and its reduction – Fundamentals of Anaerobic digestion and Aerobic digestion. Wastewater Treatment Plant Design: Physical unit operations: Screening, Flow equalization, sedimentation etc., Chemical Unit Processes: chemical precipitation, dis-infection, colour removal by adsorption Biological unit processes: Aerobic suspended - growth treatment processes, aerobic attached growth treatment processes, anaerobic suspended - growth treatment processes, anaerobic attached-growth treatment processes.

Advanced Wastewater and Water Treatment: Carbon adsorption - Ion exchange - Membrane processes - Nutrient (nitrogen and phosphorus) removal - Design of plant for treatment and disposal of sludge

Text Book:

1. C.S. Rao, "Environmental Pollution Control Engineering", Wiley 2nd Edition, New Age International Publishers, 2006.

References:

1. S.P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, New Delhi, 1985
2. Sincero and G.A. Sincero, Environmental Engineering: A Design Approach Prentice Hall of India pvt Ltd, N.Delhi.1996
3. Tchbanoglous and F.L. Burton, Metcalf and Eddy's Wastewater Treatment-Disposal And Reuse (Third Ed.), TMH publishing Co Ltd, N. Delhi. (1996)

CH- 431	Major project; 14 - Credits (L-0, T-0, P-14)

Course Objectives:-

Introduce student to Principles of project management for efficient completion of the project in optimum duration with efficient use of available resources.

Course Outcomes:

To teach our students to analyze and design chemical processes that span molecular to macroscopic scales. To this end, objectives of the Chemical Engineering Undergraduate program are to provide students:

- with a solid foundation in basic scientific and engineering principles, while allowing specialization in applied chemistry, environmental and biochemical/biomedical engineering, process control and applied mathematics
- with relevant experience using laboratory experiments and expertise using statistical tools for analyzing process data and designing experiments aimed at improving process operation and product quality
- with up-to-date computer software tools for chemical process simulation, analysis, design and control
- with an appreciation of the importance of economic, safety and environmental objectives in chemical process design optimization and control and that our graduates have the required skills to accomplish these objectives
- with the required design skills, engineering knowledge, communication skills, and exposure to problem-based learning and team-work to function as capable chemical engineers in industry
- with preparation for graduate studies

Course Contents:

This is the continuation of work started under course No. CH427 Project Work (Stage I). Every student will have to submit a detailed report (3 copies) of the Project Work as per the standard format prescribed by the department within the deadline announced by the Department. The students will make a PowerPoint presentation of their Project Work is for a panel of Examiners comprising of guide, internal examiner and external examiner. The examiners panel will assess the performance of the students considering their quality of work and presentation skills.