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170211: Chemical Process Calculations

Category	Title	Code	Credits-4			Theory Paper
			L	T	P	
Departmental Core-DC	Chemical Process Calculation	170211	2	1	2	Max.Marks-60 Min.Marks-19 Duration-2hrs.

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 & change
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.

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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.

170311: Fluid Mechanics

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Fluid Mechanics	170311	L	T	P	Max.Marks-50 Min.Marks- Duration-2 hrs.
			2	1	1	

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

W.L. Mc Cabe & I.C. Smith- UNIT OPERATIONS IN CHEMICAL ENGG- 3rd edition MC GRaw Hill & Kogakusha 1976.

Reference Books

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

List of Experiments

To determine the local point pressure with the help of pitot tube.
To find out the terminal velocity of a spherical body in water.
To determine the viscosity of a spherical body in water.
To find the pressure drop in a packed bed,
To study the flow behavior of a Non-Newtonian fluid and to determine the flow constants.

To determine the power number- Reynolds Number curve.
To differentiate between laminar and turbulent flow using Reynolds experiments.
To study the characteristics of an air compressor.
To study the characteristics of a centrifugal pump.
To study the flow of a fluid in a pipeline and to prepare the friction factor-N_{Re} plot.
To determine the friction losses, expansion losses and reduction losses in bends and pipes and verify the Bernoulli equation.
To prepare the calibration curve for an orifice meter and Rotameter.
To prepare the calibration curve for a Venturimeter.

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

170312: Organic Process Technology

Category	Title	Code	Credits-3			Theory Paper
Departmental Core-DC	Organic Process Technology	170312	L	T	P	Max.Marks-50 Min.Marks- Duration-2 hrs.
			2	1	0	

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 successful 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. Dryden C.E., Outlines of chemical technology-3rd edition AFFILIATED East – West Press , New Delhi, 1997

Reference Books

1. V.B. Gupta& V.K. Kathari-Manufacturing Fiber Technology-Chapman Hall , Newyork I edition 1997.
2. V.K. Kathari-Process in Textile, science Technology, Vol –I & II –IAFL publication, S-351 Greater Kalaish part-I New Delhi.-48 ed.
3. Austinn, G.T. Shree Chemical Process Industries -5th edition Mc Graw Hill New York 1984.

170313: Chemical Engineering Thermodynamics

Category	Title	Code	Credits-3			Theory Paper
Departmental Core-DC	Chemical Engineering Thermodynamics	170313	L	T	P	Max.Marks-50 Min.Marks- Duration-2 hrs.
			2	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 equation, Vapor-liquid equilibria.

Unit- V Chemical Reaction Equilibria: Chemical potential, Effect of pressure and temperature on heat of reaction and on free energy, Vant 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 systems.

Text Books

1. Smith J.M. & Van Ness., "Introduction to Chemical Engineering Thermodynamics", McGraw Hill
2. Sandler, S.I., "Chemical Engineering Thermodynamics", John Wiley & Sons
3. Dodge B.F., "Chemical Engineering Thermodynamics", McGraw 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

170314: Fluid Particle Mechanics

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Fluid Particle Mechanics	170314	L	T	P	Max.Marks-50 Min.Marks- Duration-2 hrs.
			2	1	1	

Course Objective:

To understand the 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 communication, size reduction, crushing, grinding, pulverizing and ultra fine size reduction equipment, power requirement in communition.

Unit-II 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, Visit to Chemical Engg. Industry engaged mainly with Mechanical Operation.

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 successful 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 along with the various principles.
CO3: Explain the separation techniques and equipments.
CO4: Illustrate the various process like sedimentation, filtration etc.
CO5: Analyze the various conveying devices.
CO6: Illustrate the fluidization and fluid catalytic process.

Text Books

1. McCabe Smith- UNIT OPEARATION OF CHEMICAL ENGG, Mc Graw Hill 2001.

Reference Books

1. Badger Bencharo- INTRODUCTION TO CHEMICAL ENGG- Tata Mc Grawhill 1998.
2. Coulson & Richordson Vol. 2-CHEMICAL ENGG. New Delhi Asian Book Pvt. Ltd.
3. G.G. Brown- UNIT OPERATIONS-CBS Publications New Delhi 1995.

List of Experiments:

To analyze the given sample by differential, cumulative methods using standard screen.
Determination of size and surface area of irregular particles using a measuring gauge.
To study the crushing behavior and to determine the Rittinger's and Bond's constant of the given solid in a jaw crusher.

To study the crushing behavior and to determine the Rittinger's and Bond's constant of the given solid in a ball mill.
To study the crushing behavior and to determine the Rittinger's and Bond's constant of the given solid in a hammer mill.
Determination of mixer effectiveness and mixing index of given slurries.
To study the filtration behavior of a given slurry using a Plate and Frame Filter press.
To study the filtration behavior of a given slurry using a leaf filter press.
To study the filtration behavior of a given slurry using a rotary drum filter press..
To study the performance of a Dorr Thickener.
To study the characteristics of liquid-solid fluidized bed.
To study the characteristics of gas-solid fluidized bed.
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.

170315 **Chemical Synthesis Lab**

List of Experiments:

To determine BOD & COD for given waste water sample.
Preparation of acetic acid from ethyl accohol.
To find out the sucrose content in aqueous solution by polarimeter.
To evaluate the viscosity of molasses.
To determine the percentage of formaldehyde in the formalene.
To determined iodine value of the given oil sample.
To determine the acetic acid , ethanol concentration in aqueous solutions.
To prepare azodye and finding the yield.
Prepare a standard phenol solution and estimate the % of phenol in the given unknown sample of phenol.
To prepare urea formaldehyde resin and report % conversion.
To determine total dissolved and suspended solids in water and waste water
To determine turbidity in water and waste water
To determine hardness of water

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

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170411: HEAT TRANSFER

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Heat Transfer	170411	L	T	P	Max.Marks-50 Duration-2hrs.
			2	1	2	

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.

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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170412: INSTRUMENTATION AND PROCESS CONTROL

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Instrumentation & Process Control	170412	L	T	P	Max.Marks-50 Duration-2hrs.
			3	-	-	

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

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

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
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170413: MECHANICAL DESIGN OF PROCESS EQUIPMENT

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Mechanical Design of Process Equipment	170413	L	T	P	Max.Marks-50 Duration-2hrs.
			3	1	-	

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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170414: MASS TRANSFER – I

Category	Title	Code	Credits-4			Theory Paper
Departmental Core-DC	Mass Transfer – I	170414	L	T	P	Max.Marks-50 Duration-2hrs.
			2	1	2	

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

CO1Relate the basics of humidification, drying, crystallization & the principle of diffusion underlying them.

CO2Translate the mechanism of diffusion through Stefan's tube.

CO3Identify the mass transfer characteristics in turbulent flows.

CO4Make use of the theoretical concepts in humidification to operate a cooling tower.

CO5Compare 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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DEPARTMENT OF INFORMATION TECHNOLOGY

DATA SCIENCE

COURSE OBJECTIVES:

- To provide the fundamental knowledge of Data Science.
- To present the basic representation and exploratory data analysis used in Data Science.
- To understand the working of techniques used in Data Science.

Unit 1

Need for data science, benefits and uses, facets of data, data science process, Introduction of basics python tool, Setting working Directory, Creating and saving a script file, File execution, removing variables from environment, clearing environment, Commenting script files, Variable creation, Data types and associated operations, Arithmetic and logical operators.

Unit 2

Control structures, loop, Functions**,** data structures: Lists, Arrays, Tuples, Dictionary, Sets, NumPy library, Data Collection: Getting to know your data, Types of Data, Data collection strategies, Data Pre-processing, Feature engineering, Exploratory Data Analytics.

Unit 3

Descriptive Statistics, Mean, Standard Deviation, Skewness and Kurtosis, inferential statistics: hypothesis testing, probability: probability theory, conditional probability, Pandas library, dataframe and dataframe related operations, Reading files.

Unit 4

Data Cleaning and Preparation, Handling Missing Data, Data Transformations using pandas and sklearn library, Removing Duplicates, Replacing Values, Detecting Outliers. Data visualization on different dataset using matplotlib and seaborn libraries, Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot.

Unit 5

Supervised learning: Regression, classification, Linear regression, logistic regression, decision tree, tree creation with entropy and information gain, ID3 algorithm, random forest, naïve bayes theorem, K-nearest neighbor and ensemble methods for solving real world problems, Unsupervised learning: Clustering, Reinforcement learning.

BOOKS AND REFERENCES

1. Mastering python for data science, Samir Madhavan
2. Introduction to linear algebra - by Gilbert Strang
3. Applied statistics and probability for engineers – by Douglas Montgomery
4. Pattern Recognition and Machine Learning, Christopher M. Bishop

COURSE OUTCOMES:

After completing the course, the student will be able to:

CO1: define different Data Science techniques.
CO2: illustrate various tools used for Data Science technique.
CO3: apply data visualization techniques to solve real world problems.
CO4: build exploratory data analysis for Data Science methods.
CO5: apply Data Science techniques for solving real world problems.
CO6. evaluate the performance of algorithms in data science.

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170512: Mass Transfer -II

Category	Title	Code	Credit-4			Theory Paper
Departmental Core-DC	Mass Transfer-II	170512	L	T	P	Max.Marks-50 Duration-2hrs.
			2	1	-	

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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170513: Chemical Reaction Engineering –I

Category	Title	Code	Credit-4			Theory Paper
Departmental Core-DC	Chemical Reaction Engineering –I	170513	L	T	P	Max.Marks-50 Duration-2hrs.
			2	1	-	

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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170514: 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-50 Duration-2hrs.
			2	1	-	

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	170515	L	T	P	Max.Marks-50 Duration-2hrs.
			2	-	-	

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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Course Code: MAC ******

(For batches admitted in 2021-2022 & onwards)

Course Name: Project Management and Financing

L	T	P	Credit
2	0	0	GRADE

Course Objectives:

1) To know about project, its attributes and essentials of project planning
2) To develop the project network
3) To take rational decisions using project networks for successful completion of the projects
4) To decide about about rational utilization of resources in project.
5) To have an elementary idea of finances involved in a project and managing it

Unit I:

Project Planning:

Introduction to Project Management, Difference between Project and Production, Attributes of a Project: Time, Cost, Quality and Safety. Stakeholders of a Project, Project life cycle. Project Planning: Types of Project Plans and feasibility.

Unit-II:

Project Network logic: Project Networking and work flows, Activity duration and methods of estimating activity duration – One time estimate three time estimates, Duration estimation procedure. Use of Bar Charts, Mile stone charts and networks, Network representation schemes: Activity on Arrow and Activity on Node Networks (**A-o-A** & **A-o-N**), Logic behind developing project network and simple network calculations, Critical paths and floats.

Unit-III:

Decision making through networks: CPM, PERT & PDM:

Use of network in Decision Making: Importance of critical path, Monitoring the progress and updating the project plan. Use of floats in Resource smoothening, Introduction to Precedence Diagramming Method (PDM), Different lag and lead relations in terms of SS(Start to Start), SF(Start to Finish), Finish to Start(FS), and Finish to Finish(FF) and composite relations.

Unit-IV:

Project Cost Control: Breakeven analysis in planning stage, Direct and indirect cost, slope of direct cost curve, Total project cost and optimum duration, contracting the network for cost optimization. Escalation & Variation in prices.

Unit-V:

Projects Financing:

Introduction to project financing; Role of governments in financing projects, Funder and Concessionaire: Economic multiplier effects of Projects; Means of financing-public finance and private finance, Granting authority: **World Bank** Group, **IMF, ADB,** Micro and Small Enterprises Funding Scheme (**MSME**), Elementary understanding of Procurement of infrastructure projects through Public Private Partnership (**PPP**) route, Build Operate Transfer (**BOT**), Build Operate Own & Transfer (**BOOT**); Stakeholders' perspectives, Lifecycle of PPP projects, Micro & Macro economics concepts and its application in Project Financing.

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Course Outcomes

Upon completion of the course, the students will be able to:

CO 1: Know the attributes of project and its different phases.

CO 2: Develop the project network based on work breakdown structure and esimation of activity durations

CO 3: Analyze the project network and make **decide** the various alternates.

CO 4: Evaluate the optimum cost of project for assigned deadlines.

CO 5: Understand the different options to arrange the finances to complete it within stipulated time

Recommended Text-Books:

1. Project Management Scheduling PERT and CPM by Dr. B.C. Punmia, K.K. Khandelawal
2. PERT & CPM Principles and Applications by L.S. Srinath, Affiliated EWP Pvt. Ltd.
3. Project Planning and Control by Albert Lester, Fourth Edition Elsevier Butterworth-Heinemann.

Recommended Reference Books:

1. A Management Guide to PERT/CPM With GERT/PDM/DCPM and Other networks by Jerome D. Wiest, Ferdinand K. Levy, Prentice Hall.
2. Project Management with CPM and PERT by Joseph J. Moder, Cecil R. Phillips, Van Nostrand Reinhold Company

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Course Code: 1000006

Course Name: Disaster Management

L	T	P
2	-	-

Course Objectives:

i) To understand basic concepts in Disaster Management
ii) To understand Definitions and Terminologies used in Disaster Management
iii) To understand Types and Categories of Disasters
iv) To understand the Challenges posed by Disaster
v) To understand Impact of Disasters key skills

Syllabus:

Unit 1: Introduction to disaster management, concepts and definitions: disaster, vulnerability, risk severity, frequency and details, capacity impact, prevention, mitigation.

Unit 2: Disasters – Disasters classification, demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends, hazard and vulnerability profile of India.

Unit 3: Disaster Impacts – Disaster impact (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues, impact of natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides etc.), impact of manmade disasters (industrial pollution, artificial flooding in urban areas, urban disasters, transportation accidents etc.).

Unit 4: Disaster Risk Reduction (DRR)- Disaster management cycle- its phases; prevention, mitigation, preparedness, relief and recovery; structural and non- structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response. Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders: Policies and legislation for disaster management. DRR programmes in India and the activities of National Disaster Management Authority.

Unit 5: Disasters, Environment and Development – Factors affecting vulnerability such as impact of development projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

Course Outcomes:

After successful completion of the course, the students will be able to

CO1: Identify disaster prevention and mitigation approaches.
CO2: Classify global and national disasters, their trends and profiles.
CO3: Determine the impacts of various disasters.
CO4: Apply Disaster Risk Reduction in management.
CO5: Infer the linkage between disasters, environment and development.

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Experiment List (Vth SEM)

170512 Mass Transfer Lab-II

1. To study the flooding and loading of packed columns using different type of packing
2. To study of different type of plates and packings
3. Preparation of the Vapor Liquid Equilibrium and Boiling point diagram for binary liquid mixture
4. Determination of relative volatility of a given system of acetic-acids water
5. To verify Reyliegh equation for differential distillation of binary system
6. To study Steam distillation Process
7. To study Batch distillation Process
8. To study Continuous distillation Process
9. Experimental study on packed tower distillation unit
10. Experimental study on Sieve plate distillation unit
11. To study Bubble cap distillation column
12. To study the adsorption of a gas in a packed column and calculation of NTU and HTU
13. To perform Batch adsorption and verify Freundich law and Langmuir isotherm

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

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170513 CHEMICAL REACTION ENGINEERING –I

1. To study the rate constant of hydrolysis of an ester-catalyzed by acid.
2. To study temperature dependency of rate constant evaluation of activation energy and verification of Arrhenius law.
3. To study a homogeneous reaction in semi- batch reactor under isothermal conditions.
4. Study of non-catalytic homogeneous saponification in CSTR.
5. To study a non-catalytic homogeneous reaction in a plug flow reactor.
6. To study the residence time distribution behaviour of batch mix- reactor.
7. To study the RTD behaviour of tubular reactor.
8. To study the RTD behaviour of CSTR.
9. To determine the velocity rate constant of the hydrolysis of ethyl acetate by sodium hydroxide.
10. Determine the rate constant and order of reaction between potassium per sulfate and potassium iodide.
11. To study a homogeneous catalytic reaction in a batch reactor under adiabatic conditions.
12. Study of catalytic saponification reaction in a tubular flow reactor.

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

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170514 Computational Methods in Chemical Engineering Lab

1. Data representation and treatment by graphical methods, pressure volume, temperature and concentration relationship for gases and their mixtures
2. Redlich-Kwong equation of state and other Viral equations to estimate thermodynamic properties like compressibility factor, molar volume and P-V-T relationship
3. Estimation of properties from empirical correlations
4. Estimation of critical properties from group contribution method
5. Measurement errors their propagation and minimization of random errors, selection of confidence limits
6. Numerical solutions of quadratic and linear algebraic equations using various methods on the solvers in MATLAB
7. Numerical solutions of batch reactor problems using Euler Algorithm
8. Polynomial root finding using "Newton Raphson method and Secant method"
9. Numerical integration by Trapezoidal rule, Simpsons $1/3^{rd}$ and $3/8^{rd}$ rule
10. Approximate solutions of ordinary differential equations by Runge-Kutta algorithm and its application in chemical engineering
11. Numerical solution of transient flow temperature profile of fluid using different computational methods on MATLAB solver
12. Mass balance problem using continuity equation applied to a dynamic system. Formation of differential equations (component balance) and their solutions

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