INSTITUTE OF ENGINEERING,
JIWAJI UNIVERSITY , GWALIOR
B.E. (CHEMICAL ENGG.)
SCHEME w.e.f. 2018

Institute Of Engineering, Jiwaji University , Gwalior
B.E. III Sem . (Chemical Engineering)
Scheme (w.e.f.2018-2022 batch)
Subject wise distribution of marks and corresponding credits

S.NO.	Subject Code	Subject Name & Title	Theory Slot			Practical Slot			Total Marks	Credit alloted Subjectwise			Total Credits
										Period per week			
			End Sem	Mid Sem	Total -1	Sessional	Practical	Total-II	T1+T2	L	T	P	C
1	BE-301	Mathematics-II	80	20	100	–	–	–	100	3	1	0	4
2	CM-302	Chemical Engg Thermodynamics	80	20	100	–	–	–	100	3	1	0	4
3	CM-303	Chemical Instrumentation	80	20	100	50	50	100	200	3	1	2	6
4	CM-304	Material & Energy Balance	80	20	100	50	50	100	200	3	1	2	6
5	CM-305	Adv.Engg.Chemistry	80	20	100	50	50	100	200	3	1	2	6
6	CM-306	Computer Programming (Java)	–	–	–	50	50	100	100	0	0	2	2
7	CM-307	Self Study (internal Assesment)	–	–	–	50	–	50	50	0	2		2
8	CM-308	Seminar/ Group Discussion (internal Assesment)	–	–	–	50	–	50	50	0	2		2
		Total	**400**	**100**	**500**	**300**	**200**	**500**	**1000**	**15**	**9**	**8**	**32**

L: Lecture - T: Tutorial - P: Practical

B.E. 301 - ENGINEERING MATHEMATICS- II

Unit I

Fourier Series: Introduction of Fourier series , Fourier series for Discontinuous functions, Fourier series for even and odd function, Half range series Fourier Transform: Definition and properties of Fourier transform, Sine and Cosine transform.

Unit II

Laplace Transform: Introduction of Laplace Transform, Laplace Transform of elementary functions, properties of Laplace Transform, Change of scale property, second shifting property, Laplace transform of the derivative, Inverse Laplace transform & its properties, Convolution theorem, Applications of L.T. to solve the ordinary differential equations

Unit III

Second Order linear differential equation with variable coefficients : Methods one integral is known, removal of first derivative, changing of independent variable and variation of parameter, Solution by Series Method

Unit IV

Linear and Non Linear partial differential equation of first order: Formulation of partial differential equations, solution of equation by direct integration, Lagrange's Linear equation, charpit's method. Linear partial differential equation of second and higher order: Linear homogeneous and Non homogeneous partial diff. equation of nth order with constant coefficients. Separation of variable method for the solution of wave and heat equations

Unit V

Vector Calculus: Differentiation of vectors, scalar and vector point function, geometrical meaning of Gradient, unit normal vector and directional derivative, physical interpretation of divergence and Curl. Line integral, surface integral and volume integral, Green's, Stoke's and Gauss divergence theorem

References

(i) Advanced Engineering Mathematics by Erwin Kreyszig, Wiley India
(ii) Higher Engineering Mathematics by BS Grewal, Khanna Publication
(iii) Advance Engineering Mathematics by D.G.Guffy
(iv) Mathematics for Engineers by S.Arumungam, SCITECH Publuication
(v) Engineering Mathematics by S S Sastri. P.H.I.

CM 302 Chemical Engg Thermodynamics

UNIT-1
Basic concepts of work & heat system, properties and state of systems; first law of thermodynamics; application, batch flow processes; steady & unsteady state flow.

UNIT-2
Critical properties corresponding state compressibility, PVT behavior of pure fluids virial equation, cubic equation, generalized correlation & eccentric factor, behaviour of liquid, second law of T.D, & its application.

UNIT-3
Carnot cycle, carnot theorem, thermodynamics temp scales, concept of entropy, calculation of entropy for varions systems, entropy for real system .

UNIT-4
Effect of pressure on specific heat, Joule Thompson effect, third law of thermodynamics & its applications.

UNIT-5
Compression & expansion of fluids; single stage, multiple stage requirements & efficiency along with effect & engineering along with effects clearance, compression of real gas.

References:

1. Smith J.M and Van Ness- Introuction to Chemical Engg Thermodynamics – 6th edition
2. Daubert; chemical engg thermodynamic; TMH
3. Rathakrishnan E; Fundamentals of Engg Thermodynamics; PHI
4. Dodge B.F. Chemcail Engineering –Thermodynamics –McGraw Hill
5. Balzhiser Samules and Eliassen-Chemical Engg- Thermodynaics Prentic Hall
6. Sandler S.I Chemical Engg-Thermodynamics-John Wiley and son
7. Rastogi and Mishra-Chemical Engg Thermodynaics

CM 303 Chemical Instrumentation

UNIT-1
Introduction to chemical process instrumentation, process variables, static and dynamic characteristics of instruments & their general classification

UNIT-2
Elements of measuring systems & their functions, principles, construction and operation of instruments for measurement

UNIT-3
Control/ indication/ recording of process variables like pressure, flow, level, humidity and composition.

UNIT-4
Principles of transducers electro pneumatic, pneumatic, electrical & multi-pressure.

UNIT-5
Process instrumentation diagram and symbols, process instrumentation for process equipments such as distillation column, Heat exchanger, fluid storage vessel

References:
1. Albert D. Cooper- Modern Electronic Instrumentation, PHI
2. Eckman-Industrial Instrumentation
3. H.S. Kalsi- Electronic Instrumentation
4. Curties Johnson- Process Control Instrumentation Technique, IV Edn, PHI
5. Harriot; Process control; TMH
6. Patranabis; Principles of process control; TMH
7. Jaggi, Mathur; Engineering Mathematics; Khanna Publisher.
8. B.G. Liptak- Instrument Engineering 'Handbook, Volume 1 : Process Measurement
9. Austin E. Fribance- Industrial Instrumentation Fundamentals, new York: Mcgraw-Hill 1962
10. Ernest Doebelin- Measurement Systems: Application and Design, McGraw-Hill

List of Experiments (Pl. expand it):
1. Time constant of pH-meter
2. Study of Bourden tube pressure gauge
3. Bellow tube pressure gauge
4. Calibration of different instruments used in chemical processes
5. Study of electro-pneumatic transducers for pressure, flow, level
6. Measurement of water level using differential pressure meter
7. Measurement of flow using electromagnetic flow meter
8. Measurement of flow using differential pressure cell across orifice/ venturimeter

CM 304 Material & Energy Balance

Unit 1

Mathematical and Engineering calculation- Units, different unit systems, conversion of unit from one system to other dimensions dimensional analysis dimensional group fundamental of conservation of mass conservation of energy Basic of calculation.

Unit 2

Ideal Gases & Vapor pressure-Introduction of ideal gas, behavior of ideal gases, real gas, Vander Wal n , compressibility factor method to solve cubic equation vapour pressure Raoult's law Humidity relative humidity humid heat humid volume dew point humidity chart and its use.

Unit 3

Material balance-Introduction of component balance solving material balance, with and without simultaneous equ at steady state material balance, with and without simultaneous at unsteady stat recycle by pass and purge calculations.

Unit 4

Energy balance- Heat capacity calculation of enthalpy changes energy balances with chemical reaction Heat of vaporization heat of mixing heat of combustion.

Unit 5

Stochiometry & unit operations-Introduction of unit operation, Distillation Crystallization Drying, Evaporation, Psychometry and its application

References:

1. O.A. Hougen, K.M. Watson, R.A. Ragatz; Chemical Process Principles Part I –CBS pub.
2. David M. Himmelblau- Basic Principles and calculations in chemical Engineering – PHI
3. B.I Bhatt, S.M. Vora; Stoichiometry; TMH.

List of Experiments (Pl. expand it)

1. Determination of boiling point relation wrt concentration of caustic soda and verify Dehring' rule.
2. Application of dry and wet bulb thermometer to find out atmospheric humidity
3. Use of humidity chart to find enthalpy dew point humid heat and saturation.
4. Solubility at room temperature and boiling point of urea in water and verify the material balance.
5. Crystallization of copper sulfate in saturated solution by cooling and finding out the crystal yield.
6. To find out the heating value of coal using a calorimeter
7. Combustion of coal & performing the material balance
8. Proximate analysis of coal sample
9. Measurement of flame temp and compare actual & theoretical temp (Business- Burner, Sprit-Lamp, Kerosene Lamp.
10. To find the heat of reaction using calcium oxide and water.

CM 305 Advanced Engineering Chemistry

Unit I

Electronic Effect: Chemical properties of molecules, hyper conjugation and steric effects,studies on formation and stability of carbonation and Carbonium ions (with Inductive effects,conjugation & resonance and their effects on physical & simple examples of SN and SN_2 reactions)

Unit II

Properties of simple monomers: Production, properties & industrial applications of following monomers- Ethylene Styrene, Vinyl Chloride, Vinyl alcohol, Acrylic acid, Methyl Acrylate, Ethyl Acrylate & Methyl Methacrylate.

Unit III

Oils and Fats: Vegetable oils by solvent extraction, processing of animal fats, hydrogenation and esterification of oils; Soaps and Detergents Bathing & laundry soaps, cationic and anionic detergents; Specially cleaning, polishing and sanitation proportions, surface active agents, sulphonate oils.

Unit IV

Chemical Kinetics: Rate constant, order and molecularity of a reaction, zero, 1_{st}, 2_{nd} and 3^{rd} order reactions; Kinetics of opposing reactions, methods of determination of order of reactions;Reaction rate theories, Arrhenius, parameters, Catalysis (including enzyme catalysis), effect of catalysis on reaction rate.

Unit V

Electrochemistry: Galvanic cell, EMF and its determination, free energy concept, Nernst equation of electrode potential, standard electrode potential; PH value, its measurement and pH metric titration, Conductance, its measurement in polar and non polar solvents; Debye & Huckel theory and its modifications in case of strong electrotypes, conducto-metric titration.

Unit VI

Phase Rule: Phases, Degrees of freedom, component definition and derivation of phase rule, phase diagram study of Pb-Ag & Zn-Mg systems.

References:

1. B.S.Bahl & G. D. Tuli- Essentials of physical Chemistry. S. Chand & Publishers.
2. Glasstone – Textbook on Physical Chemistry – Prentice Hall, India, New Delhi.
3. Dryden CE- Outlines of Chemical Technology- Prentice Hall, India, New Delhi
4. Levine; Physical Cheistry; TMH.
5. Sivasamkar; Engg Chemistry; TMH
6. Jain & Jain- Engineering Chemisry – Dhanpat Rai Publishing Company, Delhi.
7. Austin G.T, Shreeves; Chemical Process Industry – McGraw Hill – Kogmina

List of Experiments

1. To determine the viscosity of a viscous liquid by falling sphere method
2. Determination of saponification value of oil sample
3. Application of pH meter to find acidity and alkalinity of a solution.
4. To study the hydrolysis of cane sugar solution in the presence of an acid by Fehling's solution method and to find out the reaction constant.
5. To study the adsorption of benzoic acid on animal charcoal and room temperature and to determine the Freundlich constants k,n.
6. Determination of the strength of unknown hydrochloric acid (app. 0.1N) by titrating it against caustic soda by conducto-metric method.
7. To determine the % composition of a given binary liquid solution by polarimeter.

8. To determine the solubility of a sparingly soluble salt in water by conductance measurement.
9. Determination of pH of mixture of CH_3COOH and CH_3COONa and the dissociation constant of the acid.
10. Preparation of laundry soap and to determine its yield.

CM 306 Java Technology

UNIT-I
Basic Java Features - C++ Vs JAVA, JAVA virtual machine, Constant & Variables, Data Types, Class, Methods, Objects, Strings and Arrays, Type Casting, Operators, Precedence relations, Control Statements, Exception Handling, File and Streams, Visibility, Constructors, Operator and Methods Overloading, Static Members, Inheritance: Polymorphism, Abstract methods and Classes

UNIT–II
Java Collective Frame Work - Data Structures: Introduction, Type-Wrapper Classes for Primitive Types, Dynamic Memory Allocation, Linked List, Stack, Queues, Trees, Generics: Introduction, Overloading Generic Methods, Generic Classes, Collections: Interface Collection and Class Collections, Lists, Array List and Iterator, Linked List, Vector. Collections Algorithms: Algorithm sorts, Algorithm shuffle, Algorithms reverse, fill, copy, max and min Algorithm binary Search, Algorithms add All, Stack Class of Package java. Util, Class Priority Queue and Interface Queue, Maps, Properties Class, Un-modifiable Collections.

UNIT–III
Advance Java Features - Multithreading: Thread States, Priorities and Thread Scheduling, Life Cycle of a Thread, Thread Synchronization, Creating and Executing Threads, Multithreading with GUI, Monitors and Monitor Locks. Networking: Manipulating URLs, Reading a file on a Web Server, Socket programming, Security and the Network, RMI, Networking, Accessing Databases with JDBC: Relational Database, SQL, MySQL, Oracle

UNIT–IV
Advance Java Technologies - Servlets: Overview and Architecture, Setting Up the Apache Tomcat Server, Handling HTTP get Requests, Deploying a web Application, Multitier Applications, Using JDBC from a Servlet, Java Server Pages (JSP): Overview, First JSP Example, Implicit Objects, Scripting, Standard Actions, Directives, Multimedia: Applets and Application: Loading, Displaying and Scaling Images, Animating a Series of Images, Loading and playing Audio clips

UNIT–V
Advance Web/Internet Programming (Overview): J2ME, J2EE, EJB, XML.

References:

1. Deitel & Deitel, "JAVA, How to Program"; PHI, Pearson.
2. E. Balaguruswamy, "Programming In Java"; TMH Publications
3. The Complete Reference: Herbert Schildt, TMH
4. Peter Norton, "Peter Norton Guide To Java Programming", Techmedia.
5. Merlin Hughes, et al; Java Network Programming , Manning Publications/Prentice Hall
6. Cay Horstmann, Big JAVA, Wiely India.

List of Program to be perform (Expandable)
1. Installation of J2SDK
2. Write a program to show Scope of Variables
3. Write a program to show Concept of CLASS in JAVA
4. Write a program to show Type Casting in JAVA
5. Write a program to show How Exception Handling is in JAVA
6. Write a Program to show Inheritance
7. Write a program to show Polymorphism
8. Write a program to show Access Specifiers (Public, Private, Protected) in JAVA
9. Write a program to show use and Advantages of CONTRUCTOR

10. Write a program to show Interfacing between two classes
11. Write a program to Add a Class to a Package
12. Write a program to show Life Cycle of a Thread
13. Write a program to demonstrate AWT.
14. Write a program to Hide a Class
15. Write a Program to show Data Base Connectivity Using JAVA
16. Write a Program to show "HELLO JAVA " in Explorer using Applet
17. Write a Program to show Connectivity using JDBC
18. Write a program to demonstrate multithreading using Java.
19. Write a program to demonstrate applet life cycle.
20. Write a program to demonstrate concept of servlet.

CM-307 Self Study (Internal Assessment)

Objective of Self Study: is to induce the student to explore and read technical aspects of his area of interest / hobby or new topics suggested by faculty.
Evaluation will be done by assigned faculty based on report/seminar presentation and viva.

CM-308 Seminar / Group Discussion(Internal Assessment)

Objective of GD and seminar is to improve the MASS COMMUNICATION and CONVINCING/ understanding skills of students and it is to give student an opportunity to exercise their rights to express themselves.
Evaluation will be done by assigned faculty based on group discussion and power point presentation.

Institute Of Engineering, Jiwaji University , Gwalior

B.E. IV Sem . (Chemical Engineering)

Scheme (w.e.f.2018-2022 batch)

Subject wise distribution of marks and corresponding credits

S.NO.	Subject Code	Subject Name & Title	Theory Slot			Practical Slot			Total Marks	Credit alloted Subjectwise			Total Credits
										Period per week			
			End Sem	Mid Sem	Total -1	Sessional	Practical	Total-II	T1+T2	L	T	P	C
1	BE-401	Mathematics-III	80	20	100	–	–	–	100	3	1	0	4
2	CM-402	Material Science and Technology	80	20	100	–	–	–	100	3	1	0	4
3	CM-403	Fuel Technology	80	20	100	50	50	100	200	3	1	2	6
4	CM-404	Fluid ParticleMechanics	80	20	100	50	50	100	200	3	1	2	6
5	CM-405	Fluid Mechanics	80	20	100	50	50	100	200	3	1	2	6
6	CM-406	Computer Aided Process Calculation	–	–	–	50	50	100	100	0	0	2	2
7	CM-407	Self Study (internal Assesment)	–	–	–	50	–	50	50	0	2	0	2
8	CM-408	Seminar/ Group Discussion (internal Assesment)	–	–	–	50	–	50	50	0	2	0	2
		Total	**400**	**100**	**500**	**300**	**200**	**500**	**1000**	**15**	**5**	**12**	**32**

L: Lecture - T: Tutorial - P: Practical

B.E. 401 - ENGINEERING MATHEMATICS- III

Unit I

Functions of complex variables : Analytic functions, Harmonic Conjugate, CauchyRiemann Equations, Line Integral, Cauchy's Theorem, Cauchy's Integral Formula, Singular Points, Poles & Residues, Residue Theorem , Application of Residues theorem for evaluation of real integrals

Unit II

Errors & Approximations, Solution of Algebraic & Trancedental Equations (Regula Falsi , Newton-Raphson, Iterative, Secant Method), Solution of simultaneous linear equatins by Gauss Elimination, Gauss Jordan, Crout's methods , Jacobi's and Gauss-Siedel Iterative methods

Unit III

Difference Operators, Interpolation (Newton Forward & Backward Formulae, Central Interpolation Formulae, Lagrange's and divided difference formulae), Numerical Differentiation and Numerical Integration.

Unit IV

Solution of Ordinary Differential Equations(Taylor's Series, Picard's Method, Modified Euler's Method, Runge-Kutta Method, Milne's Predictor & Corrector method), Correlation and Regression, Curve Fitting (Method of Least Square).

Unit V

Concept of Probability : Probability Mass function, Probability density function. Discrete Distribution: Binomial, Poisson's, Continuous Distribution: Normal Distribution, Exponential Distribution ,Gamma Distribution ,Beta Distribution ,Testing of Hypothesis |:Students t-test, Fisher's z-test, Chi-Square Method

Reference:

(i) Numerical Methods using Matlab by J.H.Mathews and K.D.Fink, P.H.I.

(ii) Numerical Methods for Scientific and Engg. Computation by MKJain, Iyengar and RK Jain, New Age International Publication

(iii) Mathematical Methods by KV Suryanarayan Rao, SCITECH Publuication

(iv) Numerical Methods using Matlab by Yang,Wiley India

(v) Pobability and Statistics by Ravichandran ,Wiley India

(vi) Mathematical Statistics by George R., Springer

CM 402 – Material Science and Technology

Unit I

Mechanical, Thermal & Electrical properties of Materials and their measurement.

Unit II

Atomic Structure, Inter atomic attraction, Molecular structure, crystallanity, Solid solutions, crystal imperfections, Electronic structure and Electromagnetic properties/

Unit III

Single phase metal deformation, Failure of Metals, Theories of alloying, phase relationship, iron-carbon diagram, Nomenclature of steels, utilization of cast iron, mild steel, stainless steel, lead and graphite in Chemical Engg. System.

Unit IV

Theories of Corrosion and corrosion – control, stability of materials in service: Chemical, Thermal and Radiolytic stability.

Unit V

Composite materials; Semiconductors, Superconductors, Surface Modifications using linings of plastics, rubber, glass, ceramics etc.

References:

1. Van Vlack; MATERIAL SCIENCE

2. WOOLEF;

3. Perry RH & Don WG; PERRYS CHEMICAL Engineering HAND BOOK; Mc Graw Hill.

4. Murthy; Structures and properties of Engg Materials; TMH

5. Narula; Material science; TMH 6. Vijaya; Material Science; TMH

7. O.P. Khanna; MATERIAL SCIENCE & METALLURGY; Dhanpat Rai Publication.

8. S.K. Hajra Choudhry; MATERIALS SCIENCE & PROCESSES; Indian Book Distrib Co.

CM 403 – Fuel Technology

Unit I

Solid Fuels: Coal & lignite reserves in India, Classifications 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 of 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 & catalytic, coaking, reforming, Isomerisations, Crude oil classification, Reserves of Hydrocarbon in INDIA, introduction to Petroleum refining & processing, atmospheric & Vacuum crystallization.

Unit IV

Petroleum product and their utilization, blending of petrol for octane number boosting, Transport fuels: Disel, Petrol, AVL (Aviation Liquid Fuel), Kerosene, fuel & furnace oil, Testing of petroleum product: Flash Point, pore point, Fire point, Octane number, Cetene number, viscosity and viscosity index, API.

Unit V

Gaseous fuels: Natural gas, Synthetic gases, their composition & properties, producer gas, Water gas, Coal Gas, LPG, CNG,Hydrogen as a fuel.

References:

1. Sarkar S; Fuel and Combustion; Orient Long men Ltd.

2. Gupta OP; Fuel and Combustion; Khana Pub

3. Gary ;Refining of Petroleum Techonology

List of Experiments :

1. To carry on proximate analysis of the given coal sample.

2. To determine the calorific value of the coal by Bomb-Calorimeter method.

3. To determine the viscosity of the given oil sample by Redwood Viscometer. No. 1 and No. 2

4. To determine the viscosity of a given oil sample by Saybolt viscometer.

5. To determine viscosity of a given coal tar with the help of tar viscometer.

6. To determine the flash and fire points of the given oil sample by Penskey Martin's apparatus.

. 7. To determine the flash and fire points of the given oil sample by Abel's apparatus.

8. To determine the flash and fire points of the given oil sample by Cleveland apparatus.

9. To determine the carbon residue of the given oil by Conradson method.

10. To determine cloud and pour point of given oil sample (coconut) by cloud and pour point apparatus.

11. To determine the composition of given gas by Orsat apparatus.

CM 404 – Fluid Particle Mechanics

Unit I

Particulate Solid: Properties of particulate solids Evaluation of siza & shape, surface and population of particles, standard screens and screen analysis of solids.

Unit II

Size Reduction: Principles of communication, size reduction; crushing, grinding, pulverizing and ultra fining size reduction equipment, power requirement in communication.

Unit III

Mixing: Mixing of solids, Mixing equipment's, Design & Power requirement of mixers, Mixer effectiveness and mixing index.

Unit IV

Separation Principles of Separation techniques for system involving solids, liquids & gases, classification, sedimentation and filtration, Separation equipments.

Unit V

Transportation and Handling of Solids Selection of 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 VI

Fluidization Particulate & aggregative fluidization, characteristic 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.

References:

1. Perry RH & Don WG; PERRY'S CHEMICAL Engineering HAND BOOK; Mc Graw Hill.
2. Nevers De; Fluid Mechanics for Chemical Engineers; TMH
3. Banchero Badker; Introduction to chemical engg; TMH
4. McCabe S, Harriot ; Unit Operations of Chemical Engg; TMH
5. Narayan CM, Bhattacharya BC; Mechanical operations for chemical eng.; PHI

List of Experiments :

1. To analyses the given sample by differential, cumulative methods using standard screen.

2. Determination of size & surface area of irregular particles using a Measuring gauge.

3. To study Crushing behavior & to determine the Rittinger's & Bond's Constant of the given solid in a Jaw Crusher.

4. To determine the efficiency of a ball mill for grinding a material of known.

5. To determine the power consumption of the Hammer Mill.

6. To determine the specific cake resistance for the given slurry by Leaf Filter.

7. To determine the efficiency of a given cyclone separator.

8. To determine the efficiency of fluidized characteristic bed.

9. To study the Dorr type of thickener.

10. To study the Plate & Frame filter press

CM 405 – Fluid Mechanics

UNIT-1

Review of fluid properties: Engg units of measurement, mass density specific wt. specific volume, specific gravity, surface tension, capillarity viscosity, bulk modulus of elasticity, pressure & vapor pressure, fluid statics: pressure at a point, pressure variation in static fluid absolute & gauge pressure, manometers, dimensional analysis & dynamic similitude dimensional homogeneity, use of Buckingham pi-theorem, calculation of dimension less numbers.

UNIT-2

Kinematics of Flow: Types of flow-ideal & real, steady & unsteady, uniform & nonuniform, one, two and three dimensional flow, path lines, streak-lines, streamlines and stream tubes; continuity equation for one and three dimensional flow, rotational & irrotational flow, circulation, stagnation points, separation of flow, sources & sinks, velocity potential, stream function, flow nets-their utility & method of drawing flow nets.

UNIT-3

Dynamics of Flow: Euler's equation of motion along a streamline and derivation of Bernoulli's equation, application of Bernoulli's equation, energy correction factor, linear momentum equation for steady flow; momentum correction factor. The moment of moment of momentum equation, forces on fixed and moving vanes and other applications. Fluid Measurements: Velocity measurement (Pitot tube, Prandtl tube, current meters etc.) flow measurement (orifices, nozzles, mouth pieces, orifice meter, nozzle meter, venturi-meter, weirs and notches).

UNIT-4

Fluid machinery: Pumps, fans blowers, compressor & vacuum pumps, power & head requirement for pumps.

UNIT-5

Laminar flow: introduction to laminar & turbulent flow, concept of Reynolds number & friction factor; friction factor for rough & smooth pipe loss of head due to friction in pipes & fittings.

References: -

1. McCabe Smith;Unit Operation for Chemical Engg. TMH

2 Modi & Seth; Fluid Mechanics; Standard Book House, Delhi

3. Som and Biswas; Fluid Mechnics and machinery; TMH

4. Cengal; Fluid Mechanics; TMH

5. White ; Fluid Mechanics ; TMH

6. JNIK DAKE; Essential of Engg Hyd; Afrikan Network & Sc Instt. (ANSTI)

7. Douglas; Fluid Mechanics; Pearson

8. R Mohanty; Fluid Mechanics; PHI

9. Gupta; Fluid Mechanics; Pearson.

10 Rajpoot R. K. ;Fluid Mechanics and Hydrolic Machine.

11 Bansal R.K.; Fluid Mechanics and Hydrolic Machine.

List of Experiment:

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. Calibration of Venturimeter

4. Determination of Cc, Cv, Cd of Orifices

5. Calibration of Orifice Meter

6. Calibration of Nozzle meter and Mouth Piece

7. Reynolds experiment for demonstration of stream lines & turbulent flow

8. Determination of metacentric height

9. Determination of Friction Factor of a pipe

10. To study the characteristics of a centrifugal pump.

11. Verification of Impulse momentum principle.

CM 406 – Computer Aided Process Calculations

1. Introduction to Microsoft Excel.
2. Basic Operations
3. Using function
4. Unit conversions of chemical process.
5. Material Balance solution using Excel.
6. Energy Balance Solution Using Excel.

List of Experiments

1. Calculation of multi variable equations.(i.e. gauss elimination method)
2. Problems related to flow measurement
3. Problems related to roults law. and ideal gas equations.
4. Problems related to material balance (i.e stichiometry, crystallization etc)
5. problems related to energy balance

Institute Of Engineering, Jiwaji University , Gwalior

B.E. V Sem . (Chemical Engineering)

Scheme (w.e.f.2018-2022 batch)

Subject wise distribution of marks and corresponding credits

S.NO.	Subject Code	Subject Name & Title	Theory Slot			Practical Slot			Total Marks	Credit alloted Period per week			Total Credits
			End Sem	Mid Sem	Total -1	Sessional	Practical	Total-II	T1+T2	L	T	P	C
1	CM-501	Advance Chemical Engg.Thermodynamics	80	20	100	_	_	_	100	3	1		4
2	CM-502	Inorganic ProcessTechnology	80	20	100	_	_	_	100	3	1		4
3	CM-503	Computational Methods in Chemical Engineering	80	20	100	50	50	100	200	3	1	2	6
4	CM-504	MassTransfer-I	80	20	100	50	50	100	200	3	1	2	6
5	CM-505	Heat Transfer	80	20	100	50	50	100	200	3	1	2	6
6	CM-506	Chemical Process Plant Simulation Lab-I				50	50	100	100	0	0	2	2
7	CM-507	Self Study (internal Assesment)				50	_	50	50	0	2	0	2
8	CM-508	Seminar/ Group Discussion (internal Assesment)				50	_	50	50	0	2	0	2
		Total	**400**	**100**	**500**	**300**	**200**	**500**	**1000**	**15**	**9**	8	32

L: Lecture - T: Tutorial - P: Practical

CM- 501 – Advanced Chemical Engg. Thermodynamics

UNIT-1

Thermodynamic properties of homogeneous mixtures; property relationship for systems of variable compositions, partial molar properties, fugacity & fugacity-coefficient in ideal-solution, concept of fugacity departure

UNIT-2

Change of mixing activity, heat effects in mixing, activity effect in gaseous mixture

UNIT-3

Refrigeration, ideal reversed Carnot cycle, vapour compression refrigeration, component of a vapour compression plant (compressor, condenser, expansion device, evaporator) properties of refrigerant

UNIT-4

Chemical potential & its physical significance, effect of pressure & temperature on heat of reaction, concept of free energy Vant-Hoffs equation, Claussions-Clapeyron equation, GibbsBuem relationship of free energy with equilibrium constant, equilibrium & its applications.

UNIT-5

Elements of statistical thermodynamics, counting the number of microstates for a given macro-state, the most probable macrostate, Boltzman distribution, evaluation of Lagrangian constants alpha , statistical interpretation of work & heat.

References:

1. Smith J.M and Van Ness- Introuction to Chemical Engg Thermodynamics – 6th edition
2. Daubert; chemical engg thermodynamic; TMH
3. Rathakrishnan E; Fundamentals of Engg Thermodynamics; PHI
4. Dodge B.F. Chemcail Engineering –Thermodynamics –McGraw Hill
5. Balzhiser Samules and Eliassen-Chemical Engg- Thermodynaics Prentic Hall
6. Sandler S.I Chemical Engg-Thermodynamics-John Wiley and son
7. Rastogi and Mishra-Chemical Engg Thermodynaics

CM- 503 – Computational Methods in Chemical Engineering

Unit I

Treatment of engineering data – Graphical representation. Empirical equations, 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 figure, Classification of Measurements, Propagation of Errors, Variation and Distribution of Random Errors, Properties of Variance, Confidence limits for small samples.

Unit III

Ordinary Differential Equations – Formulation, Application of Law of Conservation of Mass– Mixing in flow process. Classification of ordinary Differential Equations and its applications to common Chemical Engineering problem

Unit IV

Numerical Solutions of Ordinary Different Equations– Linear Second– order Equations with variable coefficients, Numerical solution by Runge Kutta Method. Its application to higher– order equations

Unit V

Formulation of partial Different Equations. Finite difference, linear finite difference equations, non-linear difference equations, Optimization, types of methods, its application relating to chemical processes.

References:

1. Mickley HS, Sherwood and Reed; Applied Mathematics In Chemical Engineering;TMH pub.

2. Jenson & Jeffrey's; Mathematical Methods In Chemical Engineering; Mc Graw Hill

3. Luyben WL; Process modeling, simulation and control for chemical engr; Mc Graw Hill

List of Experiment (Pl. expand it):

1. Data representation and treatment by Graphical methods, Pressure- Volume-Temperature and concentration relationships for gases and their mixtures.

2. Integrated methods of data processing. Integral functions and their graphical representation.

3. Estimation of properties from empirical correlations (Nokay)

4. Estimation of critical properties from group contribution method.

5. Redlich-Kwong equation of state and other Virial equations to estimate thermodynamic properties like compressibility factor, molar volume and P-V-T relationships.

6. To study the effect of liquid viscosity and dissolved gases on pump efficiency, reciprocating pump performance.

7. Measurement errors their propagation and minimization of random errors. Selection of confidence limits.

8. Mass balance problems using continuity equation applied to a dynamic system. Formation of differential equations (component balance) and their solution & examples – CSTR and flow through pipes.

9. Numerical Solutions of batch reactor problems. Euler Algorithm

10. Runge-Kutta algorithm and its application in chemical Engineering. Implicit and explicit calculations. Problems related to effect design, optimum liquid concentration.

11. Transient flow of fluid unsteady temperature and varying concentration problems and use of partial differential equation to solve them. Note: Each student should perform at least eight experiments from the above list.

CM- 504 – Mass Transfer-I

Unit I

Fundamentals of Mass Transfer Individual and film coefficients, overall mass transfer coefficient and their inter relationships; Analogies in transfer processes, determination of mass transfer co-efficient; two phase flow in packed beds, co-current and counter current processes flooding loading, column internals: types of trays/ plates and packing, point and plate efficiency.

Unit II

Diffusion phenomenon: Molecular and eddy diffusion in gases, liquids and solids, interface mass transfer, Mass transfer theories: film theory Penetration theory and surface renewal theory

Unit III

Distillation Vapour liquid Equillibria, Boiling point diagram, Relative volatility, flash and differential distillation for two component mixture, steam distillation, azeotropic distillation, extractive distillation.

Unit IV

Continuous and Differential contact Distillation Rectification, reflux ratio, calculation of numbers of plates by NTU, optimum reflux ratio, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram, Panchon-Savarit method for calculation of number of theoretical plates. Approximate equation; Fensky and undeinrood equation for minimum numbers of plate calculation. Polarison Gilliland method for actual numbers of plate calculation, Batch distillation.

Unit V.

Absorption: Absorption and Extraction in continuous contact columns, co-current, counter current and cross current contacting fluids, calculations of NTU and HTU, concept of HETP

References:

1. Mc-Cabe W.L, Smith J.M.; Unit Operation In Chemical Engineering; Tat Mc-GrawHill.

2. Coulson J. M. Richardson; Chemical Engineering – Vol 2; Butserworth Heinmann, Oxford, Delhi

3. Treybal R.E; Mass Transfer Operatio; Mc. Graw Hill.

4. Sherwood, T.K. Pigford R.L. and Wilke, C.R.; Mass Transfer; Mc. Graw Hill.

List of Experiment (Pl. expand it):

1. To study the flooding and loading of packed columns using different types of packing.

2. To study different types of plates and packing.

3. To prepare the vapor-liquid equilibrium and Boiling point diagram for a binary liquid mixture.

4. Determination of relative volatility of a given system of acetic acid water.

5. To verify Rayleigh equation for differential distillation of binary system.

6. To carry out the steam distillation.

7. To study batch distillation.

8. To study continuous distillation.

9. Studies on packed tower distillation unit.

10. Studies on the sieve plate distillation unit.

11. Studies on bubble cap distillation column.

12. To study the absorption of a gas in a packed column and calculation of NTU and HTU. Note: Each student should perform at least eight experiments out of the above list.

CM- 505 – Heat Transfer

Unit I

Conduction: 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, cylinder and sphere.

Unit II

Convective heat transfer, heat transfer in boundary layer and in films, 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, methods 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 & pool boiling, effect of surface condition on condensation, correlation for heat transfer under condensation. Evaporation- Type 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 head vapour recompression.

Unit V

Heat Exchange equipment: Introduction to general design of double pipe ,shell and tube exchangers, condensers, extended surface equipments, heat exchanger equation – coil to fluid, jacket to fluid.

References:

1. Donald Q. Kern; Process Heat Transfer; Tata McGraw Hill.

2. Alan J. Chapman; Heat Transfer; Collier McMillan.

3. Rao Y.V.C; Heat Transfer; PHI

List of Experiment (Pl. expand it):

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 force convection.

4. To determine heat transfer coefficient in Natural convection.

5. To determine heat transfer coefficient with the help of Stefan Boltzmann Apparatus.

6. To calculate emissivity of the test plate by emissivity measurement apparatus.

7. To determine heat transfer coefficient in double pipe heat exchanger.

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 parallel and counter 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 vapour and to determine the heat transfer coefficient.

12. Demonstrate the film-wise drop-wise condensation and determination of he 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.

CM- 506 – Chemical Process Plant Simulation Lab -I

Simulation Study of Various chemical Process with the help of following Softwares : MATLAB , Chemcad , Pro – Simulator .

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Institute Of Engineering, Jiwaji University , Gwalior

B.E. VI Sem . (Chemical Engineering)

Scheme (w.e.f.2018-2022 batch)

Subject wise distribution of marks and corresponding credits

S.NO.	Subject Code	Subject Name & Title	Theory Slot			Practical Slot			Total Marks	Credit alloted Period per week			Total Credits
			End Sem	Mid Sem	Total -1	Sessional	Practical	Total-II	T1+T2	L	T	P	C
1	CM-601	Process Equipment Design I	80	20	100	–	–	–	100	3	1		4
2	CM-602	Organic Process Technology	80	20	100	–	–	–	100	3	1		4
3	CM-603	Mass Transfer - II	80	20	100	50	50	100	200	3	1	2	6
4	CM-604	Chemical process Control	80	20	100	50	50	100	200	3	1	2	6
5	CM-605	Chemical Reaction Engineering-I	80	20	100	50	50	100	200	3	1	2	6
6	CM-606	Chemical Process Plant Simulation - II	–	–	–	50	50	100	100	0	0	2	2
7	CM-607	Self Study (internal Assesment)	–	–	–	50	–	50	50	0	2	0	2
8	CM-608	Seminar/ Group Discussion (internal Assesment)	–	–	–	50	–	50	50	0	2	0	2
		Total	**400**	**100**	**500**	**300**	**200**	**500**	**1000**	**15**	**9**	**8**	**32**

L: Lecture - T: Tutorial - P: Practical

CM- 601 – Process Equipment Design - I

Unit I

Mechanics of materials: Stress- Strain relationships of elastic materials subjected to tensile, compressive and shear forces, Elastic and plastic deformation, General design considerations; Design of shell, bottom plates, self supported, and column supported roofs, wind girder, nozzles and other accessories.

Unit II

Unfired pressure vessel: Pressure vessel codes, classification of pressure vessels, Design of cylindrical and spherical shells under internal and external pressures; Selection and design of flat plate, tor-spherical, ellipsoidal, and conical closures, compensations of openings. High pressure Vessels: Stress analysis of thick walled cylindrical shell, Design of monobloc and multiplayer vessels.

Unit III

Tall vertical & horizontal vessels: Pressure, dead weight, wind, earthquake and eccentric loads and induced stresses; combined stresses, Shell design of skirt supported vessels. Vessel supports; Design of skirt, lug, and saddle supports.

Unit IV

Bolted Flanges: Types of Flanges, and selection, Gaskets, Design of non- standard flanges, specifications of standard flanges. Fabrication of Equipment; major fabrication steps; welding, non-destructive tests of welded joints, inspection and testing, vessel lining, materials used in fabrication of some selected chemical industries.

References:

1. Brownell, N.E and Young, H.E; Process Equipment Design; John Wiley

2. Bhattacharya, B.C; Introduction Of Chemical Equipment Design; CBS Publishers, Delhi.

3. Perry RH; Hand book of Chemical Engrs; Mc Graw Hill Pub

4. I.S.: 2825-1969 – Code For Unfired Pressure Vessels.

5. I.S. 803-1962, Code For Practice For Design, Fabrication And Erection Of Vertical And Mild Steel Cylindrical Welded Oil Storage Tanks.

6. Joshi, M.V.; Process Equipment Design.

7. Ludwig EE; Applied Process Design In Chemical And Petrochemical Plants;

CM- 602 – Organic Process Technology

Unit I

Soaps and detergents: Pulp and paper, pulping process, chemical recovery, stock preparation and paper making,

Unit II

Agro based alcohol industries, production of cane sugar, molasses, formation of alcohol, alcohol derivatives like acetic acid, acetic anhydride, vinyl acetate and ethylene glycol.

Unit III

Intermediates for petrochemical from petroleum based stocks, phenol, methanol, ethylene, propylene, aromatic benzene, toluene, xylene, acrylo-nitrite, styrene and butadiene.

Unit IV

Dyes and Dye intermediates, insecticides and pesticides, nitration and nitrating agents.

Unit V

Man-made fibers; rayon, polyester, polyamides, acrylics, cellulose and acetate,

References:

1. Gupta VB & Kathari VK; Manufacturing Fibre Technology; Chapman Hall, Newyork I Edition

2. Kathari V.K.; Progress In Textile, Sciences Technology, Vol I & II; IAFL Publications, S-351 Greater Kailash part I New Delhi – 48 I Ed.

3. Austin, G.T; Shreeves Chemical Progress Industries; . Mc. Graw Hill New York

4. Dryden C.E; Outlines Of Chemical Technology; Affilicted. East West press, New Delhi, 1997

List of Experiment (Pl. expand it):

1. To determine BOD and COD of given 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 percentage of formaldehyde in the formalene.

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 finding 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.

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

CM- 603 – Mass Transfer - II

Unit I

Adsorption: Adsorption theories, types of adsorbent; activated carbon, silica and molecular sieves. Batch and column, adsorption; Break through curves, Liquid percolation and gas adsorption, BDST models for adsorption, calculation.

Unit II

Humidification and Dehumidification: Humidification : General Theory, psychometric chart, fundamental concepts in humidification & dehumidification, wet bulb temperature, adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling towers and related equipments.

Unit III

Drying: Equilibrium mechanism theory of drying, drying rate curve. Batch and continuous drying for tray driers, Drum dryers, spray and tunnel dryers.

Unit IV

Leaching and Crystallization: Leaching: solid liquid equilibrium, Equipment, principles of leaching, concurrent and counter current systems and calculation of number of stage required. Crystallization: Factors governing nucleation and crystal growth rates, controlled – growth of crystals, super saturation curve, principle and design of batch and continuous type equipment.

Unit V

Liquid –Liquid extraction: Liquid equilibrium & Ponchon – Savarit method, Mc-CabeThiele method, packed & spray column, conjugate curve and tie line data, plait point, ternary liquid – liquid extraction, operation and design of extraction towers analytical & graphical solution of single and multistage operation in extraction, Co-current, counter current and parallel current system.

References:

Mc-Cabe, W.L. Smith J.M. – UNIT OPERATION IN CHEMICAL ENGG. – 5th edition Tata McGraw Hill – Hogakusha, Tokyo, New Delhi. Coulson J.M. Richardson J.F. - CHEMICAL ENGG. – Vol – 2 Edition-2, Butserworth Heinmann, Oxford, New Delhi. Treybal R.E. – MASS TRANSFER OPERATION – 3rd edition, Mc. Graw Hill Book Co. New York.

List of Experiment (Pl. expand it):

To determine to diffusion coefficient of liquid vapour in air by Stefan's tube.

To study the rate dissolution of a rotating cylinder and then to calculate the mass transfer coefficient.

To investigate the mass transfer characteristic of a wetted surface column unit.

To investigate the characteristics of cooling tower.

To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.

To prepare the drying rate curve for fluidized bed dryer.

To study the characteristics of spray dryer.

To study the characteristics of drum and Tunnel dryer. Studies on solid-liquid extraction column.

To find out the crystal yields with and without seeds.

To draw the tie lines and plot equilibrium curve for given ternary system.

Liquid- Liquid extraction in a packed column for co-current and counter current flow of binary systems.
Note: Each student should perform at least eight experiments from the above list.

CM- 604 – Chemical Process Control

Unit I

Construction and characteristics of final control elements such as Proportional, Integral, PD, PID controllers, pneumatic control valve, principles and construction of pneumatic and electronic controllers.

Unit II

Process instrumentation diagrams and symbols, process instrumentation for process equipments such as Distillation column Absorption column, Heat Exchanger, Reactors, Evaporators, fluid storage vessels.

Unit III

Laplace Transform, Linear open loop system, first order system and their transient response. Dynamic response of a pure capacitive process, Transportation lag, Dynamic response of a first order lag system.

Unit IV

Second order system and their transient response. Interacting and non-interacting system. Linear closed loop system, 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 phase margins, Ziegler Nichols controller setting.

References:

1. Coughnower & Koppel – Process System Analysis And Control- McGraw Hill, New York.

2. D. P. Eckman – Automatics Process Control – McGraw Hill, New York.

3. Peter Harriot – Process Control – McGraw Hill, New York.

4. J. J. Nagrath & M. Gopal; Control System Engineering.

List of Experiment (Pl. expand it):

1. To study the characteristics of control valves (linear, quick opening, etc)
2. To study the dynamics of liquid level systems of non-interacting and interacting types.
3. To study the response of mercury in glass thermometer with and without a thermowell.
4. To study the characteristics of an electronic PID controller.
5. To study the characteristics of a current to pneumatic converter.
6. To study the effectiveness of computer control of a distillation column.
7. To study the effectiveness of a computer control of a heat exchanger.
8. To study to effectiveness of a computer control of a chemical reactor
9. To study to dynamics of a pressure tanks.
10. To calibrate an air purged liquid level indicator.

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

List of Experiment (Pl. expand it):

1. To determine velocity rate constant of the hydrolysis of ethyl acetate by sodium hydroxide.

2. To study the rate constant of hydrolysis of an ester-catalyzed by acid.

3. Determine the rate constant and order of reaction between Potassium per sulphate and Potassium iodide.

4. To study temperature dependency of rate constant, evaluation of activation energy and verification of Arrhenius law.

5. To study a consecutive reaction system(hydraulic model)

6. To study a parallel reaction system (hydraulic model)

7. To study a homogeneous reaction in a semi-batch reactor under isothermal conditions.

8. Study of non catalytic homogeneous saponification reaction in CSTR.

9. To study a non-catalytic homogeneous reaction in a plug flow reactor.

10. To study the residence time distribution behavior of a back mix reactor.

11. To study the RTD behavior of a tubular reactor.

12. To study the RTD behavior of a packed bed reactor.

13. To study the behavior of a continuous flow reactor system-three reactor in series.

14. To study the kinetics of thermal decomposition of calcium carbonate.

15. To study a homogeneous catalytic reaction in a batch reactor under adiabatic conditions.

16. Study of non catalytic saponification reaction in a tubular flow reactor.

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CM- 606 – Chemical Process Plant Simulation - II

Chemical Process Plant Simulation-II 1. Introduction to Polymath software Understanding its function & working 2. CHEM CAD Understanding its functions & working

Institute Of Engineering, Jiwaji University , Gwalior
B.E. VII Sem . (Chemical Engineering)
Scheme (w.e.f.2018-2022 batch)
Subject wise distribution of marks and corresponding credits

S.NO.	Subject Code	Subject Name & Title	Theory Slot			Practical Slot			Total Marks	Credit alloted Period per week			Total Credits
			End Sem	Mid Sem	Total -1	Sessional	Practical	Total-II	T1+T2	L	T	P	C
1	CM-701	Elective-I	80	20	100	–	–		100	3	1		4
2	CM-702	Elective-II	80	20	100	–	–		100	3	1		4
3	CM-703	Process Equipment Design-II	80	20	100	50	50	100	200	3	1	2	6
4	CM-704	Chemical Reaction Engineering-II	80	20	100	50	50	100	200	3	1	2	6
5	CM-705	Environmental Engineering	80	20	100	50	50	100	200	3	1	2	6
6	CM-706	Minor Project	–	–	–	50	50	100	100	0	2	2	2
7	CM-707	Industrial Training (2 Week)& Seminar	–	–	–	50	50	100	100	0	0	2	2
		Total	**400**	**100**	**500**	**250**	**250**	500	1000	**15**	**7**	**10**	**32**

Elective - I

CM-701 (A)Petroleum Processing Tech.
CM-702 (B)Safety Engg.and Hazard Management
CM-703 (C)Pharmaceutical Technology

Elective - II

CM-702 (A) Transport Phenomena
CM-702 (B) Polymer Technology
CM-703 (C) Novel Separation Method

CM- 701 Elective –I (CM -701 (B) – Safety Engg and Hazard Management)

Unit I

Origin of process hazards, Laws Codes, Standards, Case Histories, Properties of Chemical, 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 and explosion hazards, causes of 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, purifying, and sprinkling, safety and relief valves.

Unit IV

Other Energy Hazards: Electrical hazards, noise hazards, radiation hazard in process operations, hazards communication to employees, plant management and maintenance to reduce energy hazards.

Unit V

Risk Analysis: Component and plant reliability, event probability and failure, plant reliability, risk analysis, HAZOP and HAZON, event and consequence analysis (vapor cloud modeling) Designing for safety, measurement and calculation of risk analysis.

Unit VI

Hazard Assessment: Failure distribution, failure data analysis, modeling for safety, safety training, emergency planning and disaster management, case studies.

References:

1. Crawl DA and Louvar J. A.; Chemical process safety fundamentals with applications- PHI

2. Wentz, Charles A; Safety, health and environmental protection - Tata McGraw Hill

3. Smith B.D.; Design of equilibrium state process ; Mc Graw Hill,

4. Van Winkle - Distillation - Mc Graw Hill, Book Co.

CM- 701 Elective –I (CM -701 (C) – Pharmaceutical Technology)

Unit I

Practice of the following unit operation in pharmaceutical industries: Heat transfer, evaporation, distillation, drying, mixing, size reduction, crystallization, filtration, size separation, conveying, humidification, air conditioning and refrigeration.

Unit II

Formulation, development of sterile dosage forms. Production facilities, environmental control and personnel in the production of sterile dosage form, compounding, processing, filtration, sealing, sterilization, packing and labeling of sterile dosage forms. Quality control tests like sterility, pyrogen, clarify, safety and leakage testing.

Unit III

Types of tablets. Manufacturing of tablets by wet granulation, dry granulation and direct compression. Tablet processing problems and defects, tablet standardization: hardness, friability, weights variation, disintegration, dissolution and content uniformity tests.

Unit IV

Capsules: Hard gelatin capsule, capsule size, formulation and preparation of filled hard gelatin capsules, soft gelatin capsule, soft gel - manufacturing procedures; quality control of capsules.

Unit V

Cosmetics and Toiletries: Introduction, factors to be considered in the formulation of facial cosmetics, dentifrices, deodorant, antiperspirants, shampoos, hairdressing and hair removers.

Unit VI

Pharmaceutical packing: packing components, types of packing containers and closures, materials used for and their pharmaceutical specification, method of evaluation, stability aspects of packaging materials.

References:

1. Leon lachman, Lieberman; Theory & practice of industrial pharmacy; Verghese P, Mumbai

2. Ganderto; Unit process in pharmacy.

3. HersheyD; Chemical engineering in medicine and biology - Plenum press, new york.

4. Chemical engineering in medicine - chern. Engg. Progrer syrnp series no. C 66, vol 62.

CM- 702 Elective –II (CM -702 (A) – Transport Phenomenon)

Unit-I

Similarity in momentum, heat and mass-transport - Newton's laws of viscosity, Fouriers laws of conduction and Fick's laws of diffusion, Flux-transport property relationships, Estimation of transport properties measurement and correlations, velocity distribution in Laminar flow of falling film. Flow over an inclined plane, a circular tube an annulus and between two parallel plates.

Unit-II

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 –III

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-IV

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.

References:

1. Bird R.B., Stewart W.E. and Lightfoot EW; Transport phenomena; Wiley tappon

2. Brodkey RS and Hershey -Transport phenomena a unified approach; TMH

3. Geancoplis; Transport processes & separation process principles; PHI learning.

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CM- 702 Elective –II (CM -702 (C) – Novel Separation Techniques

Unit I

Limitations of common separation techniques- sedimentation, screening, filtration, evaporation, distillation, absorption, liquid - liquid and solid -liquid extraction.

Unit II

Principles of membrane separation process classification, characterization and preparation of membrane, Analysis and modeling of membrane separation, Membrane modules and application.

Unit III

Reverse Osmosis and ultra filtration, membrane characteristics and applications, Ion selective membranes and their application in electrolysis. Per vaporization and gas separation using membranes, Liquid membrane, Industrial applications.

Unit IV

Foam and bubble separation, principle, classification, foam and surfactants, Separation techniques, Column Separations:

Unit V

Zone melting and Zone refining, electrophoresis, desalting by freezing, centrifugation. Unit VI Parametric pumping, thermal parametric pumping, batch, continuous and semicontinuous pumping, multi component separation, ph-parametric pumping, heatless parametric pumping,

References:

1. Mccabe Wl and smith IC; Unit operation of chemical engineerin; TMH

2. King J.; Separation process; TMH

3. Kaup EC; Design factors in reverse osmosis - chemical engineering

4. Arden TV; Water purification by ion exchange; Butterworth, London.

(48)

CM- 703 – Process Equipment Design-II

Unit I

Scale up criteria and scale up of process equipment. Process design calculations for heat exchanges equipment shell and tube heat exchangers general description, heat transfer coefficients and pressure drop by Kerms & 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 and packed column for distribution hand adsorption including column diameter and height.

Unit IV

Detailed process and mechanical design, Flash drum , Kettle reloerler, condenser, cooling tower rotary drier.

References:

1. Perry, Robert etal; Perrys Chemical Engg. Handbook; TMH

2. Ludwig E; Applied process design in chemical petrochemical plants; Gulf publishing co.

3. Mahajani V V, Umarji SB; Process Eqipment Design; MacMillan Pub.

4. Kern D; Process Heat Transfer; TMH

5. Smith B. D; Design of equilibrium stages. 4. Coulson JM. Richardson JF; Chemical engg. Vol ;. Pergaman process

CM- 704 – Chemical Reaction Engineering –II

Unit-I

Heterogeneous processes: Catalysis and adsorption; Classification of catalysts, Preparation of catalysts, Promoters and Inhibitors, General mechanism of catalytic reactions surface area and pore size distribution Rate equation of fluid solid catalytic reactions, Hougen - Watson & Poinule law models, Procurement and analysis of kinetic data, kinetics of catalyst deactivation.

Unit -II

External transport processes and their effects on heterogeneous reactions yield and selectivity Reaction and diffusion in porous catalysts, Isothermal and non-isothermal effectiveness factors, Effect of intra-phase transport on yield, selectivity & poisoning, Global reaction rate.

Unit -III

Design of catalytic reactors, Isothermal & adiabatic fixed bad reactor staged adiabatic reactors, Non isothermal, non adiabatic fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle bed reactors.

Unit-IV

Models for fluid - solid non-catalytic reactions, controlling mechanisms, Diffusion through gas film controls. Diffusion through ash layer controls, Chemical reaction controls, fluidized bed reactors with and without elutriation.

Unit – V

Gas-liquid reactions and liquid-liquid reaction, Rate equation based on film theory, Reaction design for instantaneous reactions and slow reactions, Aerobic Fermentation, Application to Design Tools for Fast Reactions.

References:

1. Smiili J.M; Chemical engg. Kinetics; TMH
2. Denbig K.G & Turner KG; Chemical theory - an introduction to reactors; United press
3. Cooper G. & Jeffery JVJ; Chemical kinetics and reactor engg.; PHI
4. Rajaram J, Kuriacose JC; Kinetics and mech. of Chemical Transformations; MacMillan
5. Levenspiel O; Chemical reaction engg; Wiley Eastern Singapore.
6. Hougen, watson & Ragatz; Chemical process principles part 3
7. Fogler, HS; Elements of chemical reaction engg.; PHI

CM- 705 – Environmental Engineering

Unit I

Environmental Management: Nature of environment, major component of life support system industrial development and environmental degradation, environmental impact assessment, national environmental policies, environmental guidelines for process industries, environmental pollution control through planned industrial development; environmental pollution and its effect on human beings, animal and vegetation system.

Unit – II

Air Pollution: Sources and effect of air pollution, classification of air pollutants, emission standard of air pollution. Meteorological condition influencing air pollution, Chemical inversion, principle, working and design of control equipment for particulate emission and gaseous pollutants like cyclone separator, gravity settling chamber, multi-tray settling chamber, bag filter, scrubber, E.S.P.

Unit -III

Water Pollution: Sources and effect of water pollution, water born diseases, classification of water pollutants, physical, chemical and bacteriological analysis of water; pollution laws and limits, effluent standards;, design of waste water and industrial effluent treatment plants (physiochemical and biological), advanced treatment methods, modern trends in sedimentation and filtration.

Unit – IV

Pollution due to Solid Waste and Noise: Nature of domestic, municipal, agricultural, industrial, Hospital, Nuclear Wastes; collection, treatment and disposal of solids waste; waste recovery system, solid waste management; noise pollution, sources, noise measurement and control; noise mitigation measures.

Unit – V

Case study with respect to air, water and solid waste: Fertilizer industry, refinery and petrochemical industries, pulp and paper industries, training industry, sugar and alcohol industries, alkali industries, cement and steel industries.

References:

1. Rao C S; Environmental Pollution Control Engineering; New Age India Ltd.
2. Mahajan S P; Pollution Control in Process Industries
3. Canter Lary; Environmental Impact Assessment; TMG
4. Keily; Environmental Engineering; TMG
5. Miller GT Jr; Environmental sciences-working with earth; Cegage Pub

CM- 706 – Minor Project

Provision of Minor project is made as preparation phase-I for major project or to take it as an independent small project.

CM- 707 – Industrial Training

Industrial Training Objective of Industrial Training The objective of undertaking industrial training is to provide work experience so that student's engineering knowledge is enhanced and employment prospects are improved. The student should take this course as a window to the real World and should try to learn as much as possible from real life experiences by involving and interacting with industry staff. Industrial training also provides an opportunity to students to select an engineering problem and possibly an industry guide for their Major Project in final semester. Scheme of Studies: Duration: Minimum 2 weeks in summer break after VI semester, assessment to be done in VII semester Scheme of Examination: For the assessment of industrial training undertaken by the students, following components are considered with their weightage. (a) Term Work in Industry Marks Allotted Attendance and General Discipline 5 Daily diary Maintenance 5 Initiative and participative attitude during training 10 Assessment of training by Industrial Supervisor 10 - ---------- (b) Practical/Oral Examination (Viva-Voce) in Institution Marks Allotted 1. Training Report 15 2. Seminar and cross questioning (defense) 15 ---------- ---------- Total 30 ---------- ---------- * - Marks of various components in industry should be awarded by the I/c of training in Industry but in special circumstances if not awarded by the industry then faculty in charge /T.P.O. will give the marks. During training students will prepare a first draft of training report in consultation with section in charge. After training they will prepare final draft with the help of T.P.O. /Faculty of the Institute. Then they will present a seminar on their training and they will face viva-voce on training in the Institute. Grading System 2013-14 Learning through Industrial Training During industrial training students must observe following to enrich their learning: • Industrial environment and work culture. • Organizational structure and inter personal communication. • Machines/equipment/instrument-their working and specifications. • Product development procedure and phases. • Project Planning, monitoring and control. • Quality control and assurance. • Maintenance system • Costing system • Stores and purchase systems. • Layout of Computer/EDP/MIS centers. • Roles and responsibilities of different categories of personnel. • Customer services. • Problems related to various areas of work etc. Students are supposed to acquire the knowledge on above by- • Direct Observations without disturbing personnel at work. • Interaction with officials at the workplace in free/ tea time • Study of Literature at the workplace (e.g. User Manual, standards, processes, schedules, etc.) • "Hand's on" experience • Undertaking/assisting project work. • Solving problems at the work place. • Presenting a seminar • Participating in group meeting/discussion. • Gathering primary and secondary data/information through various sources, storage, retrieval and analysis of the gathered data. • Assisting official and managers in their working • Undertaking a short action research work. • Consulting current technical journals and periodicals in the library. • Discussion with peers. Daily Diary- Industrial Training Name of the Trainee---------- College ---------- Industry / work

Institute Of Engineering, Jiwaji University , Gwalior
B.E. VIII Sem . (Chemical Engineering)
Scheme (w.e.f.2018-2022 batch)
Subject wise distribution of marks and corresponding credits

S.NO.	Subject Code	Subject Name & Title	Theory Slot			Practical Slot			Total Marks	Credit alloted Period per week			Total Credits
			End Sem	Mid Sem	Total -1	Sessional	Practical	Total-II	T1+T2	L	T	P	C
1	CM-801	Elective-II	80	20	100				100	3	1		4
2	CM-802	Entrepreneurship Management and Economics	80	20	100				100	3	1		4
3	CM-803	Bioprocess Technology	80	20	100	50	50	100	200	3	1	2	6
4	CM-804	Chemical Process Modeling and Simulation	80	20	100	50	50	100	200	3	1	2	6
5	CM-805	Major Project				100	100	200	200	0	0	8	8
6	CM-806	Computing Technique for Chemical Processes				50	50	100	100	0	0	2	2
7	CM-807	Comprehensive Viva					100	100	100	0	0	2	2
		Total	**320**	**80**	**400**	**250**	**350**	600	1000	**12**	**4**	**16**	**32**

L: Lecture - T: Tutorial - P: Practical

Elective - III

CM-801 (A)Process Piping Design
CM-801 (B)Cryogenic Engineering
CM-801 © Energy Management in Processes

Process Piping Design CM 801(A)

Unit I

Classification of pipes and tubes IS & BS codes for pipes used in chemical process industries and utilities.

Unit II

Pipes for Newtonian and non-Newtonian fluids, sudden expansion and contraction effects, Pipe surface roughness effects, Pipe bends, Shearing characteristics.

Unit III

Pressure drop for flow of Newtonian and non-Newtonian fluids through pipes, resistance to flow and pressure drop, effect of Reynolds and apparent Reynolds number.

Unit IV

Pipes of circular and non-circular cross section-velocity distribution, average velocity and volumetric rate of flow. Flow through curved pipes (Variable cross sections), effect of pipe-fittings on pressure losses.

Unit V

Non-Newtonian fluid flow through process pipes, Shear stress, Shear rates behavior, apparent viscosity and its shear dependence, Power law index, Yield Stress in fluids, Time dependant behavior, Thixotropic and rheopetic behavior, mechanical analogues, velocity pressure relationships for fluids, line.

Unit VI

Pipe line design and power losses in compressible fluid flow, Multiphase flow, gasliquid, solid - fluid, flows in vertical and horizontal pipelines, Lockhart Martinelli relations, Flow pattern regimes.

References:

1. Coulson JM and Richardson J.F; Chemical engineering - Vol I, Butterworth, Oxford;

2. Govier, G.W. and Aziz K; Flow of complex mixtures in pipe; Krieger Pub, Florida

3. Green DW and Malony, Perrys; Chemical engineers Handbook;TMH

Cryogenic Engineering CM 801(B)

Unit I

Introduction to cryogenics and cryogenic systems, thermodynamic principles of cryogenic systems, thermodynamic foundation for cryogenics, analysis of real systems with thermodynamics.

Unit II

Properties of cryogenic fluids: Fluid properties, fluid behavior at cryogenic temperatures, structural properties at low temperature, thermal properties at low temperature, Electrical properties at low temperatures, superconductivity.

Unit III

Production of low temperature, refrigeration and liquefaction, cryogenic refrigeration cycle work, J T cycles and expander cycle and difference, use of cycle analysis on real systems, cryo-coolers operation

Unit IV

Cryogenic Environment : Storage vessels, Dewars - both large and small, compressors, expanders, heat exchanges, selection of transfer lines and values, Insulation principles, separation and purification system, Helium and natural gas systems separation, gas purification, storage and transfer systems.

Unit V

Cryogenic Instrumentation and Measurements, strain, pressure flow and liquid level, measurement of low temperatures, optimization of tank designs, Details of liquefied natural gas, purification of natural gas, storages and insulation of Liquefied Natural Gas, its transportation through pipelines. Unit VI Safety in cryogenic systems, Hydrogen, Oxygen and Nitrogen, Handling of high pressure cylinders, safety in liquid nitrogen and high pressure gas systems, safety in hydrogen and oxygen systems, critical safety for H2 and 02, cleaning of H2 and 02 equipments.

References:

1. R.H. Perry, D.W. Green; Perry's Chemical Engineers Handbook; McGraw Hill.

2. Thomas M, Flynn, Dehher; Cryogenic Engineering; Marcel-Decker, Colorado P, Florida.

3. Mukhopadhyaya; Fundamentals of cryogenic Engg

Energy Management in Processes CM 801(C)

. Unit 1

Energy Management & Audit: Definition, need and types of energy audit, Energy management (audit) approach-understanding energy costs, bench marking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel & energy substitution, Energy audit instruments.

Unit 2

Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques -energy consumption, production, cumulative sum of differences (CUSUM). Global environmental concerns: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon fund (PCF).

Unit 3

Energy Efficiency: Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Insulation and Refractory: Insulation-types and application, economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractory, heat loss.

Unit 4

Waste Heat Recovery: Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential. Energy efficiency in Electrical Utilities: Electrical system, electric motors, HVAC and refrigeration system, fans and blowers, pumps and pumping system, cooling tower, lighting system.

Unit 5

Heat Exchanger Networks

References:

1. Howe & Feinberg; The Energy Source Book; Am Institute of Physics

2. Johnson & Kelly; Renewable Energy Source for Fuel & Electricity

Entrepreneurship Management and Economics CM-802

Unit-I:

System: System and subsystem in process engineering, system analysis, economic degree of freedom, various algorithms, synthesis of processes, flow-sheeting, mathematical representation of steady-state flow-sheet

Unit-II:

Management: Importance, definition and functions; schools of theories, knowledge driven learning organization and e-business; environment, uncertainty and adaptability; corporate culture, difficulties and levels of planning, BCG matrix, SWOT analysis, steps in decision making, structured and unstructured decision; dimensions of organizations, size/specialization, behavior formalization, authority centralization, departmentalization, span and line of control, technology and Minzberg organization typology, line, staff & matrix organization, coordination by task force, business process reengineering and process of change management, HR planning placement and training, MIS; attitudes and personality trait, overlap and differences between leader & manager, leadership grid, motivation, Maslow's need hierarchy and Herzberg two factor theory, expectation theory, learning process, team work and stress management.

Unit-III

Plant Economics: Interaction between design and cost equations for optimal design of equipments, inflation, energy conservation and environmental control, economic design criteria, terms involved in profitability analysis, Gross income, depreciation, net profit.

Unit-IV:

Finance: Nature and scope, forms of business ownerships, balance sheet, profit and loss account, fund flow and cash flow statements, breakeven point (BEP) and financial ratio analysis, pay-back period, NPV and capital budgeting.

Unit V:

Entrepreneurship: Definition and concepts, characteristics, comparison with manager, classification, theories of entrepreneur, socio, economic, cultural and psychological; entrepreneur traits and behavior, roles in economic growth, employment, social stability, export promotion and indigenization, creating a venture, opportunity analysis competitive and technical factors, sources of funds, entrepreneur development program.

References:

1. Peter MS, Timmerhaus KD; Plant design and economics for chemical engr; TMH
2. Schwery HE; Process engg economics; TMH
3. Daft R; The new era of management; Cengage.
4. Bhat Anil, Arya kumar; Management: Principles ,Processes Practices; Oxford H Ed
5. Khan, Jain; Financial Management;
6. Mohanty SK; Fundamental of Entrepreneurship; PHI.
7. Kuratko, Hoolgetts; Entrepreneurship; Theory Process practice; Cengage.

Bio-Process Technology CM 803

Unit I

Introduction to Bio-Chemical Engineering: Aspects of microbiology, cell theory structure of microbial cells, classification of microorganism, Essential chemicals of life lipids, Sugars and Polysaccharides, RNA and DNA, Amino acids and proteins.

Unit II

Metabolism and Energetic: Assimilatory and dissimilatory process, metabolic mechanism of the cells; Biochemical Kinetics: Simple enzyme kinetics with one or two substrates, modulation and regulation of enzymatic activity, enzyme reactions in heterogeneous systems.

Unit III

Growth cycle, phases for Batch cultivation, mathematical modeling of batch growth, products synthesis Kinetics, overall kinetics and thermal death kinetics of cells and spores.

Unit IV

Unit Operations in Biochemical Process: Agitation and aeration, gas liquid mass transfer, determination of oxygen transfer rates, determination of Kga and KLa scaling of mass transfer equipment, heat balance and heat transfer correlation for biochemical systems, sterilization, filtration and drying.

Unit V

Design and Analysis of Bio-Reactors: Classification and characterization of different bioreactors, batch and continuous reactors, tubular, CSTR and tower reactors, aerobic and anaerobic fermentation-process, design and operation of typical aerobic and anaerobic fermentation processes, manufacture of microbial products e.g. antibiotics alcohol/ wine etc; use of immobilized enzyme and whole cells for industrial processes.

References:

1. Baily, J .E. and Ollis D.F; Biochemical Engineering Fundamentals; Mc. Graw Hill

2. Coulson and Richardson; Chemical Engineers;

3. Shuler, Kargi; Bioprocess Engineering basic concepts.; PHI Learning

4. Rao ; Introduction to Biochemical Engineering;

List of Experiments(Please Expand It) Bio-Process Technology CM 803:

1. To carry out the isolation and identification of microorganism from a soil sample.
2. To examine & study effectiveness of various techniques for preserving microorganism
3. To study the kinetics of ethanol fermentation.
4. To determine the kinetic constants l.1max and Km for the growth of microorganisms.
5. To identify bacterial species using Gram staining tests.
6. To determine the biochemical oxygen demand of the given wastewater sample.
7. To determine the chemical oxygen demand of the given wastewater sample.
8. To study BOD kinetics of given wastewater sample and to determine the kinetic constant.
9. To determine the dissolved oxygen content of the given sample by Winkler method.
10. To determine the reducing sugar in the given fermentation medium.
11. To determine the protein in the given fermentation medium.
12. To determine the total sugar content in the given fermentation medium.
13. To study the kinetics of methane fermentation.
14. To study the kinetics of an enzyme catalyzed reaction.
15. To study the activity of enzymes in free and immobilized States.
16. To study the activity of whole cell enzymes in free and immobilized States.

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

Process Modeling & Simulation CM 804.

Unit I

The role of analysis: chemical engineering problems, basic concepts of analysis; the analysis process, 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 Liquid Systems: Introduction, equation of continuity, simple mass balance, application of the model equations, component mass balances, model behavior: steady state behavior, un-steady state behavior, density assumption, numerical integration methods of ordinary differential equation; Reacting Liquid Systems: Introduction, basic model equations for a tank-type reactor, reaction rate, batch reactor, pseudo first-order reactions, reversible reactions, multiple reactions; consecutive reactions, parallel reactions, complex reactions, constant density assumption, order and stochiometry.

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 iterative convergence methods such as NewtonRalphson, false position, Wegstein, Muller methods.

References:

1. Russell TWF; Introduction to Chemical Engineering Analysis - John Wiley & Sons

2. Luyben W.L; Process Modeling, Simulation And Control For Chemical Engineers; TMH

3. Jana ; Chemical process modeling and computer simulation; PHI Learning

List of Experiments (Please Expand It) Process Modeling & Simulation CM 804:

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 151 and 2nd order rate kinetics.

5. Counter current double pipe heat exchanger modeling-data analysis by iterative methods.

6. Simulation of a distillation column-binary systems, equi-molal 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 study state heat transfer. Note: Each student should perform at least six experiments out of the above list.