1.1.2

List of Employability/ Entrepreneurship/ Skill Development Courses with Course Contents

Colour Codes		
Employability Contents	**Green**	
Entrepreneurship Contents	**Light Blue**	
Skill Development Contents	**Pink**	
Name of the Subjects/Related to all three Components (Employability/ Entrepreneurship/ Skill Development)	**Yellow**	

List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : *Chemical Engineering*

Programme Name : *B.Tech.*

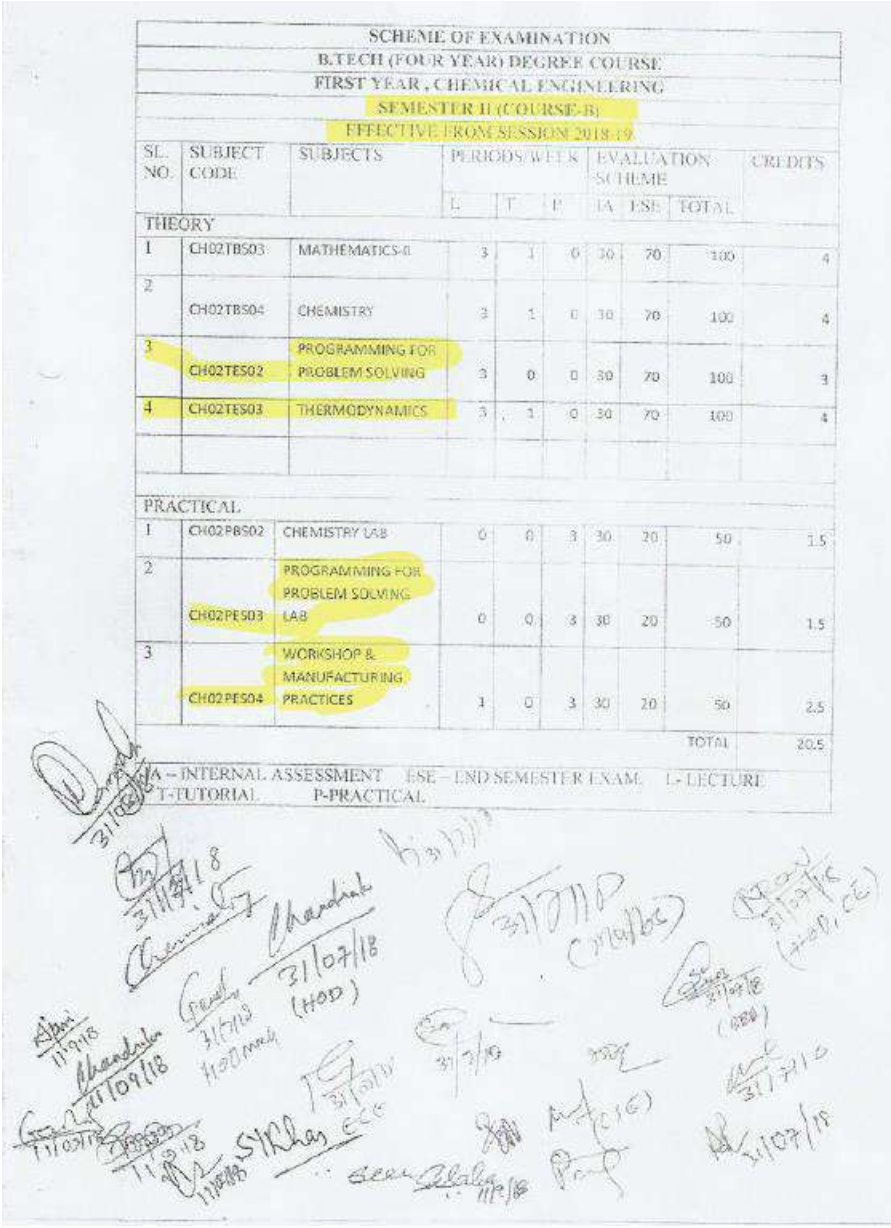
Academic Year : 2019-20

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	CH02TES03	Thermodynamics
02.	CH02PES04	Workshop and Manufacturing Practice
03.	CH02TES03	Programming For Problem Solving
04.	CH02PES03	Programming For Problem Solving Lab
05.	CH03TPC02	Fluid Mechanics
06.	CH03PPC02	Fluid Mechanics Lab
07.	CH03TPC01	Material And Energy Balance Calculations
08.	CH04TPC04	Numerical Methods In Chemical Engineering
09.	CH04PPC03	Numerical Methods In Chemical Engineering Lab
10.	CH04TPC05	Inorganic Chemical Technology
11.	CH04TPC06	Particle And Fluid Particle Processing
12.	CH04PPC04	Particle And Fluid Particle Processing
13.	CH04TPC07	Process Instrumentation
14.	CH04PPC05	Process Instrumentation Lab
15.	CH04THS02	Business Communication And Presentation Skill
16.	CH5TPC06	Heat Transfer
17.	CH5PPC03	Heat Transfer Lab
18.	CH5TPC07	Mass Transfer-I
19.	CH5PPC04	Mass Transfer-I Lab
20.	CH5TPC08	Chemical Reaction Engineering-I
21.	CH6TPC10	Process Dynamics And Control
22.	CH6PPC07	Process Dynamics & Control Lab
23.	CH5PPC05	Chemical Reaction Engineering Lab
24.	CH5TPE13	Food Engineering
25.	CH6TPE31	Fertilizer Technology
26.	CH6TPC09	Mass Transfer-II

27.	CH6TPE31	Fuel Combustion & Energy Technology
28.	CH6TPE21	Process Equipment Design-I
29.	CH6TPC11	Organic Chemical Technology
30.	CH6PPC07	Mass Transfer-II Lab
31.	CH7TPC13	Process Equipment Design-II
32.	CH7TPC14	Chemical Reaction Engineering-II
33.	CH7TPC15	New Separation Processes
34.	CH7PPC08	Minor Project
35.	CH7PPC09	Vocational Training Viva Cum Seminar
36.	CH8TPC16	Process Equipment Design-II
37.	CH8TPC17	Project Engineering, Economics And Management
38.	CH8PPC10	Project
39.	CH7TPE41	Petroleum Refinery Engineering
40.	CH8TPE51	Petrochemical Technology
41.	CH8TPE53	Membrane Separations Processes
42.	CH7TOE32	Water Conservation And Management
43.	CH8TOE41	Optimization Techniques
44.	CH8TOE42	Process Modeling And Simulation
45.	CHPG1101	Advanced Heat Transfer
46.	CHPG1102	Chemical Reactor Design
47.	CHPG1103	Fluidization Engineering
48.	CHPG1105	Membrane Separation Processes
49.	CHPG1106	Chemical Engineering Computational Lab
50.	CHPG1201	Advanced Fluid Mechanics
51.	CHPG1202	Advanced Mass Transfer
52.	CHPG1203	Industrial Pollution Control Technologies
53.	CHPG1204	Design And Development Of Catalyst
54.	CHPG1206	Project
55.	CHPG1207	Seminar

Scheme and Syllabus



SCHEME OF EXAMINATION
B.TECH (FOUR YEAR) DEGREE COURSE
FIRST YEAR , CHEMICAL ENGINEERING
SEMESTER II (COURSE-B)
EFFECTIVE FROM SESSION 2018-19

SL. NO.	SUBJECT CODE	SUBJECTS	PERIODS/WEEK			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	TOTAL	
THEORY									
1	CH02TBS03	MATHEMATICS-II	3	1	0	30	70	100	4
2	CH02TBS04	CHEMISTRY	3	1	0	30	70	100	4
3	CH02TES02	PROGRAMMING FOR PROBLEM SOLVING	3	0	0	30	70	100	3
4	CH02TES03	THERMODYNAMICS	3	1	0	30	70	100	4
PRACTICAL									
1	CH02PBS02	CHEMISTRY LAB	0	0	3	30	20	50	1.5
2	CH02PES03	PROGRAMMING FOR PROBLEM SOLVING LAB	0	0	3	30	20	50	1.5
3	CH02PES04	WORKSHOP & MANUFACTURING PRACTICES	1	0	3	30	20	50	2.5
								TOTAL	20.5

IA – INTERNAL ASSESSMENT ESE – END SEMESTER EXAM L-LECTURE
T-TUTORIAL P-PRACTICAL

SUBJECT CODE/	SUBJECT	L	T	P	Credit
CH02TE303/	THERMODYNAMICS	3	1	0	4

Objectives:
Principles and application of first and second law of thermodynamics, and phase equilibria.

Contents :

1. Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat [3L + 1T]
2. Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P,V, T processes; Mass and energy balances for open systems . [6L + 2T]
3. Phases, phase transitions, PVT behavior; description of materials – Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior [6L + 2T]
4. Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion. [3L + 1T]
5. Statements of the second law; Heat engines, Carnot's theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. (6L + 2T)
6. Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties. (6L + 2T)
7. Application of thermodynamics to flow processes-pumps, compressors and turbines

   (3L +1T)
8. Thermodynamic analysis of steam power plants; Rankine cycle; Internal combustion engine, Otto engine; Diesel engine;Jet engine. (6L + 2T)
9. The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes. (6L + 2T)

Suggested Text Books
1.J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill International Edition,2005.
Suggested References Books
1.M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering

Course Outcome: Students will be able to

1. Explain basics of thermodynamics, work and energy
2. Describe phase transition, ideal gas law and Van der Waals law
3. explain first and second laws of thermodynamics and its applications

Subject code/NAME	L	T	P	Credit
CH02TES02/PROGRAMMING FOR PROBLEM SOLVING	3	0	0	3

Unit 1
Introduction to Programming (3 lectures)
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) -
Idea of Algorithm (3 lectures): steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples.
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Unit 2
Arithmetic expressions and precedence (12 lectures)
Conditional Branching and Loops
Writing and evaluation of conditionals and consequent branching
Iteration and loops
Arrays (6 lectures) Arrays (1-D, 2-D), Character arrays and strings

Unit 3
Basic Algorithms (6 lectures)
Searching ,concept of binary search etc , Basic Sorting Algorithms Bubble sort etc.Finding roots of equations, introduction of Algorithm complexity

Unit *4*
Function (5 lectures)
Functions (including using built in libraries), Parameter passing in functions, call by value. Passing arrays to functions; idea of call by reference binary search etc
Recursion functions (5 lectures) Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, etc.

Unit 5
Structure (4 lectures)
Structures, Defining structures and Array of Structures
Pointers (3 lectures) Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Suggested Text Books
(i) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
(ii) E. Balagurusswamy, Programming in ANSI C, Tata McGraw-Hill
Suggested Reference Books
(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Course Outcome:

1. Explain a basic understanding of computer software and hardware

2. Develop skill in writing programs in a technical programming language.

3. Develop problem-solving skills and knowledge of computing fundamentals to a wide variety of engineering and technology problems

SUBJECT CODE/NAME	L	T	P	Credit
CH02PES03/PROGRAMMING FOR PROBLEM SOLVING LAB	0	0	3	1.5

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Course Outcome:

1. Familiarization with programming background

2. Knowledge of c programming

SCHOOL OF STUDIES, ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from session 2019-20)
B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, THIRD SEMESTER

S.No.	Course No.	Subject	Periods			Evaluation Scheme			Credits
			L	T	P	Sessional Exam			
	THEORY					IA	ESE	Total	
01	CH03TBS05	Biology	3	1	0	30	70	100	4
02	CH03TBS06	Mathematics -III	3	1	0	30	70	100	4
03	CH03TES04	Engineering and Solid Mechanics	3	1	0	30	70	100	4
04	CH03TPC01	Material and Energy Balance Calculations	3	1	0	30	70	100	4
05	CH03TPC02	Fluid Mechanics	3	1	0	30	70	100	4
06	CH03TPC03	Thermodynamics –II	3	1	0	30	70	100	4
Practical									
01	CH03PPC01	Chemical Engineering Lab-I	0	0	3	30	20	50	1.5
02	CH03PPC02	Fluid Mechanics Lab	0	0	3	30	20	50	1.5
Total			18	6	6			700	27

IA – Internal Assessment **ESE- End Semester Examination** **Total Marks - 700**
Total Periods - 30 **Total Credits – 27**

BOS held on 13th May 2019

SCHOOL OF STUDIES, ENGINEERING & TECHNOLOGY
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SCHEME FOR EXAMINATION (Effective from session 2019-20)
B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, FOURTH SEMESTER

S.No.	Course No.	Subject	Periods			Evaluation Scheme			Credits
			L	T	P	Sessional Exam			
	THEORY					IA	ESE	Total	
01	CH04THS02	Business Communication and Presentation Skill	3	0	0	30	70	100	3
02	CH04TPC04	Numerical Methods in Chemical Engineering	3	1	0	30	70	100	4
03	CH04TPC05	Inorganic Chemical Technology	3	0	0	30	70	100	3
04	CH04TPC06	Particle and Fluid Particle-Processing	3	0	0	30	70	100	3
05	CH04TPC07	Process Instrumentation	3	0	0	30	70	100	3
Practical									
01	CH04PPC03	Numerical Methods in Chemical Engineering Lab	0	0	3	30	20	50	1.5
02	CH04PPC04	Particle and Fluid Particle-Processing Lab	0	0	3	30	20	50	1.5
03	CH04PPC05	Process Instrumentation Lab	0	0	3	30	20	50	1.5
Total			15	1	9			650	20.5

IA – Internal Assessment **ESE- End Semester Examination** **Total Marks - 650**
Total Periods - 25 **Total Credits – 20.5**
BOS held on 13th May 2019

CH03TPC01 Material and Energy Balance Calculations [L:3, T:1,P:0]

Objectives

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Contents :

1. Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations [3L+1T]
2. Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law. [6L+2T]
3. Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use. [6L+2T]
4. Material Balances with recycle, bypass and purge. [6L+2T]
5. Material Balance: With chemical reaction. Concept of stoichiometry and mole balances, examples, including combustion. [6L+2T]
6. Material Balance: Introduction, solving material balance problems without chemical reaction. [6L+2T]
7. Energy balance: open and closed system, heat capacity, calculation of enthalpy changes. [6L+2T]
8. Energy balances with chemical reaction: Heat of reaction, Heat of combustion. [6L+2T]

Total [45L+15T]

Suggested Text Books

1. S. N. Saha, "Chemical Process Engineering Calculation", Dhanpat Rai Publication Co. (Pvt.) Ltd., New Delhi
2. Bhatt, B. I., Vora, S. M.,"Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.

Suggested References Books

1. Felder, R. M.; Rousseau, R. W.,"Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000
2. Hougen, O. A., Watson, K. M., Ragatz, R. A.,"Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors, 2004
3. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering" , Eighth Ed., Pearson India Education Services, 2015.
4. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa,"Process Calculations" , Second Edit ion, Prentice Hall of India.
5. Sikdar, D. C., "Chemical Process Calculations" , Prentice Hall of India.

Course Outcomes

Students completing the course will

- Develop mastery over process calculations relevant to Chemical Engineering Processes
- Be able to handle elementary flow-sheeting, material and energy balance calculations
- Be able to solve problems based on without and with chemical reactions, and involving concepts like recycle, bypass and purge.
- Be familiar with equations of state and properties of gases and liquids, including phase transition.

B. Tech Syllabus — Department of Chemical Engineering

CH03TPC02 Fluid Mechanics [L:3, T:1,P:0]

Objectives:
The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations. The course will introduce students to forces on fluids, hydrostatic forces on submerged bodies, Eulerian and Lagrangian descriptions of flow, flow visualization, integral analysis involving mass and momentum balances, Bernoulli equation, flow through pipes and ducts, flow measurement and instruments, flow transportation - pumps, blowers and compressors, conservation of mass, linear and angular momentum in differential form, Navier-Stokes equation, viscous flows, skin and form friction, potential flows and boundary layer theory. Turbulence and turbulent flows will be introduced.

Contents :

1. Introduction to fluids, Types of fluids, Concept of viscosity, Forces on fluids, Normal and shear stresses. [3L+1T]
2. Fluid statics –Hydrostatic equilibrium, pressure distribution, Manometry, Forces on submerged bodies, Buoyancy. [3L+1T]
3. Kinematics of fluid flow- Eulerian and Lagrangian descriptions, Flow visualization, Streamfunction, Vorticity and Circulation. [3L+1T]
4. System and control volume approaches, Integral balances – mass and momentum, Euler's equation of motion, Bernoulli equation and applications. [4L+2T]
5. Reynolds number, Laminar Flow for Newtonian and Non Newtonian fluid, Turbulent flow through pipes and close channels and its characteristic equations. [5L+1T]
6. Head loss in pipe flow, Friction losses due to sudden changes in velocity or direction of flow, expansion, contraction, Effect of fittings. [6L+2T]
7. Flow measurement, variable head meters, variable area meter, insertion meter. [3L+1T]
8. Transportation of fluids - pumps, blowers, compressors selection and design of pumps. [3L+1T]
9. Differential analysis: mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag. [6L+2T]
10. Potential flow, Potential function, Solution of Laplace equation. [3L+1T]
11. Boundary layer theory, Blasius solution, Boundary layer separation. [6L+2T]

Total [45L + 15T]

Suggested Text Books

1. M. Whit e, Fluid Mechanics, 8 th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-H ill International Edition 2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.

Course Outcomes

Students should be able to calculate

- Velocity profiles by simplification of equations of motion in simple 1-D flows
- Boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
- Two phase gas/liquid pressure drop
- Power requirements, NPSH requirements of pumps

CH03TPC03 Thermodynamics –II **[L:3, T:1,P:0]**

Pre-requisites: Thermodynamics-I

Objectives:
To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium. Introduction to molecular thermodynamics.

Contents

1. Review of first and second law of thermodynamics. [3L+1T]
2. Solution Thermodynamics: fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties. [12L+4T]
3. Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. [6L+2T]
4. Vapor-liquid equilibrium: phase rule, simple models for VLE;VLE by modified Raoult's law; VLE from K-value correlations; Flash calculations. [6L+2T]
5. Ideal solutions, activity and activity coefficient, Wilson, NRTL, UNIFAC and UNIQUAC models. [6L+2T]
6. Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas equilibria. [6L+2T]
7. Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single react ions, multi reaction equilibria. [6L+2T]

Total [45L+15T]

Suggested Text Books

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition,2005.
2. Y.V.C.Rao, "Chemical Engineering Thermodynamics", University Press, Hyderabad,1997.
3. K V Narayanan, "A Textbook of Chemical Engineering Thermodynamics", Prentice Hall Of India, New Delhi 2011

Suggested References Books

1. R.C. Srivastava, "Thermodynamics an core course", 3rd edition, PHI publication, India, 2007.

Course outcome;
Student would be able to

- Understand and calculate the various thermodynamics potentials.
- Analyse the thermodynamic properties of gases and liquids.
- Estimate the partial molar properties of gases and liquid.
- Application of various equation of state.
- Evaluate the equilibrium constant for chemical reactions.

CH04THS02 Business Communication and Presentation Skill

[L:3, T:0,P:0]

Unit I : Business communication covering, Role of communication in information age; concept and meaning of communication; skills necessary for technical communication; Communications in a technical organization; Barriers to the process of communication.

Unit II: Style and organization in technical communication covering, Listening, speaking, reading and writing as skills; Objectivity, clarity, precision as defining features of technical communication; Various types of business writing: Letters, reports, notes, memos; Language and format of various types of business letters; Language and style of reports; Report writing strategies; Analysis of a sample report

Unit III: Communication and personality development covering, Psychological aspects of communication, cognition as a part of communication; Emotional Intelligence; Politeness and Etiquette in communication; Cultural factors that influence communication; Mannerisms to be avoided in communication; Language and persuasion; Language and conflict resolution.

Unit IV: Language Laboratory emphasizing Listening and comprehension skills; Reading Skills; Sound Structure of English and intonation patterns;

Unit V: Oral Presentation and professional speaking covering, Basics of English pronunciation; Elements of effective presentation; Body Language and use of voice during presentation; Connecting with the audience during presentation; Projecting a positive image while speaking; Planning and preparing a model presentation; Organizing the presentation to suit the audience and context; Basics of public speaking; Preparing for a speech;

Text books:

1. Fred Luthans, Organizational Behaviour,McGraw Hill
2. Lesikar and petit, Report writing for Business
3. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill
4. Wallace and masters, Personal Development for Life and Work, Thomson Learning

Reference books :

1. Farhathullah, T. M. Communication skills for Technical Students
2. Michael Muckian, John Woods, The Business letters Handbook
3. Herta A. Murphy, Effective Business Communication
4. MLA Handbook for Writers of Research Papers

Course Outcomes

Students should be able to

- Communicate properly
- Write technical letters and reports
- Present reports and seminars in a attractive way

CH04TPC04 Numerical Methods in Chemical Engineering

[L:3, T:1,P:0]

UNIT – I Introduction of Errors and their Analysis, types of errors, numerical problems on error analysis, curve fitting: method of *least squares*, fittings of straight line and parabola and by method of moments, fitting of exponential curves $y = ae^{bx}$, fitting of the curve $y = ab^x$, fitting of the curve $y = ax^b$.

UNIT – II Numerical Solution of Algebraic and Transcendental Equations: Graphical method bisection Method, Secant Method, Regula-falsi Method, Newton Raphson Method, Solution of a system of simultaneous linear algebraic Equations Direct method: Gauss elimination Method, Gauss Jordan method, Iterative methods .Jacobi Iterative Method, Gauss Seidel Iterative method.

UNIT – III The Calculus of Finite Differences: Finite differences, Difference formula, operators and relation between operators. Inverse Operator, Interpolation with equal intervals: - Newton's forward and backward interpolation formula. Interpolation with Unequal intervals: - Lagrange's interpolation Newton's difference formula, inverse interpolation.

UNIT –IV Numerical Differentiation and Integration: - Numerical Differentiation Newton's forward and Backward difference interpolation formula. Maxima and Minima of a Tabulated function, Numerical Integration :- Trapezoidol rule , simpson is (1/3)rd and (3/8)th rule, Boole's rule, weddle rule , Difference Equations -: Definition ,order and degree of a difference equation, Linear difference equations, Difference equations reducible to Linear form simultaneous difference equations with constant coefficients.

UNIT – V Numerical solution of ordinary differential equation : Taylor series method, Euler's method, Modified Euler method Runge's method Runge Kutta method, numerical method for solution of partial differential equations. General linear partial differential equation. Laplace equation and Poisson equation.

Books Recommended :

1. JAIN & IYNGAR Numerical Methods for Scientific and Engineering Computations.
2. RAO G.S. Numerical Anlysis.
3. Grewal B S Numerical Methods In Engineering and Science.
4. Das K K Advance Engineering Methods.
5. Rajaraman V Computer Oriented Numerical Methods

Course Outcomes

Students will be able to

- Solve chemical engineering problems involving Linear and non-linear equations
- Solve ordinary and partial differential equations using programming languages like C and softwares like MATLAB.

CH04TPC05 Inorganic Chemical technology [L:3, T:0,P:0]

Unit I : Sulfur and Sulfur Chemicals : Sulfur, Sulfuric acid, SCSA, DCDA processes, Sodium thiosulfate, Alums.
Marine Chemical Industries : Common salt, Chemicals from sea bittern.

Unit II : Industrial Gases and Selected Inorganic Chemicals : Manufacture and use of Hydrogen, Carbon dioxide, Acetylene, Oxygen, Nitrogen and inert gases, Inorganic chemicals: Barium, boron, chromium, lithium, manganese.

Unit III : Fertilizers : Status of industry, Grading and classification of fertilizers, Raw materials, Hydrogen production, Fixation of nitrogen, Synthesis, Ammonia based fertilizers, Phosphoric acid, Phosphatic and other fertilizers: SSP, TSP, UAP, DAP and nitro-phosphate, Potash fertilizers, NPK, Corrosion problems and Materials of construction, Bio-fertilizers.

Unit IV : Soda Ash : Manufacturing, Special materials of construction, Solvay and modified Solvay process, Environmental consideration, Corrosion problems and materials of construction.

Chlor Alkali Industry : Electrochemistry of brine electrolysis, Current efficiency, Energy efficiency, Diaphragm cells, Mercury cells, Mercury pollution and control, Caustic soda, Chlorine, Hydrochloric acid, Corrosion problems and materials of construction .

Unit V : Cement, Glass and Refractory: Manufacturing, Environmental consideration, Corrosion problems, Engineering problems and materials of construction.

Books Recommended:
1. R.N. Shreve & J. A. Brink, "Chemical Process Industries"
2. Chem Tech I, II, III, IV- IIT, Madras
3. Dryden Co. M. G. Rao and M. Sitting, "Outlines of Chemical Technology".

Course Outcomes

Students will be able to

- describe sources and processes of manufacture of various industrially important chemicals
- Draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals
- Explain and calculate economic aspects of Projects involved in manufacturing of chemicals

CH04TPC06 Particle and Fluid Particle-Processing [L:3, T:0,P:0]

Pre-requisites : Fluid Mechanics

Objectives

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Contents :

1. Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. [1L+0T]
2. Solid particle characterization: Particle size, shape and their distribution, Screen analysis, standard screens; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area. [3L+1T]
3. Mixing and storage of Solids: Types of important mixers like kneaders, dispersers, masticaters, roll mills, muller mixer, pug mixer, blender, screw mixer etc., mixing index; Types of storage equipments, Bin, Silo, Hoper, etc. [3L+1T]
4. Transport of fluid-solid systems: mechanical conveying, pneumatic and hydraulic conveying. [2L+1T]
5. Size reduction: Major equipment's- Crushers, grinders, ultrafine grinders, laws of communition, Close circuit and open circuit grinding. [3L+1T]
6. Mechanical separations: Industrial screen; their capacity and effectiveness. [2L+1T]
7. Sedimentation: Elutraition, Classification and sedimentation, Free Settling, hindered settling, flow of solids through fluid, Stoke's law, Richardson-Zaki equation, design of settling tanks. [3L+1T]
8. Centrifugal separation, design of cyclones and hydrocyclones. [2L+1T]
9. Separation of solids from fluids: Introduction, filter bags, venture scrubber, electrostatic precipitator. [2L+1T]
10. Filtration: cake filtration, Concepts, plate and frame filter, leaf filter, rotary drum filter, etc. [3L+1T]
11. Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Applications of fluidization. [3L+1T]
12. Packed bed: Void fraction, superficial velocity, channelling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus. [3L+1T]
13. Introduction to nanoparticles: Properties, characterization, synthesis methods, applications. [3L+1T]

Total [33L+12T]

Suggested Text Books

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., McGraw Hill.
2. Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth-Heinemann, 5th edition 2002.

Suggested References Books

1. Rhodes, M. J., "Introduction to Particle Technology", 2nd edition, John Wiley, Chichester ; New York, 2008.
2. Allen, T., "Powder Sampling and Particle Size Determination", Elsevier, 2003.
3. Masuda, H., Higashitani, K., Yoshida, H., "Powder Technology Handbook", CRC, Taylor and Francis, 2006.
4. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., Wiley, 2013.

Course Outcomes

Students will be able to

- Calculate drag force and terminal settling velocity for single particles
- Calculate pressure drop in fixed and fluidized beds
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage

CH04TPC07 **Process Instrumentation** **[L:3, T:0,P:0]**

Objectives

Objective of the course is to introduce the basics of instrumentation and process control *through a hands-on practical experience. Principles* of operation of different measuring devices for temperature, level, pressure, flow, pH, humidity, density, and viscosity will be introduced to impart knowledge of transmitters, transducers, converters, control valves, digital and analog components related to PLC, DCS, SCADA systems.

Contents :

1.	Basics of control system components, signals and standards	[3L+1T]
2.	Pressure measuring instruments/sensors	[3L+1T]
3.	Level measurement	[3L+1T]
4.	Flow measuring instruments	[3L+1T]
5.	Temperature measuring devices	[3L+1T]
6.	Humidity, density, viscosity and pH measuring devices	[3L+1T]
7.	Pressure controllers: regulators, safety valves	[3L+1T]
8.	Flow control actuators: different types of valves	[3L+1T]
9.	Electrical and pneumatic signal conditioning and transmission	[5L+2T]
10.	Computer process control, PLC, DCS, SCADA	[2L+1T]
11.	Instrumentation of process equipment	[2L+1T]

Total [33L+12T]

Suggested Text Books

1. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, Mc-Graw Hill (2005).
2. S.K. Singh, Industrial Instrumentation and Control, 3rd edition, McGraw-Hill (2008).

Suggested References Books

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A.,"Process Dynamics and Control", 2nd edition, John Wiley (2003).
2. Stephanopoulos, G.,"Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984).

Course Outcomes

Students will be well-familiar with instrumentation and automation as relevant to modern chemical plant operation.

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)
SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
THIRD YEAR, FIFTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
						Sessional			ESE	Sub Total	
	THEORY		L	T	P	IA	MSE	Total			
01.	CH5TPC06	Heat Transfer	3	1	0	20	20	40	60	100	4
02.	CH5TPC07	Mass Transfer-I	3	1	-	20	20	40	60	100	4
03.	CH5TPC08	Chemical Reaction Engineering-I	3	1	-	20	20	40	60	100	4
04.	CH5TPE1X		3	1	-	20	20	40	60	100	4
05.	CH5TOE1X		3	0	-	20	20	40	60	100	3
	PRACTICAL										
01.	CH5PPC03	Heat Transfer Lab	-	-	3	30	-	30	20	50	2
02.	CH5PPC04	Mass Transfer-I Lab	-	-	3	30	-	30	20	50	2
03.	CH5PPC05	Chemical Reaction Engineering Lab	-	-	3	30	-	30	20	50	2
	TOTAL		15	4	9					650	25

IA – Internal Assessment
Total Marks – 650

MSE – Mid Semester Examination
Total Periods - 28

ESE - End Semester Examination
Total Credits - 25

BOS held on 24th May 2017

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
THIRD YEAR, SIXTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
						Sessional			ESE	Sub Total	
	THEORY		L	T	P	IA	MSE	Total			
01.	CH6TPC09	Mass Transfer-II	3	1	-	20	20	40	60	100	4
02.	CH6TPC10	Process Dynamics and Control	3	1	-	20	20	40	60	100	4
03.	CH6TPC11	Organic Chemical Technology	3	-	-	20	20	40	60	100	3
04.	CH6TPE2X		3	1	-	20	20	40	60	100	4
05.	CH6TPE3X		3	1	-	20	20	40	60	100	4
06.	CH6TOE2X		3	0	-	20	20	40	60	100	3
	PRACTICAL										
01.	CH6PPC06		-	-	3	30	-	30	20	50	2
02.	CH6PPC07		-	-	3	30	-	30	20	50	2
	TOTAL		18	4	6					700	26

IA – Internal Assessment
Total Marks – 700

MSE – Mid Semester Examination
Total Periods - 28

ESE - End Semester Examination
Total Credits – 26

BOS held on 24th May 2017

Dr. Chandan Guha
Professor
CHEMICAL ENGINEERING DEPT.
JADAVPUR UNIVERSITY
Kolkata-700 032

DEPARTMENT OF CHEMICAL ENGINEERING
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LIST OF PROFESSIONAL ELECTIVES OFFERD BY THE DEPARTMENT OF CHEMICAL FOR V and VI SEMESTER

Semester	Subject Code (PE)	Subject
V	CH5TPE11	Engineering Material
	CH5TPE12	Fundamentals of Biochemical Engineering
	CH5TPE13	Food Engineering
	CH5TPE14	Polymer Technology
VI	CH6TPE21	Process Equipment Desiga-I
	CH6TPE22	Fertilizer Tcehnology
	CH6TPE31	Fuel Combustion Energy Technology
	CH6TPE32	Environmental Engineering

PE - Professional Elective

B.Tech. V Semester

CH5TPC06: Heat Transfer (3 1 0)

Unit I :Conductive Heat Transfer : Heat transfer by conduction in solid, Fourier's Law, Compound resistance in series,Heat flow through a cylinder, Unsteady state heat conduction with applications.

Unit II : Convective Heat Transfer : Heat transfer by forced convection inlaminar and turbulent flow, Natural convection, Counter current, parallel flow, cross flow, Thermal analysis of heat exchangers, Rate of heat transfer, Overall heat transfer coefficient, Individual heat transfer coefficient, Fouling factors.

Unit III :Radiative Heat Transfer : Electromagnetic radiation, Radiation heat transfer, Wien's displacement law, Kirchoff's law, Stefan-Biltzmann law, Radiation between surfaces,Combinedheat transfer by conduction, convection and radiation.

Unit IV :Heat Transfer Equipments : Heat exchangers and general design of parallel, countercurrent, Shell & tube heat exchangers, Extended surface equipment.

Unit V :Heat Transfer with phase change : Evaporation – Types of evaporators and fields of their applications, Single andmultiple effect evaporators: their design and operation, Vapor recompression, Heat transfer from condensing vapours, Heat transfer to boiling liquids.

Text Books:

1. Process Heat Transfer by D.Q.Kern.
2. Heat Transmission by Mc. Adams.
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith, Julian C and HarriotPeter. Fifth edition McGraw Hill Inc.
4. Chemical Engineering by Coulson J. M., Richardson Vol.-I

Course Outcome:

Students would be able to

1. Analyze the steady state and unsteady state heat transfer by conduction.
2. Calculate heat transfer coefficients for forced and natural convection.

3. Explain and Calculate the heat transfer by radiation.
4. Design and analyze the double pipe and shell and tube heat exchanger performance for co-current and counter-current flows.
5. Explain the concepts of heat transfer with phase change.

CH5TPC07: Mass Transfer - I (3 1 0)

Unit I: Principle of Diffusion :Theory of diffusion, molecular diffusion in gases and liquids, Diffusion velocities, Mass transfer coefficient for mass transfer through known areas.

Unit II: Phase Equilibria :Vapor-liquid equilibrium curves and boiling point diagram, Volatility, Solubility of gases, Enthalpy –concentration diagrams.
Equilibrium Stage Operations Principles, Determination of number of ideal stages for two-component systems by graphical and absorption factor methods

Unit III: Flash distillation, differential distillation, steam distillation, Azeotropic distillation and Extractive distillation, Continuous distillation with rectification, Reflux ratio, Minimum reflux ratio, calculation of number of plats – Lewis sorel Method, McCabe Thiele Method.

Unit IV: Fenske equation, Optimum reflux ratio, Analysis of fractionating column by enthalpy concentration diagram method, Plate efficiencies, Packed Column, height equivalent to theoretical plate.

Unit V: Gas Absorption :Design of packed towers, Principles of absorption, Rate of absorption, Two film theory, Overall coefficients, HTU method, Interrelation between heat transfer, momentum transfer and mass transfer.

Text Books:

1. Mass Transfer by Robert E Trebyl, McGraw Hill Inc.
2. Unit Operations of Chemical Engineering by McCabe Warren, Smith Julian C andHarriot Peter. Fifth edition McGraw Hill Inc.
3. Principles of Mass Transfer and Separation Processes by B. K. Dutta, Prentice Hall, 2005.
4. Transport Processes and Unit Operations by C. J. Geankoplis, Prentice Hall International Inc.
5. Chemical Engineering Vol. I by Coulson J.M. & Richardson J.F.
6. Introduction to Chemical Engineering by Badger & Bancherro, TATA McGraw Hill Inc.

Course Outcome:

Students would be able to

1. Identify the concepts of phase equilibrium in mass transfer related problems.
2. Solve problems related to distillation, diffusion and absorption and mass transfer equipment.
3. Design plate /packed column for mass transfer operations.

CH5TPC08: Chemical Reaction Engineering-I (3 1 0)

Unit I : Kinetics of Homogeneous Reactions : Kinetics and thermodynamics of chemical reactions, Kinetics of homogenous reactions rate theories, Analysis of rate equations.

Unit II : Interpretation of Batch Reactor Data : Irreversible reactions, Total pressure method of kinetic studies, Analysis of complex rate equations, Complex reactions, Chain reactions,Variable volume reactions, Rate constants and equilibrium.

Unit III : Ideal Reactor for Single Reaction : Ideal batch reactors, Steady state mixed flow reactor, Steady state plug flow reactor, Size comparison of single reactor, Multiple-reactor system.

Unit IV : Design for Multiple Reaction : Introduction to multiple reaction, Qualitative treatment of product distribution and reactor size for parallel reactions, Reversible first order reactions in series, Favorable contacting patterns for irreversible reactions in series (First order &followed by first order)

Unit V: Temperature and Pressure Effects: Single reaction, General graphical design procedure, Optimum temperature progression, Heat effects- adiabatic and non-adiabatic operations, van Heerden relationship.
Multiple reaction: Temperature and vessel size for maximum production.

Text Books:

1. Chemical Engineering kinetics by J.M. Smith
2. Chemical Reaction Engineering by O Levenspieal
3. Elements of Chemical reaction Engineering by H.S. Foggler

Reference Book:

1. Reaction Kinetics for chemical Engineering by S. H. Walas

Course Outcome:

Students would be able to

1. Develop rate of reaction for homogeneous reactions.
2. Interpret batch reactor data and design ideal reactors for single and multiple reactions.
3. Describe different aspects of design for multiple reactions.
4. Explain the effect of temperature and pressure on reaction rate.

CH5TPE13: Food Engineering (3 1 0)

Unit I: Introduction- General aspects of food industry, world food demand and Indian scenario, constituents of food, quality and nutritive aspects.
Food additives, standards, deteriorative factors and their control, preliminary processing methods, conversion, preservation operation and quality standards.

Unit II- Energy Engineering in Food Processing - Generations of Steam, Fuel Utilization, Electric Power Utilization, Process Controls in Food Processing, Systems for Heating and Cooling Food Products.
Material and energy balance in food systems and calculation, Common unit operations in food processing – Cleaning, evaporation, crystallization.
Thermal Properties of Foods: Specific heat, Enthalpy, Thermal Conductivity, Thermal diffusivity, Latent heat, Modes of Heat Transfer - Freezing Systems , Frozen-Food Properties , Freezing Time refrigeration system for food products.

Unit III- Separation processes in food processing- Electrodialysis Systems, Reverse Osmosis Membrane Systems, Membrane Performance, Ultrafiltration Membrane Systems, Concentration Polarization.
Types of Reverse-Osmosis and Ultrafiltration Systems, Drying Processes, Dehydration Systems, Dehydration System Design, Sedimentation, Centrifugation, Mixing.

Unit IV- Production and utilization of food products –Food Process Principles: Pasteurization, Blanching, Sterilization techniques and types.
Soft and alcoholic beverages, dairy products, meat, poultry and fish products, treatment and disposal of food processing wastes.

Unit V- Packaging - Introduction, Food Protection, Product Containment, Product Communication, Product Convenience.
Innovations in Food Packaging, Food Packaging and Product Shelf-life, Food canning technology, fundamentals of food canning technology.

Text book:

1. Introduction to Food Engineering by R. Paul Singh, Dennis R. 5th Edition

Reference books:

1. Fundamentals of Food Engineering by Stanley Charm.
2. Fundamentals of Food Process Engineering by Toledo RT; 2nd ed, 2000, CBS Publishers
3. Fundamentals of Food Processing Operation by Heid, J.L. and Joslyn, M.A, The AVI Publishing Co; Westport, 1967.
4. Food Process Engineering by Heldman, D.R, The AVI Publishing Co; Westport, 1975.
5. Encyclopedia of Food Engineering by Hall, C.W; Farall, A.W. & Rippen, A.L, Van Nostrand - Reinhold.

CH6TPC09: Mass Transfer – II (3 1 0)

Unit I: Humidification Operations :Definitions, Humidity chart and its use in measurement of humidity and calculations of humidification operations, Adiabatic humidification.

Unit II : Leaching : Equipment, Principles of leaching, Calculation of number of ideal stages, Stage efficiency

Unit III : Liquid- Liquid Extraction : Equipment, Principles of extraction, Panchon – Savorit method, Counter current extraction using reflux application of McCabe method, Extraction in packed and spray column.

Unit IV: Crystallization :Principles, yield of crystals, Super solubility curve, Crystal growth, Equipment and application of principles to design.

Unit V : Drying : Equipment, Principles, Mechanism and theory of drying, Calculation of drying time.

Text Books:

1. Mass Transfer by Robert E Trebyl, McGraw Hill Inc.
2. Unit Operations of Chemical Engineering by McCabe Warren, Smith Julian C and Harriot Peter, Fifth edition, McGraw Hill Inc.
3. Principles of Mass Transfer and Separation Processes by B. K. Dutta, Prentice Hall, 2005.
4. Transport Processes and Unit Operations by C. J. Geankoplis, Prentice Hall International Inc.
5. Chemical Engineering Vol. I by Coulson J.M. & Richardson J.F.
6. Introduction to Chemical Engineering by Badger & Bancherro, TATA McGraw Hill Inc.

Course Outcome:

Students would be able to

1. Explain the basics of Mass Transfer and related laws.
2. Identification of mechanisms of mass transfer, Formulation of rate equations.
3. Solve problems related to drying, leaching and crystallization.

CH6TPC10: Process Dynamics and Control (3 1 0)

Unit I : Process Control : Importance of process control in chemical plants and systems, Various types of Control systems viz open loop and closed loop control, feedback and feed forward control, servo and regulator control; Importance of dynamic behavior of processes in process control, Physicaland block diagram representation of control system, Use of Laplace transformation in analysisof control systems.

Unit II : Simple System Analysis : Laplace transformation and transfer function, Blockdiagrams, Linearization, First and higher order systems, Interacting and non-interactingsystems, Distributed and lumped parameters systems, Dead time.

Unit III : Linear Open Loop Systems : Response of first order, second order and higherorder systems, Linearization of non-linear systems, Transportation lag.
Linear Closed Loop Systems : Study of various control system and their components viz.controllers, final control elements, Measuring instruments, Closed loop transfer functions,Transient response of simple control system, Stability criterion and analysis.

Unit IV : Root Locus, Stability Criterion and Transient Response :
Transient response analysis form root locus, Application of root locus to control system, Routh stability criterion.

Unit V : Frequency Response Analysis : Design of control system by frequency response, Closed loop response by frequency response, Frequency response technique: Phase marginand gain margin, Bode stability criterion; Nyquist stability criterion

Text Books:

1. Process Systems Analysis and Control by D.R. Coughnaowr, McGraw-Hill,Inc.
2. Chemical Process Control by G. Stephanopolous, Prentice-Hall.
3. Process Control by P. Hariott., TMH edn.

Reference Books:

1. Process Dynamics and Control by D.E. Seborg , T. Edgar and D.A. Mellichamp, JohnWiley and Sons, Inc
2. Process Control: Modeling, Design, and Simulation by B.W. Bequette, Prentice-Hall,Inc.

Course Outcome:

Students would be able to

1. Evaluate dynamic behaviour of first and second order system.
2. Determine the process stability in Laplace domain.
3. Analyze open-loop systems and linear closed loop systems.
4. Develop working knowledge of control system by frequency response.

CH6TPC11: Organic Chemical Technology (3 0 0)

Unit I : Oils & Fats : Status and scope, Major oils seeds production in India, Expression, Solvent extraction, Energy & solvent requirements, Mineral, seeds and other oil bearing materials, Hydrogenation of oils, Corrosion problems and materials of construction of equipments.

Unit II : Soaps & Detergents : Raw materials, Manufacture of detergents, Active detergent matter, Biodegradability, Fat splitting, Purification of fatty acids, Soap manufacture, Total fatty matters (TFM), Glycerin manufacture, Materials of construction.

Unit III : Cane Sugar : Cane production & varieties, Manufacturing equipment &technology, Cane sugar refining, Bagasses utilization, Energy requirements and conservation, Environmental considerations, Khandsari technology, Molasses based industries, Materials of construction.

Unit IV : Polymers : Status and scope, Applications, Classification of polymers, Degree and modes of polymerization, Molecular weight and it distribution, Selected industrial polymerization including plastics, Synthetic rubber and polymeric foams, Synthetic fibers.
Penicillin : Manufacturing process, Scope and applications.

Unit V : Regenerated Cellulose : Growth of industry, Raw materials, Pretreatment, Pulping, Manufacture of paper, Recovery of chemicals, Environmental considerations, viscose rayon.
Varnishes and Paints : Scope and applications, Types of coatings, General manufacturing procedure, Environmental considerations.

Text Books:

1. Chemical Process Industries – R.N. Shreve & J.A. Brink
2. Chemtech I , II, III , IV – IIT Madras
3. Outlines of Chemical Technology by Dryden , Co. M.G. Rao and M. Sitting.

Reference Book:

1. Handbook of Oil &Colour, Chemists Association OCCA.

Course Outcome:

Students would be able to

1. Describe the processes involved in manufacturing of various organic chemicals.
2. Make the process flow diagrams.
3. Analyze important process parameters such as raw materials, MOC etc. and major engineering problems associated with production of such chemicals.

CH6TPE21: Process Equipment Design–I (3 1 0)

Pressure and Storage Vessels : Design of pressure and storage vessels and their supports. End closures, Flat plates, Flanged, Dished, Hemispherical, Ellipsoidal and conical ends.

Text Books:

1. Introduction to Chemical Equipment Design (Mechanical Aspects) by B.C. Bhattacharya– Chemical Engineering Education Development Center.
2. Process Equipment Design By Brownell & Young
3. Process Equipment Design by M.V. Joshi
4. Chemical Engineering by Coulson J.M., Richardson Vol- I
5. Process Equipment Design by Shrikant D. Dawande

Reference Books:

1. Hand book of Chemical Engineering by J.H.Perry
2. IS Codes.

Course Outcome:

Students would be able to

1. Design pressure and storage vessels and their supports.
2. Evaluate the parameters of equipment design and important steps involved in design.

CH6TPE22: Fertilizer Technology (3 1 0)

Chemical fertilizers and organic manures – types of chemical fertilizers, Nitrogenous fertilizers- Methods of production, Characteristics, Specification and storage of ammonium sulphate, ammonium nitrate and ammonium chloride and urea Phosphatic fertilizers- Methods of production, Characteristics, Specification and storage of single super phosphate, triple super phosphate, Potassic fertilizers- Methods of production, Characteristics, Specification and storage of potassium chloride, potassium sulphate and potassium schoenite; Complex and NPK fertilizers-Methods of production, Characteristics, Specification and storage of Mono ammonium phosphate, Diammonium phosphate, Nitrophosphates, Fertilizers And Environment.

Text Books :

1. Commercial Fertilizers by G.H. Collings, 5th Edn., McGraw Hill, New York, 1955.
2. Chemistry and Technology of Fertilizers by A.V. Slacks, Interscience, New York, 1966.

Reference Book :

1. Editorial board-Handbook of fertilizer technology, The Fertilizer Association of India, New Delhi, 1977.

Course Outcome:

Students would be able to

1. Explain reactions and unit operations steps in manufacturing of various fertilizers.
2. Explain characterization process and engineering problems in fertilizer industries.

CH6TPE31: Fuel Combustion Energy Technology (3 1 0)

Unit I : Solid Fuel : Classification of fuel, Origin, Composition, Characteristics and analysis of coal washing & storage of coal. Physical & chemical processing of coal. Various classification systems of coal briquetting, Carbonization, Gasification of coal.

Liquid fuels: Origin, composition, characteristics and classification of crude oil, crude oil processing cracking and reforming, storage and handling of liquid fuel

Gaseous fuel: Classification of gaseous fuel, Natural gas, Coal gas, Coke oven and blast furnace gas, producer gas, water and Carbureted water gas

Unit II: Fuel Combustion Calculation: Fundamentals of various combustion calculations with numerical examples.

Unit III: Combustion Process: General Principles of combustion, Flame, Draught, Limits of Inflammability, Types of combustion Process- Surface, Submerged, Pulsating, Slow combustion.

Unit IV: Energy Conservation: Energy consumption pattern in various sectors, various ways of energy conservation in various process industries including petroleum.

Unit V: Non – Conventional Energy Technologies : General principles with applications and technology of Biomass Energy, Solar Energy, Geothermal Energy, Wind Energy, Nuclear Energy, Hydal, Tidal and Ocean Energy.

Text Book:

1. Elements of Fuel Combustion & Energy Engineering by S.N. Saha, Dhanpat Rai Publication Co. Pvt. Ltd. New Delhi, 2014

Course Outcome:

Students would be able to

1. Analyze solid, liquid, gaseous fuels and their characterization.
2. Compute fuel combustion calculation in industries with recommendation of better combustion processes in relation to better efficiency and pollution control technologies.
3. Study and recommend the various energy conservation routes in various industries.
4. Study and recommend the alternative sources of energies including the renewable energies in view of energy conservation to utilize them effectively.

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FOURTH YEAR, SEVENTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
	THEORY		L	T	P	Sessional IA	Sessional MSE	Sessional Total	ESE	Sub Total	
01.	CH7TPC13	Process Equipment Design- II	3	1	-	20	20	40	60	100	4
02.	CH7TPC14	Chemical Reaction Engineering-II	3	1	-	20	20	40	60	100	4
03.	CH7TPC15	New Separation Processes	3	1	-	20	20	40	60	100	4
04.	CH7TPE4X		3	1	-	20	20	40	60	100	4
05.	CH7TOE3X		3	1	-	20	20	40	60	100	4
	PRACTICAL										
01.	CH7PPC08	Minor Project	-	-	6	30	-	30	20	50	3
02.	CH7PPC09	Vocational Training Viva Cum Seminar	-	-	3	50	-	50	-	50	2
	TOTAL		15	5	9					600	25

IA – Internal Assessment
MSE – Mid Semester Examination
ESE - End Semester Examination
Total Marks – 600
Total Periods - 29
Total Credits - 25

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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SCHEME FOR EXAMINATION
B.Tech. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FOURTH YEAR, EIGHTH SEMESTER

S. No.	Course No.	Subject	Periods			Evaluation Scheme					Credits
	THEORY		L	T	P	Sessional IA	Sessional MSE	Sessional Total	ESE	Sub Total	
01.	CH8TPC16	Process Equipment Design- III	3	1	-	20	20	40	60	100	4
02.	CH8TPC17	Project Engineering, Economics & Management	3	1	-	20	20	40	60	100	4
04.	CH8TPE5X		3	1	-	20	20	40	60	100	4
06.	CH8TOE4X		3	1	-	20	20	40	60	100	4
	PRACTICAL										
01.	CH8PPC10	Project	-	-	8	60	-	60	40	100	4
	TOTAL		12	4	8					500	20

IA – Internal Assessment
MSE – Mid Semester Examination
ESE - End Semester Examination
Total Marks – 500
Total Periods - 24
Total Credits – 20

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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LIST OF PROFESSIONAL ELECTIVES OFFERD BY DEPARTMENT OF CHEMICAL ENGINEERING FOR VII and VIII SEMESTER

Semester	Subject Code (PE)	Subject
VII	CH7TPE41	Petroleum Refinery Engineering
	CH7TPE42	Polymer Technology - I
	CH7TPE43	Design and Development of Catalyst
VIII	CH8TPE51	Petrochemical Technology
	CH8TPE52	Polymer Technology - II
	CH8TPE53	Membrane Separation Processes

PE - Professional Elective

BOS held on 15th May 2018

DEPARTMENT OF CHEMICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
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LIST OF OPEN ELECTIVES OFFERD FOR VII and VIII SEMESTER

Semester	Subject Code (OE)	Subject
VII	CH7TOE31	Transport Phenomena
	CH7TOE32	Water Conservation and Management
VIII	CH8TOE41	Optimization Techniques
	CH8TOE42	Process Modeling & Simulation
	CH8TOE43	Renewable Energy

OE- Open Elective

Note: In addition to the open elective courses, as prescribed above, the students are free to opt for any other subject of same credit from inter/intra school duly approved by the Board of Studies of the respective departments.

BOS held on 15th May 2018

B.Tech. VII Semester

CH7TPC13 : Process Equipment Design- II (3 1 0)

Design of Heat Transfer Equipments : Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Vertical & Horizontal Condensers and Evaporators.

The candidates will be allowed to use the following reference book in the examination hall :

1. Hand book of Chemical Engineering J. H. Perry
2. Tubular Heat Exchange Manufacture Association Manual
3. ISI Codes.

Candidates have to bring their own copies of the above books and they will be not supplied by the university or the examination centers.

Text Books :

1. Process Heat Transfer by D. Q. Kern
2. Heat Transmission by McAdams
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith Julian and Harriot Peter, Fifth Edition, McGraw Hill Inc.
4. Chemical Engineering by J. M. Coulson and Richardson, Volume- I

Course Outcomes

Students should be able to design, calculate size/power/internals, etc required for all the process equipment in the PFD together with necessary instrumentation, safety aspects. Students should be able to calculate costs of equipment. Students should be able to perform a techno economic feasibility of the selected process.

CH7TPC14 : Chemical Reaction Engineering - II (3 1 0)

Unit-I : Basics of Non-Ideal Flow : Exit Age Distribution of Fluid, RTD, Conversion in Non-ideal Flow Reactors, Models for Non-ideal Flow- Dispersion Model, Chemical Reaction and Dispersion, Tank in Series Model.

Unit-II : Mixing of Fluids : Self Mixing of Single Fluid- Degree of Segregation, Early and Late Mixing, Mixing of Two Miscible Fluids.

Unit-III : Fluid Particle Reactions : Un-Reacted Core Model: Diffusion Through Gas Film Control, Diffusion Through Ash Layer Control, Chemical Reaction Control, Rate of Reaction for Shrinking Spherical Particles, Determination of Rate Controlling Step.

Unit-IV : Fluid – Fluid Reactions : Kinetic Regimes for Mass Transfer and Reaction, Rate Equations for Various Regimes, Film Conversion Parameter, Application to Design, Reactive and Extractive Reactions.

Unit V: Catalysis : Heterogeneous Catalysts, General Characteristics, Adsorption on Solid Surface, Physical Properties of Catalysts, Preparation of Catalyst, Steps in Catalytic Reaction.

Text Books :

1. Chemical Engineering Kinetics. J.M. Smith.
2. Chemical Reaction Engineering. Octave Levenspiel.
3. Chemical Reaction Engineering. H.Scott Fogler.
4. Principles of Reaction Engineering, Central Techno Publications. S.D.Dawande,
5. Chemical Engineering, Volume IV. Coulson and Richardson

Course Outcomes

Students would be able to (a) explain the concepts of reactor design and reaction kinetics; (b) interpret reactor data; (c) identify ideal reactors and explain various aspects of design for single reactions; (d) explain various aspects of design for multiple reactions, (e) analyze effects of temperature and pressure on conversion.

CH7TPC15 : New Separation Processes (3 1 0)

Unit I : Overview of Separation Processes: Basic Concepts of Separation Processes, Physico-Chemical Properties and Other Factors Controlling Separation, Limitations of Conventional Separation Processes and New Separation Processes, Equilibrium and Rate Governed Separation Processes and their Characteristics.

Unit II : Membrane Based Separation Processes: Principle of Membrane Separations Process, Advantages and Disadvantages, Classification, Membrane Materials, General Methods of Preparation and Characterization of Membranes, Membrane Modules, Concentration Polarization.

Unit III : Porous Membrane Based Processes: Reverse Osmosis, Ultrafiltration, Microfiltration, Nano-filtration, Dialysis, Ion-Selective Membranes and Electro-dialysis, Industrial Applications of Porous Membrane Based Processes.

Unit IV : Non-Porous Membrane Based Processes: Gas separation, Pervaporation, Liquid Membranes and their Industrial Applications, Medical Applications of Membranes, Miscellaneous Membrane Processes, Membrane Distillation, Membrane Reactors.

Unit V : Other Non-Conventional Separation Processes: Foam and Bubble Fractionation, Pressure and Temperature Swing Adsorption, Cloud Point Extraction, Centrifugal Separation Processes, Super Critical Fluid Extraction.

Text Books :

1. Separation Process Principles by J D Seader and E J Henley John Wiley & Sons, Inc.
2. Separation Processes by C J King, McGraw-Hill, Inc.
3. Membrane Separation Processes by K. Nath, PHI, New Delhi.
4. Membrane Technology and Applications by R W Baker, John Wiley and Sons, Ltd, UK.
5. Handbook of Industrial Membrane Technology by M.C. Porter, Crest Publishing House.

Course Outcomes

Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions. Distinguish among microfiltration, ultrafiltration, Nano filtration, virus filtration, sterile filtration, filter-aid filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

CH7TPE41: Petroleum Refinery Engineering (3 1 0)

Unit I : Petroleum Crude and Refining : Origin, Formation & Occurrence of Petroleum Crude, Exploration, Drilling and Processing, Reserve and Deposit of World, Indian Petroleum Refinery, Compositions, Classification & Physical Properties of Petroleum Crude.

Unit II : Physical Properties and Testing Methods of Petroleum Products : Evaluation of Petroleum, Physco-Chemical Properties of Various Petroleum Products as Per API / ASTM / BIS Specifications.

Unit III : Crude Processing : Pre-Treatment of Crude, Heating Techniques of Crude, Types of Distillation Columns & their Efficiencies, Atmospheric and Vacuum Distillation of Crude, Blending of Gasoline.

Unit IV : Chemical Treatment & Refining Operation : Chemical Treatment of Petroleum Products, Caustic Soda Treatment, Treatment With H_2SO_4 & H_2, Mercaptan Removal & Oxidation Process, Sulphur-Removal From Petroleum Products – Doctor's Treatment, Hydro De-Sulphurization, Dewaxing and Refining of Lubricating Oils.

Unit V : Cracking & Reforming Operation : Visbreaking, Thermal Cracking, Catalytic Cracking, Hydrocracking, Catalytic Reforming, Alkylation, Isomerization and Polymerization, Naphtha Cracking, Delayed Coking & Fluidized Coking.

Text Books :

1. Petroleum Refinery Engineering by W.L. Nelson
2. Petroleum Refining by Gary and Handwarke, Marcel Dekker
3. Petroleum Refining & Petrochemicals by N.K. Sinha, Umesh Publications New Delhi.
4. Petroleum Refining Technology by I.D. Mall, CBS Publishers & Distributors Pvt. Ltd. New Delhi.

Course Outcomes

Students would be able to (a) explain petroleum refining and thermal cracking processes; (b) detail catalytic cracking and catalytic reforming processes; (c) produce fuels such as aviation gasoline, motor fuel, kerosene, jet fuel; (d) manufacture lubricating oil; (e) store and transport petroleum products.

B.Tech. VIII Semester

CH8TPC16: Process Equipment Design- III (3 1 0)

Mass Transfer Equipments : Absorption Tower, Distillation Tower, Tunnel and Rotary Dryers.

Text Books :

1. Hand Book of Chemical Engineering J. H. Pery
2. Coulson & Richardson Volume–VI
3. Mass Transfer by R. Treybal
4. ISI Codes

Candidates have to bring their own copies of ISI Code book and they will be not be supplied by the university or the examination centers.

Course Outcomes

Upon completion of this course, the students will be able to: (a) design mass transfer equipment's for chemical process.; (b) prepare drawing for chemical process equipment's.

CH8TPC17: Project Engineering, Economics & Management (3 1 0)

Unit I : Nature and Importance of Project and Project Engineering : Concept of Project and Project Management, Characteristics of Project, Introduction to Project Engineering, Role of a Project Leader, General Design Considerations, Plant Layout and Site Selection, Flow Diagram, Concept of Scale Up, Concepts of Techno-Economic Feasibility Report.

Unit II : Technical and Financial Analysis : Technical Analysis, Financial Analysis, Significance of Financial Analysis, Elementary Knowledge of Book of accounts- Journal, Ledger, Balance sheet, Profit and Loss Account. Cost Estimation, Cash Flow Investment, Production Cost, Capital Investment, Cost Indices, Production and Overhead Cost, Interest and Taxes.

Unit III : Project Financing and Value Engineering : Meaning and Importance of Project Finance, Means of Finance and Sources of Project in India, Financial Institution Structure and Financial Assistance, Norms of Finance and Term Loan Procedure, Value Engineering – Function, Aims and Procedure.

Unit IV : Capital Expenditure, Profitability & Alternative Investments : Importance and Kinds of Capital Expenditure Decision, Capital Budgeting Process, Criteria of Capital Budgeting, Depreciation and its Calculation Methods, Methods of calculating profitability, Alternative investments, Break Even Analysis.

Unit V : Network Techniques for Project Management : Introduction, Development of Project Network, Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Time Analysis, Gantt Chart.

Text Books :

1. Plant Design & Economics for chemical Engineers by M.S. Peters & K. D. Timmerhaus.
2. Projects: Planning, Analysis, Selection, Financing, Implementation and Review by Prasanna Chandra.
3. Project Engineering of Process Plants by H. F. Rase
4. Pilot Plants and Models and Scale up Methods in Chemical Engineering by R. E. Johnston.

Course Outcomes

Upon completion of this course, the students will be able to: (a) select a site for the project from given alternatives, (b) calculate working capital requirement for a given project, (c) calculate cost of equipment used in a plant total project cost, (d) calculate cash flow from a given project, (e) understand the break-even analysis; (f) calculate depreciation; (g) list out various milestones related to project concept to commissioning.

CH8TPE51: Petrochemical Technology (3 1 0)

Unit I : Survey of Petrochemical Industries : Petrochemical Industries in India, Plastic and Synthetic Fiber Industries, Product of Petroleum Industries, Feed Stocks for Petrochemical Production, Purification and Separation of Feed Stocks, Chemicals from Methane.

Unit II : Chemicals From C_2 Hydrocarbons : Chemicals from Ethane, Ethylene and Acetylene, Naphtha Cracking and Reforming, Hydrogen from Reforming of Hydrocarbons.

Unit III : Chemicals From C_3, C_4 and Higher Fractions : Chemicals from Propane, Propylene, Butanes, Butylene etc. Production of Synthesis Gases from Higher Fractions. Carbon Compound, Dehydrogenation of Hydrocarbon and Higher Paraffins.

Unit IV : Polymers of Olefins : Polymers and their Properties, Polymers from Olefins-Polyethylene (HDPE, LDPE), Polypropylene, Vinyl Polymers. Production of BTX, Benzene Derivatives, Products from Toluene, Oxidation Products of Toluene, Synthetic Fibers and their Production.

Unit V : Synthetic Rubber, Plastics and Detergents : Synthetic Rubber and its Production, Classifications of Plastics, Different types of Resin and their Production, ABS Plastics, Poly Carbonates (PC), Poly Urethanes, Polyamides, Polystyrene, Synthetic Detergents and their Production, Petroleum Coke and Carbon Black.

Text Books :

1. Modern Petroleum Technology by G.D. Hobson and W Pow.
2. A Textbook on Petrochemical Technology by Bhaskara Rao.

Course Outcomes

Upon completion of this course, the students will be able to: (a) select the appropriate characterization parameters; (b) specify the properties of petroleum products; (c) attain knowledge of various separation & conversion processes involved in petroleum refining; (d) attain knowledge of manufacturing of various petrochemical products.

CH8TPE53: Membrane Separation Processes (3 1 0)

Introduction to Membrane Separation Process, Principle of Membrane Separation, Physical and Chemical Properties of Membranes, Classification, Driving Forces in Membrane Separation Processes, Advantages and Limitations of Membrane Processes, Membrane Types, Materials, Preparation and Characterization, Various Methods of Membrane Manufacture, Structure and Function of Symmetric and Asymmetric Membranes, Membrane Modules, Module Cascading, Chemical Potential and Osmosis, Retention and Permeability and its Estimation, Salt Rejection, Concentration Polarization and Membrane Fouling, Concept of Zeta Potential, Major Application Areas of Membrane, Various Membrane Processes, Design, Operation, Maintenance and Industrial Applications of Membrane Based Processes.

Text Books :

1. Separation Process Principles by J. D. Seader, Ernest J. Henley, Wiley
2. Separation Process Engineering by Phillip C. Wankat, PHI
3. Membrane Technology and Applications by R W Baker, John Wiley and Sons, Ltd, UK.
4. Membrane Separation Processes by K. Nath, PHI, New Delhi

Reference :

1. Webcourse (NPTEL) Novel Separation Processes by Prof. Sirshendu De, IIT Kharagpur

CH8TOE41 : Optimization Techniques (3 1 0)

System Analysis and Modeling : Introduction to Systems Analysis and Modeling with Reference to Chemical Engineering Problems, Differential Method for Solving One and Two Variable Problems With and Without Constraints, Case Studies, Application of Langrangian Multiplier Method.

Search Methods: One Dimensional Search Method- Newton's Method, Quasi Newton's Method, Polynomial Approximation Methods, Sequential Search Methods - Golden Section Method, Dichotomous Search Method, Interval Halving Method, Fibonacci Method.

Linear Programming: Modeling, Graphical Method, Single Phase Simplex Method, Two Phase Simplex Method, Duality, Dual Simplex Method.

Geometric Programming: As Applied to Chemical Engineering Problems with Degree of Difficulty Equal to Zero and One, with and without Constraints.

Dynamic Programming: Introduction to Dynamic Programming as Applied to Discrete Multistage Problems Like Cascade of CSTR, Train of Heat Exchanger etc., Computer Programming Techniques applied to Optimization.
Methods for Global Optimization.

Text Books :

1. Optimization Theory and Practice by Beveridge and Schecheter
2. Optimization Techniques for chemical Engineers by AsgharHussain
3. Optimization by S.S. Rao
4. Linear Programming by Hadley

Course Outcomes

Upon completion of this course, the students will be able to: (a) formulate the objective functions for constrained and unconstrained optimization problems; (b) use different optimization strategies; (c) Solve problems using non-traditional optimization techniques; (d) use of different optimization techniques for problem solving.

CH8TOE42: Process Modeling & Simulation (3 1 0)

Introduction : Uses of Mathematical Models, Scope of Coverage, Principles of Formulations. Mathematical Modeling in Chemical Reaction Engineering: CSTR, PFR, Batch Reactor, Semibatch Reactor, Series of Isothermal CSTR, Constant Hold-Up CSTR's, CSTR's with Variable Hold Ups, Gas Phase Pressurized CSTR, Non Isothermal CSTR, Bioreactor, Trikle Bed Reactor.

Mathematical Modeling in Mass Transfer : Ideal Binary Distillation Column, Multi-Component Non-ideal Distillation Column, Batch Distillation with Hold Up, Steam Distillation, Multi-Solute Batch Liquid- Liquid Extraction, Continuous Extraction, Multistage Countercurrent Extraction, Plug Flow Type Liquid- Liquid Extraction, Reactor with Mass Transfer, Absorption, Adsorption.

Mathematical Modeling in Heat Transfer : Two Heated Tanks, Single Component Vaporizer, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Multicomponent Flash Drum, Cooling Towers.

Mathematical Modeling of Other Chemical Processes: Interacting and Non-Interacting Systems with and without Heaters, Isothermal Hydraulic System, Forward and Backward Feed Triple Effect Evaporator.

Introduction of MATLAB and Use of Language, Simulation, Program Development and Numerical Solutions of Above Processes.

Text Books :

1. Process Modeling, Simulation and Control for Chemical Engineers by W. L. Luyben, McGraw Hill, 1990.
2. Process Plant Simulation by B. V. Babu, Oxford University Press, 2004.
3. Optimisation Techniques for Chemical Engineers by A. Hussain and K. Gangaiah, Macmillan, 2001.
4. Process Control: Modeling, Design and Simulation by B. W. Bequette. Prentice-Hall India, 2006.
5. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.

Course Outcomes

Students would be able to (a) explain detail importance of ODE and PDE; (b) develop model equations for the given system; (c) solve structural, thermal, fluid flow problems; (d) demonstrate the model solving ability for various processes/unit operations; (e) demonstrate the ability to use a process simulation.

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SCHEME FOR EXAMINATIONS

M.Tech. (TWO YEARS POST GRADUATE COURSE), CHEMICAL ENGINEERING

FIRST YEAR **FIRST SEMESTER**

S. No.	Course No. Theory	Subject	Periods /week	Evaluation Scheme IA	ESE	Sub. Total	Credits
01.	CHPG1101	Advanced Heat Transfer	3	40	60	100	3
02.	CHPG1102	Chemical Reactor Design	3	40	60	100	3
03.	CHPG1103	Fluidization Engineering	3	40	60	100	3
04.	CHPG1104	Process Optimization	3	40	60	100	3
05.	CHPG1105	Elective - I	3	40	60	100	3
Practical							
06.	CHPG1106	Chemical Engineering Computational Lab	3	50	--	50	2
Total						550	17

IA- Internal Assessment
Total Marks - 550

ESE- End Semester Examination
Total Credits - 17

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SCHEME FOR EXAMINATIONS

M.Tech. (TWO YEARS POST GRADUATE COURSE), CHEMICAL ENGINEERING

FIRST YEAR **SECOND SEMESTER**

S. No.	Course No. Theory	Subject	Periods /week	Evaluation Scheme IA	ESE	Sub. Total	Credits
01.	CHPG1201	Advanced Fluid Mechanics	3	40	60	100	3
02.	CHPG1202	Advanced Mass Transfer	3	40	60	100	3
03.	CHPG1203	Industrial Pollution Control Technologies	3	40	60	100	3
04.	CHPG1204	Design and Development of Catalyst	3	40	60	100	3
05.	CHPG1205	Elective – II	3	40	60	100	3
Practical							
06.	CHPG1206	Project	3	50	--	50	2
07.	CHPG1207	General Seminar	2	50	--	50	1
Total						600	18

IA- Internal Assessment
Total Marks - 600

ESE- End Semester Examination
Total Credits - 18

Elective – I (CHPG1105)

1. Operations Research & Management
2. Advanced Wastewater Treatment Technology
3. Numerical Methods for Chemical Engineering
4. Chemical Process Modeling
5. Membrane Separation Processes

Elective – II (CHPG1205)

1. Safety Hazards & Risk Analysis
2. Advanced Process Control
3. Steady State Process Simulation
4. Process Intensification

CHPG1101 : Advanced Heat Transfer

General equation of heat conduction, Transient heat Conduction numerical and analytical methods for the solution of transient heat conduction problems, Critical radius and optimum thickness of insulation. Free convective heat transfer under different situation and application of dimensional analysis to estimate the convective heat transfer coefficients. Heat transfer factor Reynolds No. Plot, Analogy equation for heat momentum transfer. Boiling heat transfer with particular reference to Nucleate and film boiling and estimation of boiling heat transfer coefficient. Heat transfer from condensing vapors. Nusselt equation for film type condensation of vapors over vertical surfaces and inclined tubes. View factors and emmisivity factors for different situation. Radiation shield and radiation error in pyrometry. Combined conduction, convection and radiation heat transfer.

Texts/References

- Hallman J. P., Heat Transfer Operation, McGRAW-Hill
- R.C.Sachdeva ,Fundamentals of Engineering Heat & Mass Transfer ,
- Bird, R. B., Steward, W.E. and Lightfoot E N., Transport Phenomena, Second edition, John Wiley and sons,
- Deen W. M. Analysis of Transport phenomena, Oxford University Press, 1998.
- Slattery J. C., Momentum Heat and Mass Transfer, Krieger Publishing, 1981

Course Outcome:

After learning the course, the students will be able to :

- To design and analyze the performance of heat exchangers and evaporators
- To Analyze the various analytical and numerical heat transfer problem.
- Understand the basic concepts of phase change and their coefficient, impact on heat transfer

CHPG1102 : Chemical Reactor Design

Review of Design of ideal isothermal homogeneous reactor for single and multiple reactions, RTD of Ideal reactor, interpretation of RTD data, Flow models for non ideal reactors, dispersion model, N tanks in series, multi parameter model, diagnosing the ills of reactor , influence of RTD and micro mixing on conversion. Adiabatic and non adiabatic operations in batch and flow reactors, optimal temperature in progression. Hot spot in tubular reactor auto thermal operation and steady state multiple steady state introduction to bifurcation theory Catalytic reactors, effectiveness factor, selectivity, catalyst deactivation, Design of heterogeneous catalytic reactors.

Text/References

- James J Carberry: Chemical and catalytic reaction engineering McGraw Hill
- J M Smith " Chemical Engineering Kinetics", McHill
- O. Levenspiel, " Chemical Reaction Engineering", Wiley Eastern, 2nd ed. 1972
- Frinebt G. F. Bischoff K. B; " Chemical Reactor Analyzer and design" John Wiley & Sons
- H. S. Foggler; Elements of Chemical Reaction Engineering

Course Outcomes :

At the end of the course, the student will be able to:

1. Understand the Adiabatic and non-adiabatic operations in batch and flow reactors,
2. Understand the reactor design involving Catalytic reactors, effectiveness factor, selectivity, catalyst deactivation,
3. Understand the design of heterogeneous catalytic reactors.

CHPG1103 : Fluidization Engineering

Phenomenon of Fluidization, Industrial applications of fluidized beds, Gross behavior of fluidized beds-Minimum fluidizing velocity and pressure drops; Voidage, Transport disengaging height; Bubbles in dense beds-Davidson Model, stream of bubbles, Bubbling bed models, Emulsion phase, Turn-over rate of solids, Residence Time Distribution of Solids, Diffusion model of solids movement, Interchange coefficient of solid into and out of wake; Flow Pattern of Gas through fluidized beds, diffusion model for gas flow; two region models, evaluation of interchange coefficients, Mass and heat transfer between fluids and solid- from bubbling bed models; Catalytic conversion from bubbling bed model; contacting efficiency; application to successive reactions; Theories and bed wall heat transfer; comparison of theories; Entrainment and elutriation, Circulation rates of solids, flow of high and low bulk density mixtures; Design for catalytic reactors; Design for non catalytic gas-solid reactors.

Text/References

- D Kuinl and O Levenpiel, Fluidization Engineering, John Wiley, 1969
- J. F. Davidson and D. Harrison, Fluidization, Academic Press 1971.
- F.A. Zenz and D. F. Othmer, Fluidization and Fluid Particles Systems, Reinhold Publishing,1960

Course Outcomes :

At the end of the course, the student will be able to:

- Performing and understanding the behavior fluidization in fluidized bed
- Evaluate the characterization of particles and power consumption in fluidization regimes
- Understanding the applicability of the fluidized beds in chemical industries

CHPG1201 : Advanced Fluid Mechanics

The Physical Properties of Fluids, Newtonian and Non Newtonian and non viscous fluid, Kinematics of the Flow Field: Specification of the flow field, Continuity Equation in Cartesian, Cylindrical and Spherical coordinates, Derivation of general momentum equation for Newtonian fluid in Cartesian coordinates, Euler's Equations principles of rotational and irrotational flow, velocity potential, Bernoulli's Equation, Laplace equations, stream function, vorticity, Cauchy Rieman Equation, Analytical solution for simple two dimensional irrotational fluid flows: flow along to inclined plates. Stokes law of viscosity, Nevier-Stokes equation, creeping flow around a solid sphere, expression for total drag, turbulent flow: transition to turbulence. Prandtl's mixing length, turbulence models. Boundary layer on immersed bodies, two dimensional boundary layer equation, laminar boundary layer on flat plat (Blasius Exact solution), Von-Krmann's Integral momentum equation, boundary layer separation flow and pressure drag, flow of compressible fluids, thermodynamics considerations, continuity and momentum equation for one dimensional compressible flow.

Text/References

- Bird, R. B., Steward, W.E. and Lightfoot E N., Transport Phenomena, Second edition,
- R. W. Fox, A.T. McDonald, P.J. Pritchard; Introduction to Fluid Mechanics, John Welly 6th Edition.
- J.G. Knudsan, D.L. Katz; Fluid Dynamics & Heat Transfer, McGraw Hills

CHPG1202 : Advanced Mass Transfer

Qualitative behavior of the vapour-liquid equilibria (VLE). Simple models for vapour- liquid equilibria: Raoult's and Henry's laws. Dew point and bubble point calculations. VLE by modified Raoult's law and K-value correlations. Flash calculations.

Ternary and multicomponent system, fractionation. Theories and design, No. of plates, Lewis Sorel's method, minimum reflux ratio, Underwood's equation, Colburn's equation.

Unsteady state mass transfer, multicomponent Gas-Phase systems, effective diffusivity, Maxwell's law, Regular and Random surface renewal, Harriot Model, Danckwerts model.

Mass Transfer across a phase boundary – the film-penetration theory, other theories of mass transfer. Interfacial turbulence, Mass Transfer coefficient, Applications of theories of interphase transfer. Mass Transfer and chemical reaction – steady state and unsteady state

Momentum, heat and mass transfer, molecular diffusion, Eddy diffusion, mixing length and eddy kinematics viscosity, overview of all separation processes including adsorption

Universal velocity profile – The laminar sub-layer, the buffer layer, Reynolds analogy, Taylor – Prandtl Modifications.

Text / References :

- J.D. Seader, Ernest J. Henley ; Chemical Engineering Principles.
- J.M. coulson & J.F. Richardson; Chemical Engineering.

CHPG1203 : Industrial Pollution Control Technologies

Brief review of industrial, municipal and natural Pollution sources, dynamics of pollutants from point, non-point, line and area sources; Generation, transport and decay of air pollutants; Sampling and monitoring methods.

Strategies and methods for removal of gaseous pollutants and particulates from process exhaust streams; Air pollution abatement technology; Detail design of particulates and gaseous emission control equipment; Air pollution indices; Air pollution survey; Costs of air pollution control, Air Pollution legislation and regulations.

Case studies of a few industrial pollution control system

Waste water characteristics. Wastewater treatment objectives, methods and implementation considerations liquid hazardous waste treatment such as chemical, biological, and thermal oxidation, carbon adsorption, ion exchange.

Design of facilities for physical and chemical treatment; Design of facilities for treatment and disposal of sludge; Effluent disposal

Water pollution legislation and regulation

Text / References :

- K B Schnelle & C. A. Brown, Air Pollution Control Technology Handbook, CRC Press
- H. S. Peavy, Donald R Rowe & George Tchobanoglous, Envo\ironment engineering, McGraw-Hill
- R. K. Trivedy & P K Goel, An Introduction to Air Pollution, Technoscience Pub.
- Dharmendra S. Sengar; Environmental Law, PHI
- Dr B. C, Arun Ku. Jain, Ashok Ku. Jain; Waste Water Engineering.

Course Outcome :

After learning the course, the students will be able to:

1. Recognize the causes and effects of environmental pollution
2. Analyze the mechanism of proliferation of pollution
3. Develop methods for pollution abatement and waste minimization
4. Design treatment methods for gas, liquid and solid wastes

CHPG1204 : Design and Development of Catalysts

Structure of solid surfaces; Chemisorption and physiosorption; Thermodynamics and kinetics of surface processes; Principles of heterogeneous catalysis; Preparation, characterization and classification; Structure and activity; Lattice imperfection; Geometric and electronic factors Prepartion and characterization of catalysts.

Kinetics of heterogeneous reactions.

Physical, Chemical and mathematical description of catalyst deactivation; Deactivation by fouling, poisoning and sintering.

Deactivation and regeneration of catalyst pellets.

Deactivation and regeneration of fixed beds.

Dynamics of polyfunctional catalysts.

Electrocatalysis and photocatalyis.

Mechanism and kinetics of some typical heterogeneous catalytic reactions.

Applications in fertilizer, petroleum , petrochemical industries and pollution control.

Text / References :

- G. Poncelet, J. Martens, B. Delmon; Preparation of Catalyst VI : Scientific bases for the preparation of Haterogeneous Catalysts; Elseveir
- John Regalbuto; Catalyst Preparation : Science and Engineering; CRC Press

Course Outcomes :

At the end of the course, the student will be able to:

1. To understand the concepts of homogenous and heterogeneous catalysis, with specific examples.
2. To study reaction mechanisms and kinetics of homogenous and heterogeneous catalytic reactions.
3. To familiarize with the characterization of catalysts
4. To understand the application and mechanisms of several types of catalysts in chemical industry

Membrane Separation Processes

Principles, characteristic, and classification of membrane separation processes; Membrane materials, structures, and preparation techniques; Membrane modules; Plant configurations.

Membrane characterization: Pore size and pore distribution; Bubble point test; Challenge test; Factors affecting retentivity, concentration polarization, gel polarization, fouling, cleaning and regeneration of membranes.

Mechanisms of separation: Porous membranes, dense membranes, and liquid membranes.
Membrane separation models: Irreversible thermodynamics; Capillary flow theory; Solution diffusion model; Science and technology of microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation, liquid membrane permeation, gas permeation.

Membrane reactors: Polymeric, ceramic, metal and bio-membrane.

Texts/References

- J. D. Seader, Ernest J. Henley; Separation Process Principles.
- Phillip C. Wankat; Separation Process Engineering; PHI

Course outcome:-
Student would be able to

1. Understand the different membrane based separation process.
2. Characterize the membranes and their applications.