MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
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170302: ORGANIC PROCESS TECHNOLOGY

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Organic Process Technology	170302	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			3	1	-	

Course Objective:
The purpose of the organic process technology course is to improve knowledge of the chemical processes along with emphasis on recent technological development.

Syllabus:

Unit-I: Pulp and paper industry-Raw Materials, types of pulp and its preparation, Manufacturing of paper, Agro based industries, Fermentation industry, Alcohol by fermentation, Citric acid and Antibiotic like Penicillin.

Unit-II: Intermediates for petrochemical from petroleum based stocks, phenol, methanol, ethylene propylene, aromatic , toluene and xylene, polymer industries.

Unit-III: Preparation, manufacturing and properties of Fats and oil, manmade fiber; rayon, polyester polyamides and acrylics, cellulose and acetate, Rubber industries, Soap and detergent. Insecticides and pesticides, Dyes and dyes intermediate.

Unit-IV: Carbon Technology: Introduction, Classification of activated carbons, raw materials and manufacture of activated carbons, classification of carbon fibers, precursors for carbon fibers, manufacture of carbon fibers from polyacrylonitrile, manufacture of carbon black by furnace black process, applications.

Unit-V: Nanotechnology: Introduction, properties of nano particles like optical properties, reactivity, synthesis, Introduction, Structure and properties of carbon nano tubes and fabrication of carbon nanotubes & applications.

Course Outcomes: After the completion of this course, Students will be able to

CO1: **Explain** the processing of natural products.
CO2: **Describe** about microbial processes and edible oil refining process.
CO3: **Elaborate** the processes for producing petrochemicals.
CO4: **Characterize** polymers and elaborate its production processes.
CO5: **Describe** the production processes of fibres.
CO6: **Evaluate** the different processes from economical aspects.

Text Books

1. Austinn, G.T. Shreves Chemical Process Industries -5th edition Mc Graw Hill New York 1984.
2. Dryden C.E., Outlines of chemical technology-3rd edition affiliated East – West Press, New Delhi, 1997.

Reference Books

1.V. B. Gupta & V.K. Kothari- Manufacturing Fiber Technology- Chapman Hall, New York I edition 1997.
2. V.K. Kothari-Process in Textile, science Technology, Vol –I & II –IAFL publication, S-351 Greater Kailash part-I New Delhi.-48 Ed.

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170303: FLUID MECHANICS

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Fluid Mechanics	170303	L	T	P	Max.Marks-70 Min.Marks-22
			3	-	2	Duration-3hrs.

Course Objective:
To understand basic concept of fluid flow and its application to chemical process industries including pipe flow, fluid machinery like pumps and various flow meters.

Syllabus:

Unit –I: Introduction: Properties of fluid, forces on fluid, stresses, the concept of constitution relations, fluid statics, Normal forces in fluid, pressure measurement, forces on submerged bodies, buoyancy, Stability.

Unit-II: Classification of Fluids: Newtonian and Non – Newtonian fluid, Viscosity measurement, Equations of changes: Equation of Continuity & Equation of Motion, Navier stokes equation, concept of Reynolds number and friction factor: friction for rough and smooth pipes, loss of head due to friction in pipes and fittings.

Unit-III: Boundary layer theory, Bernoulli's equation, fluid machinery, pumps, fans, blowers, compressors and vacuum pumps, Power and head requirement for pumps.

Unit-IV: Flow of incompressible fluid in conduits and thin layers, flow past immersed bodies, Dimensional analysis, Buckingham π- Theorem, dimensionless numbers and their significance, similitude criteria.

Unit-V: Measurement of Flow: Fluid flow Measurement pitot tube, orifice meter, venture meter, rotameter, weirs and notches.

Course Outcomes: After the completion of this course, Students will be able to

CO1 **Explain** the basic fundamentals of fluid statics & fluid flow.
CO2 **Estimate** pressure drops, forces acting on bodies & power and head requirements of pumps.
CO3 **Apply** equations of change to various fluid flow systems.
CO4 **Formulate** the inter-dependency of various parameters using dimensional analysis.
CO5 **Determine** the flow rate through different flow measuring devices.
CO6 **Examine** the losses due to friction in pipes and other fluid machinery.

Text Books

1.W.L. Mc Cabe & J.C. Smith- UNIT OPERATIONS IN CHEMICAL ENGG- 7rd edition Mc Graw Hill.

Reference Books

1. J.M. Coulson & J.F. Richardson- CHEMICAL ENGINEERING- Vol I & II.
2. B.S. Maney, Zel(SI) Van Nostand & Reinhold- MECHANICS OF FLUID-ELBS, 1970.
3. I. Grannet- FLUID MECHANICS FOR ENGINEERING AND TECHNOLOGY.
4. S.K. Gupta- MOMENTUM TRANSFER- New Age Publication

List of Experiments:

1. To determine the local point pressure with the help of pitot tube.
2. To find out the terminal velocity of a spherical body in water.
3. To determine the viscosity of a spherical body in water.

4. To find the pressure drop in a packed bed,
5. To study the flow behavior of a Non-Newtonian fluid and to determine the flow constants.
6. To determine the power number- Reynolds Number curve.
7. To differentiate between laminar and turbulent flow using Reynolds experiments.
8. To study the characteristics of an air compressor.
9. To study the characteristics of a centrifugal pump.
10. To study the flow of a fluid in a pipeline and to prepare the friction factor-N_{Re} plot.
11. To determine the friction losses, expansion losses and reduction losses in bends and pipes and verify the Bernoulli equation.
12. To prepare the calibration curve for an orifice meter and Rotameter.
13. To prepare the calibration curve for a Venturimeter.

Note: Every student should perform at least eight experiments out of the above list.

Lab Course Outcomes

After the completion of this lab course, Students will be able to

CO1 Analyze the effects of flow measurement by flow measuring devices.

CO2 Calculate the degree of error in discharge rate of rotameter.

CO3 Calculate the coefficient of discharge for venturimeter and orifice meter.

CO4 Calculate the coefficient of discharge for notches & weirs.

CO5 Analyze the losses in pipe fittings & pressure drop in packed bed

CO6 Analyze transportation of fluids via pumps & other devices.

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170304: MATERIAL AND ENERGY BALANCE

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Material & Energy Balance	170304	L	T	P	Max.Marks-70 Min.Marks-22
			3	-	2	Duration-3hrs.

Course Objective:
To understand and apply the basics of calculations related to material and energy flow in the processes.

Syllabus:

Unit-I: Mathematical and Engineering Calculations:- Units and dimensions, conversion units, expression and equations, Dimensional groups and constants, stochiometric and composition relationships, conversion of mass, mass and volumetric reactions, basis of compositions, Excess reactants , degree of completion.

Unit-II: Ideal Gases & vapor Pressure: Behavior of ideal gases, Gaseous mixtures, vapor pressure , Clausius Clapeyron equation, Cox chart, Duhring's plot, Raoult's law, Humidity and saturation, relative humidity, humid volume, dew point, humidity chart and its use.

Unit-III: Material Balance: Crystallization, dissolution, solving material balance problems with and without simultaneous equations, Recycle, bypass and purge calculations

Unit-IV: Energy Balance: Heat capacity, calculation of enthalpy changes, Energy balance with chemical reactions,

Unit-V: Heat of vaporization, Heat of formation, Laws of thermo chemistry, Heat of combustion of fuels, Heat and Theoretical flame temperature, Case study of selected problems.

Course Outcomes: After the completion of this course, Students will be able to

CO1 **Recall** different unit system, basic mass volume relationship, conversion of units
CO2 **Classify** ideal and non –ideal gases.
CO3 **Solve** energy balance problems.
CO4 **Analyze** the recycle, bypass, and purge calculation.
CO5 **Estimate** the raw material requirement for synthesis of a chemical product based on stoichiometry.
CO6 **Estimate** the performance of chemical equipment using material and energy balance

Text Books

1. O.A. Hougen, K.M. Watson, R.A. Ragatz (CBS publications New Delhi 1995 edition)- Chemical Process Principles, part-I

Reference Books

1. David M. Himmelbau (prentice Hall ,sixth edition Feb. 1999)- BASIC PRINCIPLES AND CALCULATIONS IN CHEMICAL ENGINEERING.
2. B.L.Bhatt, S.M. Vora(Tata Mc-Graw –Hill, 1996) STOCHIOMETRY.

List of Experiments:

1. To determine the boiling point relation with respect to concentration of caustic soda and verify Duhring's rule.
2. Application of dry and wet bulb Thermometer to find out atmospheric humidity.
3. Use of humidity charts to find enthalpy , dew point , humid heat and saturation.

4. Solubility at room temperature and at boiling point of urea in water and verify the material balance.
5. Crystallization of copper sulphate in saturated solution by cooling and finding out of the crystal yield.
6. Combustion of coal and performing the material balance.
7. Proximate analysis of coal sample.
8. Measurement of flame temperature and compare actual & Theoretical temp. (Bunsen-Burner, spirit lamp, Kerosen lamp.)
9. To find the heat of reaction using CaO and water.

Note: Every student should perform at least eight experiments out of the above list.

Lab Course Outcomes

After the completion of this lab course, Students will be able to

CO1: Determine the proximate analysis for coal samples

CO2: Proficiency to integrate the data and formulate the mass and energy balance problems.

CO3: Use mathematical knowledge for solving mass and energy balance problems with and without chemical reactions

CO4: Use the energy balance to solve particular problems with and without chemical reactions

CO5: Material balance for recycle drying operation for solids

CO6: Easy to do the material balance and energy balance for evaporation unit operation.

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170305: FLUID PARTICLE MECHANICS

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Fluid Particle Mechanics	170305	L	T	P	Max.Marks-70 Min.Marks-22
			3	-	2	Duration-3hrs.

Course Objective:
To understand basic principles of various mechanical operations & construction and working of the equipments.

Syllabus:

Unit-I: Particulate Solids: Properties of particulate solids, Evaluation of size and shape, surface and population of particles, standard screens and screen analysis of solids. **Size Reduction:** Principles of comminution, size reduction, crushing, grinding, pulverizing and ultra fine size reduction equipment, power requirement in comminution.

Unit-I: Mixing: Mixing of solids, mixing equipment's design and power requirement of mixers, Mixer Effectiveness and Mixing Index.

Unit-III: Separation: Principles of Separation techniques for system involving solids, liquids and gases, Classification, Sedimentation, filtration, separation equipments.

Unit-IV: Transportation and Handling of Solids: Selection and conveying devices for solids: Belt, Chain, Screw- conveyors, elevators and pneumatic conveying devices, Elementary design aspects of the devices

Unit –V: Fluidization & Application: Particulate & aggregative fluidization, Characteristics of fluidized bed due to particle size, size distribution, shape and density, Pressure drop through a fluidized bed, Character of dense phase fluidization as revealed by pressure drop fluctuations, Up flow and down flow fluidization, Fluid Catalytic process, bed drying, Mass transfer in fluidized beds.

Course Outcomes: After the completion of this course, Students will be able to

- **CO1** **Recognize** the application of Screen Analysis in Industry.
- **CO2** **Describe** the various methods of size reduction using the various principles.
- **CO3** **Explain** the separation techniques and equipments.
- **CO4** **Illustrate** the various process like sedimentation, filtration etc.
- **CO5** **Classify** the various conveying devices.
- **CO6** **Illustrate** the fluidization and fluid catalytic process.

Text Books

1. Badger & Bencharo- INTRODUCTION TO CHEMICAL ENGG- Tata Mc Grawhill 1998.
2. McCabe Smith- UNIT OPEARATION OF CHEMICAL ENGG, Mc Graw Hill 2001.

Reference Books

1. Coulson & Richordson Vol. 2-CHEMICAL ENGG. New Delhi Asian Book Pvt. Ltd.
2. G.G. Brown- UNIT OPERATIONS-CBS Publications New Delhi 1995.

List of Experiments:

1. To analyze the given sample by differential, cumulative methods using standard screen.
2. Determination of size and surface area of irregular particles using a measuring gauge.

3. To study the crushing behavior and to determine the Rittinger's and Bond's constant of the given solid in a jaw crusher.
4. To study the crushing behavior and to determine the Rittinger's and Bond's constant of the given solid in a ball mill.
5. To study the crushing behavior and to determine the Rittinger's and Bond's constant of the given solid in a hammer mill.
6. Determination of mixer effectiveness and mixing index of given slurries.
7. To study the filtration behavior of a given slurry using a Plate and Frame Filter press.
8. To study the filtration behavior of a given slurry using a leaf filter press.
9. To study the filtration behavior of a given slurry using a rotary drum filter press..
10. To study the performance of a Dorr Thickener.
11. To study the characteristics of liquid-solid fluidized bed.
12. To study the characteristics of gas-solid fluidized bed.
13. Study of gas/liquid solid cyclone separator and to evaluate the separation efficiency.

Note: Each student should perform at least 8 experiments out of the above list.

Lab Course Outcomes

After the completion of this lab course, Students will be able to

CO1 Perform the Screen Analysis experiment.
CO2 Illustrate the performance of grinding mill on laboratory scale.
CO3 Illustrate the performance of crushers on laboratory scale.
CO4 Analyze the performance of mixing and filtration equipment.
CO5 Classify and analyze the performance of various conveying equipment.
CO6 Develop a sound knowledge of process equipment associated with fluid particle mechanics.

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170306: CHEMICAL SYNTHESIS LAB

Category	Title	Code	Credits-1			Practical Paper
Departmental Lab-DLC	Chemical Synthesis Lab	170306	L	T	P	Max.Marks-30 Min.Marks-10.
			-	-	2	

Course Objective

The aim of this course is to give you exposure to advanced synthetic techniques, introduce you to chemical literature searches, give you experience following and expanding on literature preparations, provide you with an opportunity to improve your technical writing.

List of Experiments:

1. To determine BOD & COD for given waste water sample.
2. Preparation of acetic acid from ethyl alcohol.
3. To find out the sucrose content in aqueous solution by polarimeter.
4. To evaluate the viscosity of molasses.
5. To determine the percentage of formaldehyde in formalin.
6. To determine iodine value of the given oil sample.
7. To determine the acetic acid, ethanol concentration in aqueous solutions.
8. To prepare azodye and find the yield.
9. Prepare a standard phenol solution and estimate the % of phenol in the given unknown sample of phenol.
10. To prepare urea formaldehyde resin and report % conversion.
11. To determine total dissolved and suspended solids in water and waste water
12. To determine turbidity in water and waste water
13. To determine hardness of water

Note: Each student should perform at least eight experiments out of the above list.

Course Outcomes: After the completion of this course, Students will be able to

CO1. Research a specific compound, or a family of compounds, to propose a synthetic route for isolation of this compound.

CO2. Perform advanced manipulations of apparatus relevant to a synthetic chemistry laboratory; use a Schlenk line to synthesize oxygen- and moisture-sensitive products.

CO3. Characterize chemical compounds using modern spectroscopic techniques.

CO4. Maintain a laboratory notebook following scientific best practices.

CO5. Communicate findings in a format consistent with the scholarly standards of the chemical sciences.

CO6. Articulate and follow ethical principles in a scientific context, including professional standards of laboratory practice, the communication of literature research without plagiarism, and the crediting of collaborators.

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170402: HEAT TRANSFER

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Heat Transfer	170402	L	T	P	Max.Marks-70 Min.Marks-22
			2	1	2	Duration-3hrs.

Course Objective:
To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

Syllabus:

Unit – I: Modes of heat transfer one dimensional and two dimensional , heat rate equations, theory of insulation ,critical radius calculations, types of insulation material , conduction through slab, cylindrical and sphere.

Unit-II: Consecutive heat transfer, heat transfer in boundary layer and in film, natural and forced convection, co/ counter /cross current contacting for heat transfer, individual and overall heat transfer coefficient, fouling factor.

Unit- III: Radiative heat transfer, Black body radiation, concept of shape factor, method of determination of shape factor, radiation exchange in enclosure with black surfaces.

Unit-IV: Heat transfer under phase change conditions, boiling and condensation of pure components, heat flux temperature diagram for boiling and condensation under vertical and horizontal surfaces, nucleate and pool boiling, effect of surface condition of condensation, correlation for heat transfer under condensation. Evaporation: Types of evaporators and their applications, single and multiple effect evaporators, Design and operation of forward, backward and mixed feed operations, effect of boiling point elevation and hydrostatic heat vapor recompression.

Unit- V: Heat exchange equipment- General design of shell and tube exchangers, condensers, extended surface equipments, heat exchanger equation – coli to fluid, jacket to fluid, double pipe, shell and finned tube heat exchanger.

Course Outcomes: After the completion of this course, Students will be able to

CO1: Explain the mechanism of heat transfer by conduction, convection and radiation.

CO2: List dimensionless Numbers applicable in heat transfer and their physical significance.

CO3: Illustrate individual and overall heat transfer coefficient.

CO4: Explain all parts of the Heat Exchangers and Evaporators.

CO5: Analyze the design of various types of Heat exchangers.

CO6: Analyze the design of various types of Evaporators.

Text Books

1. J. P. Holman – Heat Transfer – P.H.I.

Reference Books

1. Donald Q. Kern- Process Heat Transfer– Tata Mc Graw Hill.
2. Alan J. Chapman- Heat Transfer IV ED. – Collier Mc. Millan.

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List of Experiments:

1. To determine the thermal conductivity of metal rod.
2. To determine the equivalent thermal conductivity of composite wall.
3. To determine heat transfer coefficient in forced convection.
4. To determine heat transfer coefficient in natural convection.
5. To determine heat transfer coefficient with the help of Stephan Boltzman Apparatus.
6. To calculate emissivity of the test plate by emissivity measurement apparatus.
7. To determine heat transfer coefficient in double pipe heat exchangers.
8. To study the heat transfer characteristics of a shell and tube heat exchanger (Heating / cooling) of water.
9. To determine heat transfer coefficient in counter and parallel flow heat exchanger.
10. To measure the rate of evaporation using an open pan evaporator.
11. To measure the rate of condensation of pure water vapor and to determine the heat transfer coefficient.
12. Demonstrate the film wise, drop wise condensation and determination of heat transfer coefficient.
13. To study the single effect evaporator and find out the heat transfer coefficient.

Note: Each student should perform at least eight experiments out of the above list.

Lab Course Outcomes

After the completion of this lab course, Students will be able to

CO1: Able to understand the modes of heat transfer conduction, convection and radiation

CO2: Analyze the application of various experimental heat transfer correlations in engineering applications

CO3: Evaluate the thermal analysis and sizing of heat exchangers.

CO4: Evaluate the emissivity of materials

CO5: Study the thermal conduction in metal rod

CO6: Able to know the application of heat exchanging equipment in chemical process industries.

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170403: MASS TRANSFER – I

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Mass Transfer – I	170403	L	T	P	Max.Marks-70 Min.Marks-22
			2	1	2	Duration-3hrs.

Course Objective: The purpose of this course is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations.

Syllabus:

Unit-I: Diffusion Phenomenon: Molecular and eddy diffusion in gases, liquid and solids, interface mass transfer, Mass transfer theories; film theory, penetration theory and surface renewal theory, Concept of mass transfer coefficient: Individual and film coefficients, overall mass transfer coefficient and their inter relationship. Continuous contact and differential contact.

Unit –II: Absorption: Absorption in continuous contact columns, co- current, counter current and cross current contacting of fluids, Absorption in packed column, calculation of NTU and HTU, concept of HETP.

Unit –III: Humidification: Humidification: general theory , psychometric chart, fundamental concepts in humidification and dehumidification, wet bulb temperature adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling tower and related equipments.

UNIT- IV: Drying: Equilibrium mechanism, theory of drying, drying rate curve, batch and continuous drying for tray dryers, drum dryers , spray and tunnel dryers.

Unit-V: Crystallization: Factor governing nucleation and crystal growth rate, controlled-growth of crystals, super saturation curve, principal and design of batch and continuous type equipment.

Course Outcomes: After the completion of this course, Students will be able to:

CO1: Tell the basics of absorption, humidification, drying, crystallization & the principle of diffusion underlying them.

CO2: Infer the necessary information useful in design of mass transfer equipment.

CO3: Analyze the different cases of diffusion phenomena.

CO4: Apply the theoretical concepts for solving practical problems.

CO5: Interpret psychometric charts & equilibrium data.

CO6: Propose favorable conditions for a separation to be carried out.

Text Books

1. Treybal R.E. – Mass Transfer Operation – 3rd Edition, Mc- Graw Hill.

Reference Books

1. Mc- cabe , W.L. Smith J.M.- Unit Operation in Chemical Engineering- 5th edition Tata Mc Graw Hill, New Delhi.

2. Coulson J.M. & Richardson J.F. -Chemical Engineering – Vol.2, 2nd Edition, Oxford, New Delhi

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List of Experiments:

1. To determine the diffusion coefficient of liquid vapor in air by Stefan's tube.
2. To study the rate of dissolution of rotating cylinder and then to calculate the mass transfer coefficient.
3. To investigate the mass transfer characteristics of a wetted surface column unit.
4. To investigate the characteristics of a cooling tower.
5. To study the drying characteristics of wet granular material using natural and forced circulation in a tray dryer.
6. To prepare the drying rate curve for fluidized dryer.
7. To study the characteristics of spray dryer.
8. To study the characteristics of drum and tunnel dryer.
9. To find out the crystal yield with and without seeds.
10. To draw the tie lines and plot equilibrium curve for given ternary system.

Note: Each student should perform at least eight experiments out of the above list.

Lab Course Outcomes

After the completion of this lab course, Students will be able to

CO1	**Relate** the basics of humidification, drying, crystallization & the principle of diffusion underlying them.
CO2	**Translate** the mechanism of diffusion through Stefan's tube.
CO3	**Identify** the mass transfer characteristics in turbulent flows.
CO4	**Make use of** the theoretical concepts in humidification to operate a cooling tower.
CO5	**Compare** the drying operation in tray dryer, rotary dryer & fluidized bed dryer.
CO6	**Decide** on various factors governing crystal yield in both batch as well as continuous crystallization.

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170404: INSTRUMENTATION AND PROCESS CONTROL

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Instrumentation & Process Control	170404	L	T	P	Max.Marks-70 Min.Marks-22
			3	1	-	Duration-3hrs.

Course Objectives: To gain the knowledge of different process instruments, To understand dynamic modeling of a physical process using first principles, To convert the model to a form amenable to solution and analysis, To design various control schemes, and To apply the control system in various processes.

Syllabus:

Unit – I: Introduction of process variables, static and dynamic characteristics of instruments and classification of instruments. Temperature measuring instruments- Principle, construction and operation, Pressure measuring instruments –Bourdon, diaphragm and bellow pressure gauge.

Unit –II: Construction and Characteristics of final control elements such as Proportional, Integral, PD, PID, controllers ,pneumatic control value, principal and construction of pneumatic and electronic controllers.

Unit- III: Process instrumentation diagrams and symbols, process instrumentation for process equipments such as – Distillation column, Heat exchanger, fluid storage vessel.

Unit – IV: Laplace Transform, Linear open system, first and second order system and their transient response, Interacting and non interacting system, Transportation lag and linear closed loop systems block diagram of closed loop transfer function, controllers, transient response of closed loop system.

Unit-V: Stability concept, Routh stability criterion, relative stability, Hurwitz stability criterion, Nyquist's stability criterion. Root locus technique, introduction to frequency response, Bode diagram, Bode stability criterion, gain and margins, Ziegler Nichols controller setting.

Course Outcomes: After the completion of this course, Students will be able to:

CO1 Tell the basic principles & importance of process control in industrial process plants.

CO2 Explain the use of block diagrams & the mathematical basis for the design of control systems.

CO3 Identify controller that can be used for specific problems in chemical industry.

CO4 Analyze the Dynamic behaviour of first and second order control system.

CO5 Compare the Linear open loop and Closed loop system.

CO6 Test the stability of a given system & Analyze the transient and frequency response of systems.

Text Books:

1. Process system Analysis and Control By Coughnower and Koppel (Mc- Graw Hill, New York)

Reference Books

1. Automatic Process Control by D.P. Eckman (Mc- Graw Hill, New York)
2. Process Control by Peter Harriot (Mc- Graw Hill, New York)
3. Control System Engineering by J.J. Nagrath and M. Gopal.

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170405: MECHANICAL DESIGN OF PROCESS EQUIPMENT

Category	Title	Code	Credits-4			Theory Paper
			L	T	P	
Departmental Core-DC	Mechanical Design of Process Equipment	170405	3	1	-	Max.Marks-70 Min.Marks-22 Duration-3hrs.

Course Objective: The objective of this course is to acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports etc.), and different types of equipment testing methods.

Syllabus:

Unit-I: Mechanics of materials: Stress – strain relationship of elastic materials: Thermal stress, membrane stresses and stress concentrations, Theories of failures. Design stress, Welded joints, efficiencies, Corrosion allowances.

Unit-II: General Design Consideration: Design of storage tanks for liquid s and gases - classification, design of shell, bottom and roofs and other accessories.

Unit-III: Unfired Pressure Vessel: Pressure codes, classification of pressure vessels, design of cylindrical and spherical shells under internal and external pressures; Selection and design of flat plate, ellipsoidal, torispherical and conical closures, compensation of openings.

High pressure vessel: stress analysis of thick walled cylinder shell, Design of monoblic and multilayer vessels.

Unit-IV: Tall Vertical & Horizontal Vessels: pressure, dead weight, wind, earthquake and eccentric loads and induced stress; combined stresses, shell design of skirt supported vessels.

Vessel Supports: Design of skirt, lug and saddle supports.

Unit-V: Bolted Flanges: Types of flanges, and selection, Gasket, Design of non standard flanges, specification of standard flanges, fabrication of equipment: Major fabrication steps; welding, non destructive tests of welded joints, inspection and testing, vessel lining, material used in fabrication of some selected chemical industries.

Course outcomes: After the completion of this course, Students will be able to:

CO1: Evaluate the basics of process equipment design and important parameters of equipment design.

CO2: Design problems related to internal and external pressure vessels.

CO3: Evaluate stress distribution in process vessels.

CO4: Design special vessels (e.g. tall vessels).

CO5: Design of various parts of equipments such as supports, closure and heads.

CO6: Analyze the equipment fabrication and testing methods.**Text Books:**

1. Process equipment design by Brownell, N.E. and Young, H.E. (John Wiley 1959).
2. Introduction of chemical equipment design by Bhattacharaya, B.C. (CBS Publishers)

Reference Books

1. Code for unfired vessels by I.S.: 2825-1969
2. Code of practice for Design, Fabrication by I.S. 803-19 Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
3. Process Equipment Design by Joshi, M.V.

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170407: PROCESS CONTROL LAB

Category	Title	Code	Credits-2			Practical Paper
Departmental Lab-DLC	Process Control Lab	170407	L	T	P	Max.Marks-30 Min.Marks-10
			-	-	4	

Course Objectives: To gain the knowledge of different process instruments, To understand dynamic modeling of a physical process using first principles, To convert the model to a form amenable to solution and analysis, To design various control schemes, and To apply the control system in various processes.

List of Experiments:

1. To prepare thermocouple set and to calibrate the same.
2. To study the constructional details of bourdon tube pressure gauge and to calibrate it using a
   (i) Manometer
   (ii) Dead weight tester
3. To study the Characteristics of control valves (linear, quick opening, etc.)
4. To Study the dynamics of liquid level control systems of non - interacting and interacting types.
5. To study the response of mercury in glass thermometer with and without a thermo well.
6. To study the characteristics of an electronic PID Controller.
7. To study the characteristics of a current to pneumatic converter.
8. To study the effectiveness of computer control of a distillation column.
9. To study the effectiveness of computer control of a heat exchanger.
10. To study the effectiveness of computer control of a chemical reactor.
11. To study the dynamics of pressure tanks.
12. To calibrate an air purged liquid level indicator.

Note: Each student should perform at least eight experiments out of the above list.

Lab Course Outcomes

After the completion of this lab course, Students will be able to

CO1: Tell the importance of process control in industrial process plants.
CO2: Explain the working of a level control trainer and its applications.
CO3: Explain the working of a flow control trainer and its applications.
CO4: Identify controller that can be used for specific problems in chemical industry.
CO5: Analyze the Dynamic behavior of first and second order control system.
CO6: Explain and differentiate between interaction and non-interacting systems.

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170501: Chemical Engineering Thermodynamics

Category	Title	Code	Credit-4			Theory Paper
Departmental Core-DC	Chemical Engineering Thermodynamics	170501	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			3	1	0	

Course Objective:
To understand the basic concepts and applications of classical thermodynamics, thermodynamic properties, equations of state, methods used to describe and predict phase and chemical equilibria.

Syllabus

Unit- I The First law of Thermodynamics and Equations of State: Steady and unsteady closed and flow process, Critical properties corresponding state, Compressibility, P-V-T behavior of pure fluids, Virial-equations, Generalized correlations and eccentric factor.

Unit-II The Second and Third Law of Thermodynamics: Entropy of various systems, Thermodynamics equations, Effect of pressure on specific heat, Joule-Thompson effect, Third law of thermodynamics, Compression of ideal gas, Refrigeration capacity, Carnot cycle, Vapor compression cycle, Air refrigeration cycle.

Unit-III Thermodynamic Properties of Fluids: Thermodynamic properties of homogeneous mixtures, Property relations for systems of variable compositions, Partial properties, Fugacity and Fugacity co-efficient in ideal solutions, Properties change of mixing, Activity, Heat effects of mixing process, Excess properties, Activity coefficient of gaseous mixtures.

Unit-IV Phase Equilibria: Criteria of phase equilibrium and stability, Phase equilibrium in single component system, Phase rule, Gibbs-Duhem's equation, Vapor-liquid equilibria.

Unit- V Chemical Reaction Equilibria: Chemical potential, Effect of pressure and temperature on heat of reaction and on free energy, Van't Hoff's equation, Clausius-Clapeyron equation, Chemical Reaction Equilibria and its applications

Course Outcomes: After the successful completion of this course, students will be able to

CO1: **infer** the fundamental concepts of thermodynamics to chemical engineering applications.
CO2: **explain** the first and second laws of thermodynamics with their practical implications.
CO3: **analyze** the processes involving refrigeration and compression.
CO4: **classify** the thermodynamic properties of solutions with their relationships.
CO5: **infer** the detail of vapour liquid equilibria and its use in practical situations.
CO6: **analyze** the chemical equilibrium with thermodynamics for predicting behavior of reacting syster

Text Books

1.Smith J.M. & Van Ness., "Introduction to Chemical Engineering Thermodynamics", Mc Graw Hill
2. Sandler, S.I., "Chemical Engineering Thermodynamics", John Wiley & Sons
3. Dodge B.F., "Chemical Engineering Thermodynamics", Mc Graw Hill
4. Narayanan K.V., "Chemical Engineering Thermodynamics", Prentice Hall India Learning Private Limited

Reference Books

1. Balzhiser, Samuels and Eliassen, "Chemical Engineering Thermodynamics", Prentice Hall.
2. Rao Y.V.C, "Chemical Engineering Thermodynamics", University Press (I) Ltd., Hyderabad
3. Kyle B.G., "Chemical Process Thermodynamics", Prentice Hall of India Pvt. Ltd., New Delhi

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170502: Mass Transfer -II

Category	Title	Code	Credit-4			Theory Paper
Departmental Core-DC	Mass Transfer-II	170502	L	T	P	Max.Marks-70 Min.Marks-22
			2	1	2	Duration-3hrs.

Course Objectives: To know the brief knowledge of different separation techniques and the design of distillation column and adsorber and calculations involved in liquid-liquid extraction and solid liquid extraction as well.

Syllabus

Unit-I Fundamentals of Mass Transfer & Leaching: Analogies in transport processes, Determination of mass transfer coefficient in co- current and counter current processes in two phase packed beds, Flooding, Loading column internals: types of trays /plates and packing, point and plate efficiency. Leaching: Solid liquid equilibrium, Equipments, Principal of leaching, Co-current and counter-current system and calculation of number of stage required

Unit-II Distillation Operations: Vapor liquid Equilibria, Boiling point diagram, Relative volatility, Flash and differential/·Batch distillation for two component mixtures, Steam distillation, Azeotropic distillation and Extractive distillation.

Unit–III Continuous and Batch Distillation: Rectification, Reflux ratio, Calculation of numbers of plates by NTU, Optimum reflux ratio, Open steam , multiple feed and multiple product calculations, Enthalpy concentration diagram, Mc-Cabe Thiele and Panchon-Savarit method for calculation of number of theoretical plates, Approximate equations, Fensky and Underwood equations, Gilliland Correlation for actual numbers of plate calculation.

Unit- IV Extraction: Liquid–Liquid equilibria, packed & spray column, conjugate curve and tie line data, plait point, ternary liquid – liquid extraction, operation and design of extraction towers, analytical & graphical solution of single and multistage operation in extraction, Co-current, counter current and parallel current system.

Unit-V Adsorption: Adsorption theories, Types of adsorbent: activated carbon, silica and molecular sieves, Batch and column adsorption. Break through curves, Liquid percolation and gas adsorption, [single & multistage gas-solid and liquid-solid adsorption calculations.]

Course Outcomes: After the successful completion of this course, students will be able to

CO1: know the fundamental of adsorption, leaching, distillation, & liquid-liquid extraction.

CO2: infer the necessary information useful in design of mass transfer equipment.

CO3: analyze the different contacting patterns & Analogies in transfer process.

CO4: apply the theoretical concepts for solving the practical problems.

CO5: interpret the equilibrium data obtained in various mass transfer operations.

CO6: propose favorable conditions for a separation to be carried out.

Text Books

1. R.E. Treybal, "Mass Transfer Operations", Mc Graw Hill
2. Binay K. Dutta, "Principles of Mass Transfer and Separation Processes", PHI learning private ltd

Reference Books

1. W.L. Mc Cabe, J.M. Smit, "Unit Operation in Chemical Engineering", Tata Mc Graw Hill
2. J.M. Coulson, J.F. Richardson, "Colson & Richardson's Chemical Engineering", Butter worth Heinemann, Oxford
3. T.K. Shrewood, R.L. Pigford and C.R. Wilke., "Mass Transfer", Mc- Graw Hill

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170503: Chemical Reaction Engineering –I

Category	Title	Code	Credit-4			Theory Paper
Departmental Core-DC	Chemical Reaction Engineering –I	170503	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			2	1	2	

Course Objectives: To examine reaction rate data and determine the rate laws for designing chemical reactors with/ without temperature and heat effects & account for non-idealities prevailing in real reactors.

Syllabus

Unit-I Basic Concepts in Chemical Reaction Engineering and Classification of reactions: Definition of reaction rate, Variables affecting the rate, Concept of reaction equilibria, Order of reaction and its determination, Theoretical study of reaction rate, collision and activated complex theories, Mechanism of series reaction, Parallel or consecutive reactions, Autocatalytic reactions, Chain reactions & Polymerization reactions.

Unit-II Reactions Kinetics and Interpretation of data: Interpretation of kinetic data, integral and differential method of analysis, variable volume reactions, total pressure method of kinetic analysis.

Unit-III Reactor Design for Single Reactions: Classification of reactors, Concept of ideality, Development of design equation s for Batch, Semi batch, Continuous Stirred Tank & Plug Flow Reactors, Design of isothermal and non isothermal Batch reactor, CSTR & PFR, Combination of reactors, Reactors with recycle.

Unit-IV Reactor Design for Multiple Reactions: Multiple Reactions in Batch, Continuous stirred tank and Plug flow reactors, Yield and selectivity in multiple reactions. **Temperature & Heat Effects:** Multiple steady states in continuous stirred tank reactor, Optimum temperature progression and thermal characteristics of reactors.

Unit- V Basics of Non-Idea Flow: Non ideal reactors, RTD, Dispersion model, Tank in Series Model, Recycle Reactor, Segregated flow, Evaluation of RTD characteristics.

Course Outcomes: After the successful completion of this course, Students will be able to:

CO1: Apply the basic concepts in the analysis of homogenous system and deviation from ideal behavior.

CO2: Propose the different steps in reaction mechanisms and identify the Rate-determining step.

CO3: Develop Batch, CSTR, and PFR performance equations from general material balances.

CO4:Analyze Non-Isothermal operation in industrial Reactors

CO5: Determine conversion, selectivity & yield for Multiple chemical reactions.

CO6: **Analyze** the Non-Ideal behavior for any flow reactor.

Text Books

1. Octave Levenspiel, "Chemical Reaction Engineering", John Willey & Sons

2. H. S. Fogler., "Elements of Chemical Reaction Engineering", Prentice Hall of India Pvt. Ltd., New Delhi.

Reference Books

1. J.M. Smith, "Chemical Reaction Kinetics", McGraw Hill

2. K.G. Denbigh & K.G. Turner, "Chemical Reaction Theory an Introduction", United Press & ELBS

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170504: Computational Methods in Chemical Engg.

Category	Title	Code	Credit-4			Theory Paper
Departmental Core-DC	Computational Methods in Chemical Engg.	170504	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			2	1	2	

Course Objectives: To get the exposure about finite differences and interpolation, to find numerical solutions of ordinary differential equations and unsteady state heat and mass transfer problems and also find numerical solutions of partial differential equations.

Syllabus

Unit-I Treatment of Engineering Data: Graphical representation, Empirical equation, Interpolation, Newton's formula, Lagrange's Interpolation formula, Extrapolation, Integration, Graphical integration, Graphical construction of integral curves, Numerical integration.

Unit-II Interpretation of Engineering Data: Significant figures, Classification of measurements, Propagation of error, Variation and distribution of random errors, Properties of variance, Confidence limit for small samples.

Unit-III Ordinary Differential Equation: Formulation, Application of law of conservation of mass- mixing in flow process, Classification of ordinary-differential equations and its application of common chemical engineering problems.

Unit-IV Numerical Solution of Ordinary Differential Equations: Liner second order equation with variable coefficients, Numerical solution by Runge-Kutta method and its application to higher order equations.

Unit-V Formulation of Partial Differential Equations: Finite difference, Linear finite difference equations, Non linear difference equations, Optimization types and methods, its application related to chemical processes.

Course outcomes: After the successful completion of this course, students will be able to:

CO1: explain the mathematical problems as applied to Chemical Engineering.

CO2: interpret the engineering data& the features of different numerical methods.

CO3: illustrate the use of numerical methods in Chemical Engineering scenario.

CO4: outline the scope of optimization in chemical processes & use of numerical solution of the ODEs.

CO5: simplify the solution of engineering problems using PDEs & ODEs.

CO6: solve PDEs & ODEs in various physico-chemical systems.

Text Books:

1. Jenson and Jeffrey's, "Mathematical Methods in Chemical Engineering", Academic Press
2. S. K. Gupta, "Numerical Methods for Engineers", New Academic Science

Reference Books:

1. H.S. Mickley, T.K. Sherwood, C.R. Reed, "Applied Mathematics in Chemical Engineering", McGraw Hill publication
2. Alan Myers and Warren Seider, "Introduction to Chemical Engineering and Computer Calculations", Prentice Hall.

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170505: Inorganic Process Technology

Category	Title	Code	Credit-3			Theory Paper
Departmental Core-DC	Inorganic Process Technology	170505	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			3	0	0	

Course Objectives: To impart the basic concepts of Inorganic process technology.To develop concepts of unit process and unit operations in various industries.To learn manufacturing processes and flow sheets of Inorganic chemicals, its applications and major engineering problems encountered in the processes.

Syllabus

Unit I Alkalies: Chlor - alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine-common salt.

Unit II Acids: Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid, Manufacture of hydrochloric acid, Phosphoric acid.

Unit III Fertilizers: Nitrogen Fertilizers: Synthetic ammonia, nitric acid, Urea, Ammonium Chloride, Ammonium Sulphate ; Phosphorous Fertilizers: Phosphate rock, phosphoric acid, Super phosphate and Triple Super phosphate, MAP, DAP; Potassium Fertilizers: Potassium chloride, Potassium sulphate and Bio-fertilizers.

Unit IV: Cement, Glass and Industrial Gases: Cement: Types and Manufacture of Portland cement, Glass: Manufacture of glasses and special glasses, Industrial gases: manufacture of Nitrogen, Oxygen, Hydrogen, Helium and Argon.

Unit V: Inorganic Chemicals: Manufacture of Bromine, Iodine and Fluorine, Alumina and Aluminum chloride, Inorganic pigments.

Course outcomes: After the successful completion of this course, students will be able to:

CO1: **explain** the basics of heavy and inorganic chemical industry.
CO2: **relate** the importance of different unit operation and different unit processes involved in heavy and inorganic chemical industry.
CO3: **develop** process flow diagram.
CO4: **analyze** the major engineering problems involved in the process.
CO5: **evaluate** different types of processes based on the conversion and yield of desirable products.
CO6: **explain** the importance of fertilizer and cement technology

Text Books:

1. G.T. Austin, N. Shreves, "Chemical Process Industries", 5th Edition, McGraw Hill, New York, 1984.
2. W. V. Mark, S.C. Bhatia, "Chemical Process Industries volume I and II", 2nd Edition 2007.

References:

1. R. Gopal and M. Sittig, "Dryden's Outlines of Chemical Technology: For the 21st Century", Third Edition, Affiliated East-West Publishers, 1997.
2. S. D. Shukla and G. N. Pandey, "Text book of Chemical Technology" Vol 2, 1984

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170611: PROCESS EQUIPMENT DESIGN

Category	Title	Code	Credit-2			Theory Paper
Departmental Elective –DE –I(i)	PROCESS EQUIPMENT DESIGN	170611	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			4	0	0	

Course Objective:

The objective of this course is to acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment.(e.g. evaporator, flash drum, cooling tower, etc.). To develop the skill to select and design the appropriate process equipment for the required unit or process operation.

Syllabus

Unit I Scale up and scale down of chemical process equipment. Process design calculations for heat exchanges equipment shell and tube heat exchangers general description, heat transfer coefficients and pressure drop by Kern's & Bells methods rating on existing unit.

Unit II Design of a new system having one or more units in series: single effect evaporation, Multiple effect evaporator with boiling point elevation.

Unit III Process design calculations for mass exchange equipment plate (tray) and packed column for distillation and absorption including column diameter and height.

Unit IV Detailed process and mechanical design, Flash drum, Kettle reboiler, Condenser, cooling tower, rotary drier.

Course Outcomes: After the successful completion of this course, students will be able to

CO1 Interpret the parameters in design problem statement.

CO2 Apply the concepts of unit operations to design various process equipments.

CO3 Find the property values at various process conditions.

CO4 Justify the final design parameters in any process design.

CO5 Distinguish between different methods employed in design calculations & designs available for specific equipment.

CO6 Formulate certain rules of thumb to decide on some parameters encountered in process design.

Suggested Reading:

1. Dawande, S.D., "Process Design of Equipments", Central Techno Publications, Nagpur, 2000
2. R. H. Perry, "Chemical Engineers' Handbook", 7th Edn., McGraw Hill , NewYork, 1998.
3. R. K. Sinnott, "Chemical Engineering Design", Coulson and Richardson's Chemical Engineering Series, Volume-6, Fourth Edition, Butterwoth-Heinemann, Elsevier, NewDelhi,2005.
4. D.Q.Kern "Process Heat Transfer", Tata McGraw Hill Edn., 2004.
5. Chemical Engg. Vol-6 By Coulson J. M. Richardson

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170612: FLUIDIZATION ENGINEERING

Category	Title	Code	Credit-2			Theory Paper
Departmental Elective –DE –I(ii)	**Fluidization Engineering**	170612	L	T	P	Max.Marks-70 Min.Marks-22 Duration-3hrs.
			4	0	0	

Course Objective:

To learn the fluidization phenomena, industrial applications of fluidized beds and their operational and design aspects.

Course Objective:

To learn the fluidization phenomena, industrial applications of fluidized beds and their operational and design aspects.

Unit:-I Introduction and applications: Introduction to fluidized bed systems. Fundamentals of fluidization. Industrial applications of fluidized beds - Physical operations. Synthesis reactions, cracking and reforming of hydrocarbons, Gasification, Carbonization, Gas-solid reactions, calcining and clinkering.

Unit:-II Gross behaviour of Fluidized beds: Gross behaviour of fluidized beds. Minimum and terminal velocities in fluidized beds. Types of fluidization. Design of distributors. Voidage in fluidized beds. TDH, variation in size distribution with height, viscosity and fluidity of fluidized beds, Power consumption.

Unit:-III Analysis of bubble and emulsion Phase: Davidson's model, Frequency measurements, bubbles in ordinary bubbling bed model for bubble phase. Emulsion phase: Experimental findings. Turnover rate of solids. Bubbling bed model for emulsion phase Interchange co-efficient.

Unit:-IV Flow pattern of Gas and heat & mass transfer in Fluidized beds: Flow pattern of gas through fluidized beds. Experimental findings. The bubbling bed model for gas inter change, Interpretation of Gas mixing data. Heat and Mass Transfer between fluid and solid: Experiment findings on Heat and Mass Transfer. Heat and mass transfer rates from bubbling bed model.

Unit:-V Heat transfer between Fluidized beds and surfaces - Entrainment & Elutriation: Heat transfer between fluidized beds and surfaces: Experiment finding theories of bed heat transfer, comparison of theories. Entrainment of below or above TDH, model for Entrainment and application of the entrainment model to elutriation.

Course Outcomes:

After completion of this course, the student will be able to

CO1 Explain the basics of fluidization

CO2 Describe the various industrial application of fluidization

CO3 Explain the various fluidization regimes, classification of particles

CO4 Analyze Heat and Mass Transfer between fluid and solid

CO5 Estimate Voidage, TDH, size distribution with height, viscosity, fluidity

CO6 Evaluate Heat transfer coefficients in fluidized beds

Suggested Reading:-

1. J.F. Davidson, R. Clift & D. Harrison, "Fluidization", 2nd Edn., Academic Press, 1985
2. D. Kunii and O. Levenspiel, "Fluidisation Engineering", 2nd Edn., Butterworth Heinemann, 1991
3. W.L. Mc Cabe, Smith & Harriott, Ünit Operations in Chemical Engineering", 5th Edn., Mc. Graw Hill

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170613: MULTI – COMPONENT DISTILLATION

Category	Title	Code	Credit-2			Theory Paper
Departmental Elective –DE –I(iii)	MULTI – COMPONENT DISTILLATION	170613	L	T	P	Max.Marks-70
			4	0	0	Min.Marks-22 Duration-3hrs.

Course Objective: This course will enable students to understand the basic theories of multicomponent distillation and learn the design procedure for multicomponent distillation.

UNIT-I Multi component systems consisting hydrocarbons of different molecular structure, Thermodynamics and vapor liquid equilibrium, Distribution coefficients, the effect of temperature, pressure and composition. Definition and expressions of bubble point, dew point in multi component systems.

UNIT-II Key components-light and heavy key components, Flash Distillation, material balance and equilibrium, relationship for conventional distillation column, convergence methods.

UNIT-III Enthalpy balance for conventional columns, refinements for conventional column, total reflux, product composition , Lewis and Matheson methods, Composition corrections, Liquid/Vapor ratios, Method of Thiele and Geddes.

UNIT-IV Conventional and complex columns at total and minimum reflux, minimum reflux. Minimum reflux calculations, Plate efficiencies, Q- method of convergence for systems of distillations columns. Use of efficiencies for mass and heat transfer in conventional complex columns.

UNIT-V Equipments for distilling by non-conventional methods, Azeotropic extractive and molecular distillations. Use of packed columns, columns diameter and height of transfer unit (HTU). Super critical flux and extraction.

Course Outcomes:-

CO1 Select key component.

CO2 Solve number of theoretical and actual stages required for multi component distillation by usingvarious methods.

CO3 Examine how to break azeotrope using azeotropic and extractive distillation.

CO4 Estimate reflux ratio required for the distillation operation.

CO5 Estimate tower diameter and operating pressure for multi distillation column.

CO6 Analyze various design options for energy conservation in distillation column.

Suggested Reading:

1. Holland-Fundamentals to multi component distillation –McGraw Hill, NY.
2. Holland and liaps – Computer methods for solving dynamic separation problems – McGraw Hill, N.Y.
3.Treybal RE- Mass transfer operation- McGraw Hill, International edition. New Delhi.
4. Smith BD-Design of Equilibrium Stage Process- McGraw Hill, New Delhi.
5.Van Winkle- Distillation – Mc Graw Hill, Booh Co., New Delhi.

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170614: POLYMER TECHNOLOGY

Category	Title	Code	Credit-2			Theory Paper
Departmental Elective –DE –I(iv)	POLYMER TECHNOLOGY	170614	L 4	T 0	P 0	Max.Marks-70 Min.Marks-22 Duration-3hrs.

Course Objective:

To understand mathematical modeling of polymerizations and design batch and continuous reactors.

Unit I: Introduction Addition polymerization kinetics, Condensation polymerization kinetics and Ionic polymerization kinetics, Relationship between kinetic chain length and average degree of polymerization.

Unit II: Kinetics of Polyaddition and Chain Chemical reactions Kinetics and rates of polymerization of styrene, Methyl methacrylate, Ethylene, Polycondensation reactions Characteristics, Homogeneous and heterogeneous Polycondensation reaction kinetics, Maximum degree of Polycondensation, Industrial Polycondensation, Characteristics of chain reactions, Stationary and non stationary chain reactions, kinetics of branched chain reactions, Auto acceleration and inhibition of chain kinetics, Kinetics of inhibition.

Unit III: Copolymerization Introduction, Classification of copolymers, Basic principles of copolymers, Kinetics of copolymerization, Mayo's copolymer equation, Determination of feed and polymer, Determination of monomer Reactivity ratios, Copolymerization for limiting cases, Types of copolymers behavior, Overall rate of copolymerization, Alfrey Price Q–e scheme, Statistical derivation of copolymerization equation, Range and applicability of copolymerization, variation of copolymer composition with conversion and applications of copolymerization, Rates of copolymerization for chemical and diffusion controlled termination, Examples.

Unit IV: Emulsion and Suspension Polymerization Introduction to Smith- Ewart's emulsion polymerization kinetics, Experimental techniques in emulsion polymerization, Rates of polymerization for case I and case II, Estimation of total number of particles, Empirical correlations for emulsion polymerization, Vinyl Chloride suspension polymerization.

Unit V: Reactors for polymerization Batch, PFR, CSTR with residence time, Average molecular weight and control strategies, Programmed operation of Polyaddition reactors, Low and high conversion reactors, Industrial Polymerization reactors.

Course Outcomes: After the completion of this course, Students will be able to:

CO1: Analyze the classification of polymers, identification of their physical properties and establishing structure-property relations.

CO2: Describe polymerization methods, emulsion and suspension techniques of polymerization.

CO3: Apply governing equations for a polymerization process modeling.

CO4: Analyze of polymer processing operations and choice of operation depending on the material and final product requirements.

CO5: Estimate copolymerization and its kinematics along with its range and applicability.

CO6: Examine various reactors for carrying out polymerization reactions.

Suggested Reading:

1. G.N. Burnett, "Mechanism of polymerization reaction", Inter science, 1954.
2. Anil Kumar, S.K. Gupta, "Fundamentals of Polymer Science and Engineering", Wiley, 1978.
3. G.S. Misra, "Introductory Polymer Chemistry", Wiley Eastern Ltd., New Delhi, 1993.
4. F.Wilkinson, "Chemical Kinetics and Reaction Mechanism", Van Norstrand Reinhold Company Ltd, England, 1980.
5. F. Rodrigues, "Principles of Polymers systems", McGraw Hill, New York 1970
6. George Odian, "Principles of Polymerization", John Wiley and Sons, New York 1981.

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Department of Chemical Engineering

Elective- VI through SWAYAM /NPTEL/MOOC (Online Mode)

S.No.	Course Name	Course Code	Duration	Course Start Date	Course End Date	Exam date	Name of the Faculty
1	Chemical Rection Engineering -II	170651	12 Week	January 18, 2021	April 9, 2021	April 24, 2021	Prof. Swati Gupta
2	Multiphase Flow	170652	8 Week	January 18, 2021	March 12, 2021	March 21, 2021	Prof. Sulochana Nagar
3	Membrane Technology	170653	12 Week	January 18, 2021	April 9, 2021	April 24, 2021	Prof. Anish P. Jacob

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900109: Fuels & Combustion

Category	Title	Code	Credit-2			Theory Paper
Open Course I – OC(i)	Fuels & Combustion	900109	L	T	P	Max.Marks-70
			2	1	0	Min.Marks-22 Duration-3hrs.

Course Objectives:

To understand processing and limitations of fossil fuels (coal, petroleum and natural gas) and necessasity of harnessing alternate energy resources such as solar, wind, nuclear, geothermal, tidal and biomass. Also, to understand and practice various characterization techniques for fuels.

Unit-I Solid Fuels: Coal and lignite reserves in India, Classification of coal, Washing of coal, analysis of coal, proximate and ultimate analysis.

Unit-II Coal Carbonization, Mechanism of low temperature carbonization and high temperature carbonization, by- product recovery from coke oven, properties og coke, coal, grinding, pulverization, briquetting of solid fuels.

Unit-III Liquid Fuels: Origin of Petroleum production, Indian petroleum resources and their nature, Petroleum processing, distillation, cracking- thermal and catalytic, coking, reforming, Isomerization, crude Oil Classification, Reserves of Hydrocarbon in India, Introduction to petroleum refining and processing, atmospheric and vacuum crystallization.

Unit-IV Petroleum product and their utilization, Blending of petrol for octane number boosting, Transport fuels: Diesel, Petrol, AVL(Aviation Liquid Fuel), Kerosene, fuel and furnace oil, Testing of petroleum product: Flash Point, pore point, fire point, Octane number, cetane number, viscosity and viscosity index, API.

Unit-V Gaseous fuels: Natural gas, synthetic gases, their composition & properties, producer gas, water gas, coal gas, LPG.

Course Outcomes:

After completion of this course, the student will be able to

CO 1. Explain the origin of fossil fuels

CO 2. Classify fossil fuels and their reserves in India

CO 3. Analyze various alternate energy options available in earth

CO 4. Explain various fuel-processing techniques used in solid, liquid and gaseous fuels

CO5 Examine characterization techniques for fuels

CO6 Examine quality of fuels based on its properties and possible utilization

Suggested Reading:

Sarkar S. – FUEL AND COMBUSTION- 2nd ed. ORIENT Longmen, Mumbai, 1996.

Gupta O.P. FUEL & COMBUSTION-3rd ed. Khanna Publishers, New Delhi, 1996.

Francis W. & Peters M. C. – Fuel & Fuel Technology – 2nd Edn., Pergamon, 1980.

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900110: Nano Technology

Category	Title	Code	Credit-2			Theory Paper
Open Course 1 – OC(ii)	Nano Technology	900110	L	T	P	Max.Marks-70
			2	1	0	Min.Marks-22 Duration-3hrs.

Course Objective:

To learn the fundamental concepts of energy, mass and electron transport in materials confined or geometrically patterned at the nanoscale, where departures from classical laws are dominant.

Unit-I :- Introduction: Importance of Nano-technology, Emergence of Nano-Technology, Introduction of Bottom-up and Top-down approaches, challenges and Applications of Nano Technology.

Unit:-II Introduction to Physics of the solid-state and Properties: Structure, Energy Bands and Localized particles. Properties of Metal Nano clusters, Semiconducting Nano particles, Rare Gas & Molecular Clusters and Method of Synthesis.

Unit:-III Methods of Synthesis of Nanomaterials: Equipment and processes needed to fabricate nanodevices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

Unit:-IV Biologically-Inspired Nanotechnology: Basic biological concepts and principles that may lead to the development of technologies for nano engineering systems. Coverage will be given to how life has evolved sophisticatedly; molecular nanoscale engineered devices, and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans.

Unit:-V Instrumentation for Nanoscale Characterization: Instrumentation required for characterization of properties on the nanometer scale. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

Course Outcomes: After the completion of this course, Students will be able to:

CO1. Analyze the understanding of length scales concepts, nanostructures and nanotechnology.

CO2. Examine the principles of processing, manufacturing and characterization of nanomaterials and nanostructures.

CO3. Examine Analyze the understanding of the electronic microscopy, scanning probe microscopy and nanoindentation techniques to characterize the nanomaterials and nanostructures.

CO4. Examine the mechanical properties of bulk nanostructured metals, alloys, nanocomposites and carbon nanotubes.

CO5. Analyze the structure of materials down to the nanometer (atomic) level, with particular emphasis on crystal structure, nano-defects and their kinetics

CO6. Analyze the functional properties of various nanostructures, such as quantum dots, nanowires, ultrathin films and various nanocomposite structures.

Suggested Reading:-

1. Introduction to Nanotechnology by Charles Poole & Frank Owens, Wiley
2. Supramolecular Chemistry by Jonathan Steed & Jerry Atwood
3. Nanotechnology by William Illsey Atkinson, Amacom

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170602: Process Modeling and Simulation

Category	Title	Code	Credit-3			Theory Paper
Departmental Core-DC	Process Modeling and Simulation	170602	L	T	P	Max.Marks-70
			2	1	2	Min.Marks-22 Duration-3hrs.

Course Objectives: To provide an adequate knowledge of modeling in chemical engineering process system and to develop solutions for these models.

Syllabus

Unit I The Role of Analysis: Chemical Engineering Problems, Basic concepts of analysis, the analysis process, a simple example of estimating an order, Source of the model equations, Conservation equations, Constitutive equations, Control volumes, Dimensional analysis, System of units, Dimensional consistency in mathematical descriptions, Dimensional analysis and constitutive relationships, Final observations.

Unit II Non-Reacting and Reacting Liquid Systems: Introduction, Equation of continuity, Simple mass balance, Application of the model equations, Component mass balances, Model behavior, Steady state and unsteady state behavior, density assumptions, Numerical integration methods of ordinary differential equation. Reacting Liquid Systems: Introduction, basic model equations for a Tank-Type reactor, the reaction rate, the batch reactor, Pseudo First-order reactions, Reversible reactions, multiple reactions: consecutive reactions, parallel reactions, complex reactions, constant density assumption, order and stoichiometry.

Unit III Treatment of Experimental Data: Introduction, criteria for Best Fit, Best Slope-I, Best Slope-II, Best straight line, Physical property correlations, Fitting a quadratic, Simulation examples of gravity fluid flow, heat and mass transfer, Monte-Carlo simulation.

Unit IV Dynamic Modeling of Simple Processes: Sequential, Simultaneous modular and equation oriented approaches, Partitioning and tearing.

Unit V Computer Programming of Various processes: Iterative convergence methods such as Newton- Raphson, False position, Wegstein, Muller methods.

Course Outcomes: After the successful completion of this course, students will be able to:

CO1: **Explain** the basic concepts involved in process analysis & simulation.

CO2: **Formulate** a chemical engineering problem as a mathematical model from basic engineering principles.

CO3: **Apply** the conservation equations in various physico – chemical systems.

CO4: **Examine** the experimental data for further processing.

CO5: **Compare** various iterative convergence methods and numerical solution of ODEs.

CO6: **Analyze** different approaches involved in dynamic modeling of process systems.

Text Books

1. W.L. Luyben, "Process Modeling Simulation and Control for Chemical Engineers", McGraw Hill
2. T.W.F. Russell, "Introduction to Chemical Engineering Analysis", John Wiley & Sons New-York

Reference Books

1. Ismail Tosun, "Modeling in Transport Phenomena-A Conceptual Approach", Elsevier Publications
2. A.K. Jana , " Chemical Process Modeling & Computer Simulation", PHI learning Private Ltd
3. M.E. Davis, "Numerical Methods and Modeling for Chemical Engineers", Wiley, New York

List of Experiments:

1. Process dynamics experiments like flow of incompressible fluids at a variable flow rate.
2. Dynamics of a tank draining through an orifice in the bottom. Differential equation formulation and verification with the experimental data
3. Mass balance in a tank filling at certain rate and emptying at another rate. Rectangular and wedge-shaped tank and incompressible fluid
4. Modeling a batch reactor-verification of 1^{st} and 2^{nd} order rate kinetics.
5. Counter current double pipe heat exchanger modeling-data analysis by iterative methods.
6. Simulation of a distillation column-binary systems, equimolal overflow, constant relative, volatility.
7. Input-Output response study in non-ideal flow reactors.
8. Simulation of a perfectly mixed reactor with heat transfer. Derivation of a mathematical model and solving for steady state heat transfer
9. Simulation of False Position method.
10. Simulation of Newton-Raphson method.
11. Simulation of Muller method.
12. Simulation of Euler's & R-K methods.

Course Outcomes Lab:- After the successful completion of this course, Students will be able to:
CO1: Develop fundamental understanding of chemical engineering problem.
CO2: Develop dynamic model equations of chemical engineering systems.
CO3: Solve the differential equations by using different convergence methods.
CO4: Develop MATLAB code to solve dynamic model equations.
CO5: Analyze the plotted data generated by Matlab code.
CO6: Analyze the variation of state variable with respect to time.

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1. Transport Phenomena

Category	Title	Code	Credits-3			Theory Paper
Departmental Elective	Transport Phenomena	170711	L	T	P	Max. Marks-70 Min. Marks-22 Duration- 3 hrs
			3	-	-	

Course Objective:

This course will provide the fundamentals to solve real life problems involving transports of momentum, energy and mass in biological, mechanical and chemical systems using a unified approach.

Syllabus

Unit-I Similarity in momentum, heat and mass-transport –Newton's laws of viscosity, Fourier's laws of conduction and Fick's laws of diffusion.Flux-transport property relationships, Estimation of transport properties-measurement and correlations.

Unit-II Velocity distribution in laminar flow of falling film. Flow over an inclined plane, a circular tube annulus and between two parallel plates.

Unit-III Shell balance approach for developing equations of change for momentum, Heat and mass transport, Equations of change and their approximations for transport in one dimension.

Unit-IV Transport equations in turbulent flow and equations for turbulent fluxes.Velocity, Temperature and concentration profiles for laminar and turbulent flow conditions.Temperature and concentration profiles for conductive and convective transport in solids and fluids.

Unit-V Macroscopic momentum and heat balance equations, Kinetic energy calculations Constant area and variable area flow problems. Flow through bends. Time determination for emptying of vessels.

Course Outcomes: After the successful completion of this course, students will be able to:

CO1 **Tell** the basic terminology of Transport phenomena.

CO2 **Apply** shell balance to mass, momentum and heat transfer.

CO3 **Deduct** and **Solve** the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration

CO4 **Analyze** industrial problems along with appropriate boundary conditions.

CO5 **Identify** and **Apply** analogies among momentum, heat and mass transfer.

CO6 **Identify** and **Describe** mechanisms of transport phenomena, present in given isothermal and non-isothermal, laminar and turbulent flow systems.

Text Books:

1. Transport Phenomena By Bird R.B., Stewart W.E and Lightfoot E.W.(John Wiley & Sons)
2. Transport Phenomena A Unified Approach By Brodkey R.S. and Hershey (McGraw Hill Book Co.)

Reference Books:

1. R.W.Fahien., Elementary Transport Phenomena, McGraw Hill, New York, 1983.
2. Welty J.R.,Wicks C.E., Wilson R.E. and Rorer G.L, Fundamentals of momentum, heat and mass transfer, 5th edition, John Wiley & sons, New York 2007.

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2. Equilibrium Stage operation

Category	Title	Code	Credits-3			Theory Paper
Departmental Elective	Equilibrium Stage operation	170712	L	T	P	Max. Marks-70 Min. Marks-22 Duration- 3 hrs
			3	-	-	

Course Objective:

To provide an adequate knowledge of equilibrium stage operations such as multi component multistage separations distillation, absorption, stripping and extraction

Syllabus

UNIT I - Distillation-Stage wise contact operation. Methods of distillation: batch, continuous, flash, steam, vacuum, molecular distillations.

UNIT II - McCabe-Thiele and Ponchon-Savarit methods. Design of distillation towers.Elements of multi component distillation, Fenske-Underwood – Gilliland Method Azeotropic and extractive distillation.

UNIT III -General principles of leaching, Bollman extractor, Hildebrandt extractor. General principles of liquid –liquid extraction, working principle of extraction equipments: mixer-settlers, spray and packed extraction towers, agitated tower extractors. Percentage extraction calculation for single stage and multistage crosscurrent operations, Minimum solvent rate and number of theoretical stages for continuous countercurrent operation

UNIT IV - Introduction to adsorption, adsorbents and adsorption processes, adsorption equipment: fixed-bed absorbers, gas-drying equipment. Pressure-swing adsorption, adsorption from liquids, adsorption isotherms. Equilibrium Consideration – Liquid adsorption, Kinetic and Transport Considerations

UNIT V - Theoretical Model for an Equilibrium Stages used in separation operation, General Strategy of Mathematical and Graphical Methods for separation operation, Bubble Point Method for Distillation operation, Triangular diagram, Isotherms.

Course Outcomes: After the successful completion of this course, students will be able to:

CO1 **Describe** the fundamentals of separation operation.

CO2 **Describe** the approximation technique and its algorithms for multicomponent multistage separations

CO3 **Interpret** the equilibrium data obtained in the various separation operation

CO4 **Analyze** industrial problems along with equilibrium stage operation.

CO5 **Identify** and **Apply** the knowledge of kinetics and transport.

CO6 **Apply** themechanisms of industrial equilibrium separation operation

Text Books:

1. Treybal. R .E, "Mass Transfer Operations", 3rd Edition, McGraw Hill, 1980.

Reference Books:

1. Smith. J.M., "Chemical Engineering Kinetics", 3rd edition, McGraw Hill International Editions, New Delhi, 1981.

2. Ronald. W.Missen, Charles.A.Mions, Bradley.A.Saville, "Introduction to Chemical Reaction Operation and Kinetics", John Wiley and Sons, Singapore, 1999.3.Seader.J D, & E J Henley, "Separation Process Principles", John Wiley & Sons Inc., 1998.

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3. Industrial Pollution prevention and Control

Category	Title	Code	Credits-3			Theory Paper
			L	T	P	
Departmental Elective	Industrial Pollution prevention and Control	170713	3	-	-	Max. Marks-70 Min. Marks-22 Duration- 3 hrs

Course Objective:

This course presents fundamentals of Industrial pollution prevention and control aspects towards sustainable developments

Syllabus

UNIT I: Industrial activity and environment, Fates of Industrial Contaminants, Industrialization and sustainable development, Sustainability strategies, Barriers to sustainability, Pollution prevention in achieving sustainability

UNIT II: Prevention vs control of industrial pollution, Environment policies and Regulations to encourage pollution prevention, Environment friendly chemical processes, Regulations for clean environment and implication for industries

UNIT III: Definition of pollutant, types of pollution, Air, water, land, noise- adverse effects of pollutants eco system and human health, Need for effluent treatment and toxicity, control, Water standards for portable, agricultural and left-off streams- air Standards for cities, industrial areas, resorts.

UNIT IV: Introduction to particulate emission control, Gravitational settling chambers- cyclone separators, fabric filters, Electrostatic precipitators, wet scrubbers, absorbers, Control of sulphur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons, Noise pollution measurements and its control.

UNIT V: Primary, secondary and tertiary treatments, advanced waste water treatments, Recovery of metals from process effluents

Course Outcomes: After the successful completion of this course, students will be able to:

CO1 **Describe** the industrial activities and fates of industrial contaminants.

CO2 **Describe** the concept of pollution prevention, control and sustainability development

CO3 **Identify** the laws and regulations pertained to pollution prevention and control

CO4 **Analyze** the significance of different industrial pollution.

CO5 **Identify** the concepts of air pollution control and methods.

CO6 **Apply** theprinciples of industrial water treatment methods

Text Books:

1. Bishop.P, "Pollution Prevention: Fundamentals and Practice", McGraw Hill International Edn., McGraw Hill Book Co.

Reference Books:

1. James. G. Mann and Liu.Y.A, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 1999
2. Freeman.H.M, "Industrial Pollution Prevention Hand Book", McGraw Hill, 1995
3. Rose.G.R.D, "Air pollution and Industry", Van Nostrand Reinhold Co., New York 1972
4. Kapoor.B.S, "Environmental Engineering", 3rd Edn., Khanna publishers,1997
5. Pandey.G.N and Carney.G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi,1989

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4. Petrochemical Technology

Category	Title	Code	Credits-3			Theory Paper
Departmental Elective	Petrochemical Technology	170714	L	T	P	Max. Marks-70 Min. Marks-22 Duration- 3 hrs
			3	-	-	

Course Objective:

This course helps the students to know about the various raw materials and manufacturing processes involved in the petrochemical industries.

Syllabus

UNIT I: Petro chemicals - Definition, overview of petrochemical, Importance and growth potential of petrochemical in India, Economics and feedstock selection for petrochemical

UNIT II: Reforming and cracking: Cracking of Naphtha and Feed stock gas for the production of C_2 and C_3 Compounds, Ethylene, Acetylene, Propylene, Isobutylene and Butadiene, Ammonia, Alcohol, Synthesis gas

UNIT III: Production of intermediate chemicals: Acrylonitrile, ethylene oxide, Propylene oxide, ethyl chloride, Vinyl acetate and vinyl chloride, Higher olefins: Benzene, toluene, xylene, Phenol and Styrene

UNIT IV: Polymerization process: Plastics-Ethenicpolymers -polyvinyl chloride, Polycondensation polymers - phenol formaldehyde, Synthetic rubber-SBR, Polymeric Oils-Silicones, Synthetic fibers- polyesters- polyesters ribbon, Polyethylene Terephthalate, Polyamides adpic acid, nylon 6,6

UNIT V: Agrochemicals, synthetic detergents through olefins from kerosene, Carbon black-delayed coking,-fluid coking, Pharmaceuticals, Concepts of quality and environmental pollution control in petrochemical industries.

Course Outcomes: After the successful completion of this course, students will be able to:

- CO1 **Identify** thesuitable feedstock and predict potential growth of petrochemical industries.
- CO2 **Describe** the various aspects of production of olefin containing gases
- CO3 **Identify** various aspects of important intermediate material for petrochemical industries
- CO4 **Analyze** the various aspects of cracking and polymerization processes.
- CO5 **Identify** the manufacturing methods of important for petrochemical industries
- CO6 **Identify** the concepts of quality and environmental pollution control in petrochemical industries

Text Books:

1. BhaskaraRao. B.K, "A Text on Petroleum Chemicals", 4thEdn.,Khanna Publishers, New Delhi, 2007.
2. Steiner H. "Introduction to Petroleum Chemicals", Pergammon Press, 1992

Reference Books:

1. Brownstein. A.M. "Trends in Petrochemical Technology", Petroleum Publishing Company, 1976.
2. Sittig, M. "Aromatic Hydrocarban, Manufacture and Technology", Noyes Data Corporation, 1976.
3. GopalaRao M. and Marshall Sittig. "Dryden's Outlines of Chemical Technology", 3rd Edn.,East-West Press, New Delhi, 1997.

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Department of Chemical Engineering

Elective- IV, VII Semester through SWAYAM /NPTEL/MOOC (Online Mode)

S.No.	Course Name	Course Code	Duration	Course Start Date	Course End Date	Exam date	Name of Faculty
1.	Numerical Methods for Engineers	170753	12 Weeks	July 20, 2020	October 9, 2020	October 17, 2020	Prof. Anish P. Jacob
2.	Energy conservation and waste heat recovery	170754	12 Weeks	July 26, 2021	October 15, 2021	October 23, 2021	Dr. Shourabh Singh Raghuwanshi
3.	Principles and Practices of Process Equipment and Plant Design	170755	12 Weeks	July 26, 2021	October 15, 2021	October 24, 2021	Prof. Swati Gupta

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900211: Petroleum Processing Technology (OC-2)

Category	Title	Code	Credits-4			TheoryPaper
Departmental (OC-2)	Petroleum Processing Technology	900211	L	T	P	Max.Marks-70 Min.Marks-22
			2	1	-	Duration-3hrs.

Course objectives:

This course will provide the knowledge about the extraction and distillation process for different hydrocarbons chains from crude oil to meet different energy needs as well as refining of crude oil for a widespectrum of useful products such as petrochemicals, Chemicals, Plastics.

Syllabus:

Unit-I: Origin and occurrence of petroleum crude: Status of petroleum refining in India, Composition of petroleum, and classification and physical properties of petroleum, Evaluation of crude oil and petroleum products future refining trends.

Unit-II: Crude oil Distillation Process: Pretreatment of crude, atmospheric and vacuum distillation process.Secondary conversion process: Catalytic reforming, Catalytic Cracking and deep catalytic cracking.

Unit-III: Heavy Residue Upgradation Technologies: Hydrocracking, Hydrotreating, Visbreaking and delayed coking alkylation, Isomerization, dehydrogenation Processes, polymerization.

Unit-IV: Lubricating oil, grease and Bitumen: Dewaxing and deoilingdeasphalting, Lube hydrofinishing, bitumen airblowing, sweetening and Desulphurization of petroleum products.

Unit-V: Refinery products, refinery, refinery gas utilization: LPG, propylene and hydrogen recovery, Reformulated Gasoline Present and future requirements

Course Outcomes: Afterthecompletionofthiscourse, Studentswillbeable to

CO1: **Explain** the chemistry of petroleum and its characterization.

CO2: **Analyze** the petroleum refining and petrochemical processing and current scenario

CO3: **Analyze** the improvement for the profitability of refining and petrochemical complexes.

CO4: **Evaluating** the application of advance technologies for petroleum exploration, production and economics of energy sector

CO5: **Analyze** the systems for ensuring safe, reliable design and operation of process unit.

CO6: **Design** the parameters for safe, healthy environment in petrochemical industries.

Text Books:

1. R. Prasad (1sh Edition 1995, Khanna Publishers) - Petroleum Refinery Technology

Reference Books:

1. G.D. Hobson (9th Edition 1986, John Willy & Sons) - Modern Petroleum Technology Part- I&II
2. W.L. Nelson (4th Edition1987, McGraw Hill) - Petroleum Refinery Engineering

900223: Industrial Safety & Hazard Analysis (OC-3)

Category	Title	Code	Credits-4			TheoryPaper
Departmental OC	Industrial Safety & HazardAnalysis	900223	L	T	P	Max.Marks-70 Min.Marks-22
			3	1	-	Duration-3hrs.

Course Objective:

This course will provide effective use of chemical industries utilities. This course also emphasis on the knowledge of loss prevention, personal safety, industrial safety, hazard analysis, toxicology and personal proactive equipments.

Syllabus:

Unit-I: Origin of process hazards: Laws Codes, Standards, Case Histories, properties of Chemicals, Health hazards of industrial substances.

Unit-II: Toxicology:Toxic materials and their properties, effect of dose and exposure time, Relationship and predictive models for response, Threshold value and its definitions, material safety data sheets, industrial hygiene evaluation.

Unit-III: Fire & Explosion:Fire are exposure hazards causes fire and preventive methods Flammability characteristics of chemical, fire and explosion hazard, rating of process plant, Propagation of fire and effect of environmental factors, Ventilation, Dispersion, Sprinkling, Safety and relief values.

Unit-IV: Other Energy Hazards: Electrical hazards, noise hazards, Radiation hazards in Process operations, Hazards communication to employees, Plant management and maintenance to reduce energy hazards.

Unit-V: Risk Analysis and Hazard Identification: Event probability and failure, Plant reliability and risk analysis,HAZOP, HAZON event and consequence analysis,Measurement and calculation of Risk analysis, Safety Training program, Disaster management and emergency planning.

Course Outcomes: Afterthecompletionofthiscourse, Studentswillbeable to

CO1:**Analyze** the origin of hazards and fundamental principles of safety

CO2:**Analyze** the issues related to toxicants and minimize the toxicants dose.

CO3:**Explain** the fire & explosion hazard and the controlling measurement techniques used in the chemical industries

CO4:**Evaluate** the professional obligations related to the plant management and maintenance to reduced energy hazard.

CO5:**Analyze** the risk analysis and plant reliability to reduce the hazard

CO6:**Formulate** the HAZOP study, event tree analysis and faulty tree analysis

Text Books:

1. D. A. Crawl, J. A. Louvar (Prentice Hall of India, New Delhi, 1990) - Chemical Process Safety Fundamentals with Applications

Reference Books:

1. C. A. Wentz (2^{th} Edition 2001, McGraw Hill) - Safety, Health and Environmental Protection
2. B. D. Smith (4^{th} Edition 2003, McGraw Hill) - Design of Equilibrium State Process

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170706: Process Computation Lab

1. To apply mass balance for a process situation using excel
2. To apply energy balance for a process situation using excel
3. To plot and learn duhrings plot
4. To plot various time changing plots for parameters involved in a process
5. To analysis parameter relations in a process situation using in-out relations
6. To develop flow-sheet in excel
7. To develop balance sheet for a process situation
8. To develop understanding of calling of workbooks for use at one time
9. To learn about data validation and consolidation in excel

After completion of this laboratory course, the student will be able to

CO1: Operate and program in MS Excel

CO2: Construct the flowsheets of chemical process unit.

CO3: Solve and apply mass balance for a process situation using excel.

CO4: Analyze and apply energy balance for a process situation using excel.

CO5: Construct various time changing plots for parameters involved in a process.

CO6: Understand about data validation and consolidation in excel.