B.Tech. (Chemical Engineering)
Scheme & Syllabi
Effective from 2020-21 Admitted Batch

Group - A

(For the branches of Civil Engg., **Chemical Engg**,Biotechnology, Computer Science Engg and Information Technology)

B.TECH I YEAR - I SEMESTER

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits C
			L	T	P				
CH-1101	BS	Mathematics – I	3	0	0	30	70	100	3
CH-1102	BS	Chemistry	3	0	0	30	70	100	3
CH-1103	HSS	English	3	0	0	30	70	100	3
CH-1104	ES	CPNM	3	0	3	30	70	100	3
CH-1105	ES	Basic Electrical Engineering	3	0	0	30	70	100	3
CH-1106	HSS	English Language Lab	0	0	2	50	50	100	1.5
CH-1107	BS	Chemistry Lab	0	0	3	50	50	100	1.5
CH-1108	ES	CPNM Lab	0	0	3	50	50	100	1.5
Total Credits									**19.5**

B.TECH I YEAR - II SEMESTER

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits C
			L	T	P				
CH-1201	BS	Mathematics – II	3	0	0	30	70	100	3
CH-1202	BS	Physics	3	0	0	30	70	100	3
CH-1203	ES	Engineering Graphics	1	0	4	30	70	100	3
CH-1204	ES	Material Science & Engineering	3	0	0	30	70	100	3
CH-1205	ES	Mechanical Engineering	3	0	0	30	70	100	3
CH-1206	ES	Workshop Lab	0	0	3	50	50	100	1.5
CH-1207	BS	Physics Lab	0	0	3	50	50	100	1.5
CH-1208	ES	General Engineering Lab. (Mechanical Engineering/ Electrical Engineering)	0	0	3	50	50	100	1.5
Total Credits									**19.5**

B.Tech II Year - I Semester

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits
			L	T	P				
CH-2101	BS	Maths-III	3	0	0	30	70	100	3
CH-2102	ES	Solid Mechanics	3	0	0	30	70	100	3
CH-2103	HSS	Managerial Economics	3	0	0	30	70	100	3
CH-2104	PC	Organic Chemistry	3	0	0	30	70	100	3
CH-2105	PC	Particle and Fluid Processing	3	0	0	30	70	100	3
CH-2106	PC	Organic Chemistry lab	0	0	3	50	50	100	1.5
CH-2107	PC	Particle and Fluid Processing lab	0	0	3	50	50	100	1.5
CH-2108	SC	*MATLAB (software training)*	1	0	2	50	50	100	2
CH-2109	MC	Environmental Science	2	0	0	-	100	100	0
Total Credits									**20**

B.Tech II Year - II Semester

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits
			L	T	P				
CH-2201	BS	Maths-IV	3	0	0	30	70	100	3
CH-2202	PC	Material and Energy Balances	3	0	0	30	70	100	3
CH-2203	PC	Heat Transfer	3	0	0	30	70	100	3
CH-2204	PC	Fluid Mechanics	3	0	0	30	70	100	3
CH-2205	HSS	Industrial Management & Entrepreneurship	3	0	0	30	70	100	3
CH-2206	PC	Heat Transfer lab	0	0	3	50	50	100	1.5
CH-2207	PC	Fluid Mechanics lab	0	0	3	50	50	100	1.5
CH-2208	SC	*ASPEN PLUS (Process design)*	1	0	2	50	50	100	2
CH-2209	MC	Professional Ethics and Human Values	2	0	0	-	100	100	0
Total Credits									**20**
Summer Internship (Community Service)									

B.Tech III Year - I Semester

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits
			L	T	P				
CH-3101	PC	Chemical Engineering Thermodynamics	3	0	0	30	70	100	3
CH-3102	PC	Mass Transfer-I	3	0	0	30	70	100	3
CH-3103	PC	Chemical Reaction Engineering - I	3	0	0	30	70	100	3
CH-3104	OE	Open Elective- I	2	0	2	30	70	100	3
CH-3105	PC	Core Elective -I	3	0	0	30	70	100	3
CH-3106	PC	Mass Transfer-I lab	0	0	3	50	50	100	1.5
CH-3107	PC	Core Elective lab (General Chemical Technology / Petro /Ceramic lab*)	0	0	3	50	50	100	1.5
CH-3108	SC	Seminar/ Minor project	1	0	2	50	50	100	2
CH-3109	MC	Indian Constitution	2	0	0	0	100	100	0
CH-3110	MC	Summer internship 2 months (Mandatory after second year) to be evaluated during V semester	-	-	-	100	0	100	2
Total Credits									**22**

* General Chemical Technology Lab for B.Tech. (Chemical Engg.) / Petroleum Engg., Lab., for B.Tech., (Chemical Engg. with Petroleum Engg. as elective) /Ceramic Technology Lab for B.Tech., (Chemical Engg. with Ceramic Technology as elective)

Core Elective-I (CH 3105)
For Chemical Engineering
A. General Chemical Technology
B. Petroleum Refinery Engineering
C. Ceramic Raw Materials
D. Fuel Cell Technology
E. Polymer Technology

For Chemical Engineering with petroleum Engineering as elective:
C. Petroleum Refinery Engineering.
For Chemical Engineering with Ceramic Technology as elective:
D. Ceramic Raw Materials

Open Elective-I (CH 3104)

Corrosion Engineering

B.Tech III Year - II Semester

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits
			L	T	P				
CH-3201	PC	Mass transfer-II	3	1	0	30	70	100	3
CH-3202	PC	Chemical Reaction Engineering-II	3	0	0	30	70	100	3
CH-3203	PC	Process Instrumentation and Control	3	0	0	30	70	100	3
CH-3204	PC	Core elective- II	3	0	0	30	70	100	3
CH-3205	OE	Open Elective – II	2	0	2	30	70	100	3
CH-3206	PC	Mass transfer –II lab	0	0	3	50	50	100	1.5
CH-3207	PC	Chemical Reaction Engineering lab	0	0	3	50	50	100	1.5
CH-3208	PC	Process Instrumentation and Control lab	0	0	3	50	50	100	1.5
CH-3209	SC	Intellectual Property Rights	3	0	0	30	70	100	2
CH-3210	MC	Essence of Indian Traditional Knowledge	2	0	0	-	100	100	0
Total Credits									**21.5**
SUMMER INTERNSHIP (2 MONTHS)									

Core Elective-II: (CH 3204)

For Chemical Engineering

A. Process Modeling and Simulation
B. Petrochemicals
C. White Ware and Heavy Clayware
D. Computational Fluid Dynamics
E. Multi Component Separation Processes
F. Chemical Engineering Mathematics

For Chemical Engineering with petroleum Engineering as elective:

B. Petrochemicals

For Chemical Engineering with Ceramic Technology as elective:

C. White ware and heavy clayware

Open Elective-II (CH 3205)

1. Nano Science & Technology
2. Industrial Safety and Management
3. Environmental Pollution Control Engineering

B.Tech IV Year - I Semester

Course code	Category	Course Title	Hours per week			Internal Marks	External Marks	Total Marks	Credits
			L	T	P				
CH-4101	PC	Transport Phenomena	3	1	0	30	70	100	3
CH-4102	PC	Process Engineering Economics	3	0	0	30	70	100	3
CH-4103	PC	Chemical Process Equipment Design	3	0	0	30	70	100	3
CH-4104	PC	Core Elective -III	3	0	0	30	70	100	3
CH-4105	OE	MOOCS	3	0	0	30	70	100	3
CH-4106	OE	MOOCS	2	0	2	30	70	100	3
CH-4107	PC	Chemical Process Equipment Design Lab	0	0	3	50	50	100	1.5
CH-4108	SC	Sustainable Process Engineering	3	0	0	30	70	100	2
CH-4109	MC	Summer internship 2 months (Mandatory after third year) to be evaluated during VII semester	-	-	-	100	-	100	2
Total Credits									**23.5**

Core Elective-III (CH 4104)

For Chemical Engineering

A. Computer Aided Design
B. Industrial Pollution Control Engineering
C. Process Optimization
D. Reservoir Engineering
E. Fuels , Refractories And Furnaces
F. Biochemical Engineering

For Chemical Engineering with petroleum Engineering as elective:

D. Reservoir Engineering

For Chemical Engineering with Ceramic Technology as elective:

E. Fuels,Refractories and Furnaces

Open Elective-III (CH 4105) & Open elective –IV (CH 4106)are MOOCS courses.

(To be specified/approved by BOS)

B.Tech IV Year - II Semester

Course code	Category	Course Title	Internal Marks	External Marks	Total Marks	Credits
CH-4201	Major Project	Project work	50	50	100	14
(6 Months Internship in industry)Total credits						**14**

MINOR REQUIREMENTS IN CHEMICAL ENGINEERING

Total Credit requirement: 20

Student must have acquired a minimum of 8 SGPA up to the end of 2nd semester without backlogs. In case after declaration 3rd semester results if student fails to score required minimum of 8 SGPA his/her registration for Minor programme stands canceled and he/she shall continue with regular programme.

Of the 20 additional credits to be acquired, 16 Credits shall be earned by selecting courses one from each of the following pools and 4 credits through MOOCs with two courses of minimum 8 weeks duration.

Subject	L-T-P	Credit
POOL 1		
Fluid Mechanics (CH-2204)	3-1-0	4
Heat Transfer (CH-2203)	3-1-0	4
Material and Energy Balances (CH-2202)	3-1-0	4
POOL 2		
General Chemical Technology (CH-3105)	3-1-0	4
Mass Transfer–I (CH 3102)	3-1-0	4
Chemical Engineering Thermodynamics (CH-3101)	3-1-0	4
Material Science and Engineering (CH-1204)	4-0-0	4
POOL 3		
Chemical Reaction Engineering -I (CH-3103)	3-1-0	4
Process InstrumentationandControl (CH-3203)	3-1-0	4
Process Engineering Economics (CH-4102)	3-1-0	4
POOL 4		
Industrial Pollution Control Engineering (CH-4104B)	4-0-0	4
Process Optimization (CH-4104C)	4-0-0	4
Particle and Fluid Processing (CH-2105)	4-0-0	4

B.Tech. (Honors) in Chemical Engineering (Total Credits: 180)

20 additional credits are to be acquired for Honors.

Student must have acquired a minimum of 8 SGPA up to the end of 2nd semester without backlogs. In case after declaration 3rd semester results if student fails to score required minimum of 8 SGPA his/her registration for Honors programme stands canceled and he/she shall continue with regular programme.

Of the 20 additional credits to be acquired, 16 credits shall be earned by undergoing specified courses listed below with four courses each carrying 4 credits. **The remaining 4 credits must be acquired through MOOCS, which shall be domain specific, each with 2 credits and with minimum duration of /12 weeks as recommended by board of studies**

The courses that are offered for B.Tech. (Hons) in Chemical Engineering are

Code	Subject	L-T-P	Credit
CHH-1001	Process Modeling and Simulation	3-1-0	4
CHH-1002	Advanced Mass Transfer	3-1-0	4
CHH-1003	Pollution Control	3-1-0	4
CHH-1004	Corrosion Engineering	3-1-0	4
CHH-1005	Petroleum Refinery Engineering	3-1-0	4
CHH-1006	Energy Engineering	3-1-0	4
CHH-1007	Transport Phenomena-II	3-1-0	4
CHH-1008	Chemical Reaction Engineering-III	3-1-0	4
CHH-1009	Advanced Process Control	3-1-0	4
CHH-1010	Analytical Techniques	4-0-0	4

CH-1101

MATHEMATICS-I

Course Objectives:

- To transmit the knowledge of Partial differentiation.
- To know of getting maxima and minima of function of two variables and finding errors and approximations.
- To evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.

Course Outcomes:

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

- Find the partial derivatives of functions of two or more variables.
- Evaluate maxima and minima, errors and approximations.
- Evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.
- Have a fundamental understanding of Fourier series and be able to give Fourier expansions of a given function.

Syllabus

(Partial Differentiation)

Introduction - Functions of two or more variables - Partial derivatives - Homogeneous functions – Euler's theorem - Total derivative - Change of variables – Jacobins. Mean value Theorems (without proofs)

(Applications of Partial Differentiation)

Geometrical interpretation -Tangent plane and Normal to a surface -Taylor's theorem for functions of two variables - Errors and approximations -Total differential. Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers - Differentiation under the integral Sign - Leibnitz's rule.

(Multiple Integrals)

Introduction - Double Integrals - Change of Order of Integration - Double Integrals in Polar Coordinates - Triple Integrals - Change of Variables.

(Multiple Integrals-Applications)

Area enclosed by plane curves - Volumes of solids - Area of a curved surface - Calculation of Mass - Center of gravity - Moment of inertia - product of inertia – principal axes- Beta Function - Gamma Function - Relation between Beta and Gamma Functions. Error Function or Probability Integral.

(Fourier Series)

Introduction - Euler's Formulae - Conditions for a Fourier Expansion - Functions having points of discontinuity - Change of Interval - Odd and Even Functions - Expansions of Odd or Even Periodic Functions, Half-Range Series - Parseval's Formula. Practical Harmonic analysis.

TEXT BOOK:

Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43rd Edition, Khanna publishers**.**

REFERENCE BOOKS:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K.International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.
6. Higher Engineering Mathematics by Dr. M.K.Venkataraman.

CH-1102

CHEMISTRY

Course Objectives:

- To apply the basic knowledge of Chemistry to the Engineering Discipline.
- To develop knowledge about water and its treatment for industrial and potable purposes.
- To develop understanding in the areas of Polymers, Mechanism of Corrosion of Metals and Corrosion Control Methods, Fuels, Lubricants and Nanomaterials for of conducting polymers, bio-degradable polymers and fiber reinforced plastics and apply the knowledge for solving existing challenges faced in various engineering and societal areas.

Course outcomes:

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

- This course applies the basic concepts and principles studied in Chemistry to Engineering.
- It provides an application of chemistry to different branches of engineering
- The students will be able acquire knowledge in the areas of Water Chemistry,Polymers, Corrosion, Fuels and Lubricants and nanomaterials and suggest innovative solutions for existing challenges in these areas.

Syllabus

Water Chemistry

Sources of Water – Impurities and their influence of living systems – WHO Limits – Hardness and its Determination – Boiler Troubles and their removal – Water Softening Methods – Lime-Soda, Zeolite and Ion Exchange - Municipal Water Treatment-Break Point Chlorination – Desalination of Sea Water – Reverse Osmosis Method, Electro-dialysis.

Polymers and Plastics

Polymers: Definition – Types of Polymerization (Addition & Condensation) – Mechanisms of Addition Polymerization – Radical and Ionic – Thermodynamics of Polymerization Process.

Plastics: Thermosetting and Thermoplastics – Effect of Polymer Structure on Properties of Cellulose Derivatives – Vinyl Resins – Nylon (6,6), Reinforced Plastics – Conducting Polymers.

Corrosion

Corrosion: Origin and Theory – Types of Corrosion: Chemical and Electrochemical; Pitting, Inter granular, Waterline, Stress – Galvanic Series – Factors Effecting Corrosion.

Corrosion Controlling Methods: Protective Coatings: Metallic Coatings, Electroplating and Electroless Plating – Chemical conversion Coatings – Phosphate, Chromate, Anodized, Organic Coatings – Paints and Special Paints.

Fuels and Lubricants

Solid Fuels: Wood and Coal, Ranking of Coal – Analysis (Proximate and Ultimate) Coke Manufacture – Otto Hoffmann's Process – Applications; **Liquid Fuels:** Petroleum Refining – Motor Fuels – Petrol and Diesel Oil – Knocking – Octane number – Cetane Number; **Gaseous Fuels:** Biogas, LPG and CNG – Characteristics – Applications; **Rocket Fuels:** Propellants – Classification – Characteristics

Lubricants: Classification – Mechanism – Properties of Lubricating Oils – Selection of Lubricants for Engineering Applications.

Nanomaterials

Nanomaterials, Properties and application of fullerenes, fullerols, Carbon nanotubes and nanowires. Synthesis - Top-down and Bottom-up approaches - Nanocomposites - Nanoelectronics- Applications of nanomaterials in catalysis, telecommunication and medicine.

TEXT BOOKS:

1. Engineering Chemistry – PC Jain and M. Jain – Dhanpath Rai and Sons, New Delhi.
2. A Text book of Engineering Chemistry – S. S. Dara – S. Chand & Co. New Delhi.

REFERENCE BOOKS:

1. Engineering Chemistry – B. K. Sharma – Krishna Prakashan – Meerut.
2. Introduction to Nanoscience - S. M. Lindsay - Oxford University Press
3. Engineering Chemistry - B. L. Tembe, Kamaluddin and M. S. Krishnan, (NPTEL).

CH-1103

ENGLISH

Course Objectives:

- To make students understand the explicit and implicit meanings of a text/topic;
- To give exposure to new words and phrases, and aid to use them in different contexts;
- To apply relevant writing formats to draft essays, letters, emails and presentations; and
- To adapt oneself to a given situation and develop a functional approach to finding solutions: adaptability and problem solving.

Course Outcomes:

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

- Students will be able to analyse a given text and discover the various aspects related to language and literature;
- Learn the various language structures, parts of speech and figures of speech;
- Develop one's reading and writing abilities for enhanced communication; and
- Learn to apply the topics in real-life situations for creative and critical use.

Syllabus

On the conduct of life: William Hazlitt

Life skills: Values and Ethics

If: Rudyard Kipling

The Brook: Alfred Tennyson

Life skills: Self-Improvement

How I Became a Public Speaker: George Bernard Shaw

The Death Trap: Saki

Life skills: Time Management

On saving Time: Seneca

ChinduYellama

Life skills: Innovation

Muhammad Yunus

Politics and the English Language: George Orwell

Life skills: Motivation

Dancer with a White Parasol: Ranjana Dave

Grammar:

Prepositions – Articles – Noun-Pronoun Agreement, Subject-Verb Agreement – Misplaced Modifiers – Clichés, Redundancies.

Vocabulary:

Introduction to Word Formation – Root Words from other Languages – Prefixes and Suffixes – Synonyms, Antonyms – Common Abbreviations

Writing:

Clauses and Sentences – Punctuation – Principals of Good Writing – Essay Writing – Writing a Summary

Writing: Essay Writing

Life skills: Innovation

Muhammad Yunus

TEXTBOOK:

1. *Language and Life: A Skills Approach* Board of Editors, Orient Blackswan Publishers, India. 2018.

REFERENCEBOOKS :

1. *Practical English Usage*, Michael Swan. OUP. 1995.
2. *Remedial English Grammar*, F.T. Wood. Macmillan.2007
3. *On Writing Well*, William Zinsser. Harper Resource Book. 2001
4. *Study Writing*, Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. *Communication Skills*, Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. *Exercises in Spoken English*, Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

CH-1104

CPNM

Course Objectives:

- The course is designed to provide complete knowledge of C language.
- To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
- To provide knowledge to the Students to develop logics which will help them to create programs, applications in C.
- This course aims to identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.
- This course provides the fundamental knowledge which is useful in understanding the other programming languages.

Course Outcomes:

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

- Identify basic elements of C programming structures like data types, expressions, control statements, various simple functions and **Apply** them in problem solving.
- Apply various operations on derived data types like arrays and strings in problem **solving**.
- Designand Implement of modular Programming and memory management using Functions, pointers.
- Apply Structure, Unions and File handling techniques to **Design** and **Solve** different engineering programs with minimal complexity.
- Apply Numerical methods to **Solve** the complex Engineering problems.

Syllabus

Introduction to C: Basic structure of C program, Constants, Variables and data types, Operators and Expressions, Arithmetic Precedence and associativity, Type Conversions. Managing Input and Output Operations Formatted Input, Formatted Output.

Decision Making, Branching, Looping, Arrays & Strings: Decision making with if statement, Simple if statement, The if…else statement, Nesting of if…else statement, the else..if ladder, switch statement, the (?:) operator, the GOTO statement., The while statement, the do statement, The for statement, Jumps in Loops ,One, Two-dimensional Arrays, Character Arrays. Declaration and initialization of Strings, reading and writing of strings, String handling functions, Table of strings.

Functions: Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions: No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Values. Nesting of functions, recursion, passing arrays to functions, passing strings to functions, the scope, visibility and lifetime of variables.

Pointers: Accessing the address of a variable, declaring pointer variables, initializing of pointer variables, accessing variables using pointers, chain of pointers, pointer expressions, pointers and arrays, pointers and character strings, array of pointes, pointers as function arguments, functions returning pointers, pointers to functions, pointers to structures-Program Applications

Structure and Unions: Defining a structure, declaring structure variables, accessing structure members, structure initialization, copying and comparing structure variables, arrays of structures, arrays within structures, structures within structures, structures and functions and unions, size of structures and bit-fields- Program applications.

File handling: Defining and opening a file, closing a file, Input/ Output operations on files, Error handling during I/O operations, random access to files and Command Line Arguments-Program Applications

Numerical Methods: Solutions of Algebraic and Transcendental Equations, Bisection Method, Newton Raphson Method. Newton's forward and backward Interpolation, Lagrange's Interpolation in unequal intervals. Numerical Integration: Trapezoidal rule, Simpson's 1/3 rules. Solutions of Ordinary First Order Differential Equations: Euler's Method, Modified Euler's Method and Runge-Kutta Method.

TEXT BOOKS:

1. Programming in ANSI C, E Balagurusamy, 6th Edition. McGraw Hill Education (India) Private Limited.
2. Introduction to Numerical Methods, SS Sastry, Prentice Hall

REFERENCE BOOKS:

1. Let Us C ,YashwantKanetkar, BPB Publications, 5th Edition.
2. Computer Science, A structured programming approach using C", B.A.Forouzan and R.F.Gilberg, " 3rd Edition, Thomson, 2007.
3. The C –Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.
4. Scientific Programming: C-Language, Algorithms and Models in Science, Luciano M. Barone (Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific.

CH-1105

BASIC ELECTRICAL ENGINEERING

Course Objectives:

- An understanding of basic EE abstractions depends on analysis and design of electric and magnetic circuits and its elements.
- To provide the students with knowledge of fundamental laws in electrical engineering
- To develop the ability of the students to analyze electrical and magnetic circuits using the basic laws of electrical engineering
- To expose the students to the concepts of various types of electrical machines and application of electrical machines.
- To inculcate the understanding about the AC fundamentals
- To prepare the students to have a basic knowledge of transformers
- To acknowledge about three phase induction motor and its operating principle
- To know about the fundamentals of synchronous motors and its working principle

Course Outcomes:

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

- Predict the behavior of any electrical and magnetic circuits.
- State and explain the basic laws of electromagnetic induction.
- Understand Constructional details, principle of operation, types of Electrical Machines performance Characteristics ,speed control methods and its applications
- Ability to conduct experiments on Ac Machines to find its characteristics.
- Calculate performance characteristics of transformer like regulation and efficiency
- Formulate and then analyze the working of synchronous motors
- Solve simple problems on synchronous motors

Syllabus

Magnetic circuits: Definitions of magnetic circuit, reluctance, magneto motive force (mmf), magnetic flux, simple problems on magnetic circuits, hysterisis loss (chapter 8, page nos. 155-175),

Electromagnetic induction: Faraday's laws of electromagnetic induction, induced E.M.F., dynamically induced E.M.F, statistically induced EMF, self inductance, mutual inductance (Chapter 9, page nos. 176-190),

D.C. generators: D.C generator principle, construction of D.C generator, E.M.F equation of D.C generator, types of D.C generators, armature reaction, losses in D.C generator, efficiency, characteristics of D.C generators, applications of D.C generators (chapter 10, 11, pages 208-238),

D.C. motors: D.C motor principle, working of D.C motors, significance of back, E.M.F, torque equation of D.C motors, types of D.C motors, characteristics of D.C motors, speed control methods of D.C motors, applications of D.C motor, testing of D.C machines, losses and efficiency, direct load test and Swinburne's test (Chapter 12, 13, page Nos. 239-269),

A.C. circuits: Introduction to steady state analysis of A.C circuits, single and balanced 3 phase circuits (chapter 16, page nos. 323-348),

Transformers: Transformer principle, EMF-equation of transformer, transformer on load, equivalent circuit of transformer, voltage regulation of transformer, losses in a transformer, calculation of efficiency and regulation by open circuit and short circuit tests (Chapter 20, page Nos. 423-455),

Three phase inductance motor: Induction motor working principle, construction of 3-phase induction motor, principle of operation, types of 3-phase induction motor, torque equation of induction motor, slip-torque characteristics, starting torque, torque under running condition, maximum torque equation, power stages of induction motor, efficiency calculation of induction motor by direct loading (Chapter 21, page nos. 463-489),

Altemator: Altenator working principle, EMF equation of altenator, voltage regulation by Synchronised impedance method (Chapter 23, page nos. 505-515),

Synchonous motor: Synchronous motor principle of operation, construction, methods of starting of synchronous motor, (Chapter- 24, page nos. 516-526),

TEXT BOOK:

1. ‘Elements of Electrical Engineering & Electronics’ by V.K. Mehta, S.Chand& Co.

REFERENCE BOOK:

1. ‘A first course in Electrical Engineering’ by Kothari.

CH-1106

ENGLISH LANGUAGE LAB

Course Objectives:

- To make students recognize the sounds of English through Audio-Visual aids;
- To help students build their confidence and help them to overcome their inhibitions and self- consciousness while speaking in English;
- To familiarize the students with stress and intonation and enable them to speak English effectively; and
- To give learners exposure to and practice in speaking in both formal and informal contexts.

Course Outcomes:

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

- Recognize of English sound patterns and the fluency in their speech will be enhanced;
- Study the communicative items in the laboratory will help students become successful in the competitive world;
- Participate in group activities like roleplays, group discussions and debates; and
- Express themselves fluently and accurately in social as well professional context.

Syllabus

Introduction to Phonetics: The Sounds of English (Speech sound – vowels and consonants) - Stress and Intonation - Accent and Rhythm.

Listening Skills: Listening for gist and specific information - listening for Note taking, summarizing and for opinions - Listening to the speeches of eminent personalities.

Speaking Skills: Self-introduction - Conversation Skills (Introducing and taking leave) - Giving and asking for information - Role Play - Just A Minute (JAM) session - Telephone etiquette.

Reading and Writing skills: Reading Comprehension – Précis Writing - E-Mail writing - Punctuation.

Presentation skills: Verbal and non-verbal communication - Body Language - Making a Presentation.

REFERENCE BOOKS:

1. Ashraf Rizvi. *Effective Technical Communication*. Tata McGraw Hill Education Private Limited, New Delhi.
2. *Speak Well*. Orient Blackswan Publishers, Hyderabad.
3. Allan Pease. *Body Language*. Manjul Publishing House, New Delhi.

CH-1107

CHEMISTRY LAB

Course Objectives:

- To develop the fine skills of quantitative determination of various chemical components through titrimetric analysis
- To prepare and use ionexchange/ zeolite columns for the removal of hardness of water
- To develop the skill of organic synthesis through the preparation of a polymer/ drug

Course Outcomes:

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

- Determine the amount of various chemical species in solutions by titrations and conduct the quantitative determinations with accuracy
- Develop novel materials to be used as zeolite and prepare columns for removal of hardness of water
- Produce a polymer or a drug

Syllabus

1. Determination of Sodium Hydroxide with HCl (Na_2CO_3 Primary Standard)
2. Determination of Alkalinity (Carbonate and Hydroxide) of water sample
3. Determination of Fe(II)/Mohr's Salt by Permanganometry
4. Determination of Oxalic Acid by Permanganometry
5. Determination of Chromium (VI) by Mohr's Salt Solution
6. Determination of Zinc by EDTA method
7. Determination of Hardness of Water sample by EDTA method
8. Determination of Chlorine in water by Iodometric Titration
9. Ionexchange/ Zeolite column for removal of hardness of water
10. Synthesis of Polymer/ drug

REFERENCE BOOKS:

1. Vogel's Quantitative Chemical Analysis – V – Edition – Longman.
2. Experiments in Applied Chemistry (For Engineering Students) – Sinita Rattan – S. K.Kataria& Sons, New Delhi

CH-1108

CPNM LAB

Course Objectives:

- To impart writing skill of C programming to the students and solving problems.
- To write and execute programs in C to solve problems such as Modularize the problems into small modules and then convert them into programs.,
- To write and execute programs in C to solve problems such as arrays, files, strings, structures and different numerical methods.
- This reference has been prepared for the beginners to help them understand the basic to advanced concepts related to Objective-C Programming languages.

Course Outcomes:

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

- Understand various computer components, Installation of software. C programming development environment, compiling, debugging, and linking and executing a program using the development environment.
- Analyzing the complexity of problems, Modularize the problems into small modules and then convert them into programs.
- Construct programs that demonstrate effective use of C features including arrays, strings, structures, pointers and files.
- Apply and practice logical ability to solve the real world problems.
- Apply Numerical methods to Solve the complex Engineering problems.

Syllabus

1. Write a program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?

2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while).
3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position, Copying one string to another, Reversing a string, adding one string to another.
4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int, long, float, and double. What happens when you add 1 to the largest possible integer number that can be stored?
5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.
6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).
7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.
8. Given two points on the surface of the sphere, write a program to determine the smallest arc length between them.
9. Implement bisection method to find the square root of a given number to a given accuracy.
10. Implement Newton Raphson method to det. a root of polynomial equation.
11. Given table of x and corresponding f(x) values, Write a program which will determine f(x) value at an intermediate x value by using Lagrange's interpolation/
12. Write a function which will invert a matrix.
13. Implement Simpson's rule for numerical integration.
14. Write a program to solve a set of linear algebraic equations.

CH-1201

MATHEMATICS – II

Course Objectives:

- The way of obtaining rank, eigen values and eigen vectors of a matrix.
- To know the importance of Cayley-Hamilton theorem and getting canonical form from a given quadratic form.
- To solve the system of equations by using direct and indirect methods.
- To solve first order and higher order differential equations by various methods.
- To obtain the Laplace transforms and inverse Laplace transforms for a given functions and their applications.

Course Outcomes:

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

- Find rank, eigen values and eigen vectors of a matrix and understand the importance of Cayley-Hamilton theorem.
- Reduce quadratic form to canonical forms and solving linear systems by direct and indirect methods.
- Demonstrate solutions to first order differential equations by various methods and solve basic applications problems related to electrical circuits, orthogonal trajectories and Newton's law of cooling
- Discriminate among the structure and procedure of solving higher order differential equations with constant and variable coefficients.
- Understand Laplace transforms and its properties and finding the solution of ordinary differential equations.

Syllabus

(Linear Algebra)

Rank of a matrix- Echelon form, Normal Form - Solution of Linear System of Equations - Consistency of Linear System of Equations - Direct & Indirect Methods: Gauss elimination

method, LU Factorization method, Gauss Seidal Method. Complex Matrices: Hermitian, Skew-Hermitian and Unitary Matrices and their Properties.

(Eigen Values and Eigen Vectors)

Eigen Values and Eigen Vectors of a Matrix - Cayley-Hamilton theorem - Inverse and Powers of a Matrix using Cayley-Hamilton's theorem and its applications. Diagonalization of a Matrix - Quadratic Forms - Reduction of Quadratic Form to Canonical Form - Nature of a Quadratic Form.

(Ordinary Differential Equations of First Order and its Applications)

Formation of ordinary differential equations (ODEs) - Solution of an ordinary differential equation - Equations of the first order and first degree - Linear differential equation - Bernoulli's equation - Exact differential equations - Equations reducible to exact equations - Orthogonal Trajectories - Simple Electric (LR & CR) Circuits - Newton's Law of Cooling - Law of Natural growth and decay.

(Differential Equations of Higher Order)

Solutions of Linear Ordinary Differential Equations with Constant Coefficients - Rules for finding the complimentary function - Rules for finding the particular integral - Method of variation of parameters - Cauchy's linear equation - Legendre's linear equation - Simultaneous linear differential equations.

(Laplace Transforms)

Introduction - Existence Conditions - Transforms of Elementary Functions - Properties of Laplace Transforms - Transforms of Derivatives - Transforms of Integrals - Multiplication by t^n - Division by t – Evaluation of integrals by Laplace Transforms - Inverse Laplace Transform - Applications of Laplace Transforms to Ordinary Differential Equations - Simultaneous Linear Differential Equations with Constant Coefficients - Second Shifting Theorem - Laplace Transforms of Unit Step Function, Unit Impulse Function and Laplace Transforms of Periodic Functions.

TEXT BOOK:

1. Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, $43r^d$ edition, Khanna publishers.

REFERENCE BOOKS:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K. International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal. Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.

CH-1202

PHYSICS

Course Objectives:

- To impart knowledge in basic concept of physics of Thermodynamics relevant to engineering applications.
- To grasp the concepts of physics for electromagnetism and its application to engineering. Learn production of Ultrasonics and their applications in engineering.
- To Develop understanding of interference, diffraction and polarization: connect it to a few engineering applications.
- To Learn basics of lasers and optical fibers and their use in some applications.
- To Understand concepts and principles in quantum mechanics and Nanopahse Materials. Relate them to some applications.

Course Outcomes:

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

- Understand the fundamentals of Thermodynamics and Laws of thermodynamics. Understand the working of Carnot cycle and concept of entropy.
- Gain Knowledge on the basic concepts of electric and magnetic fields. Understand the concept of the nature of magnetic materials. Gain knowledge on electromagnetic induction and its applications .
- Understand the Theory of Superposition of waves. Understand the formation of Newton's rings and the working of Michelson's interferometer. Remember the basics of diffraction, Evaluate the path difference. Analysis of Fraunhofer Diffraction due to a single slit
- Understand the interaction of matter with radiation, Characteristics of Lasers, Principle, working schemes of Laser and Principle of Optical Fiber. Realize their role in optical fiber communication.
- Understand the intuitive ideas of the Quantum physics and understand dual nature of matter. Compute Eigen values, Eigen functions, momentum of Atomic and subatomic

particles using Time independent one Dimensional Schrodinger's wave equation. Understand the fundamentals and synthesis processes of Nanophase materials.

Syllabus

THERMODYNAMICS

Introduction, Heat and Work, First law of thermodynamics and applications, Reversible and Irreversible process, Carnot cycle and Efficiency, Second law of thermodynamics, Carnot's Theorem, Entropy, Second law in terms of entropy, Entropy and disorder, Third law of thermodynamics (statement only).

ELECTROMAGNETISM

Concept of electric flux, Gauss's law - some applications, Magnetic field - Magnetic force on current, torque on current loop, The Biot-Savart's Law, B near a long wire, B for a circular Current loop, Ampere's law, B for a solenoid, Hall effect, Faraday's law of induction, Lenz's law, Induced magnetic fields, Displacement current, Maxwell's equations (no derivation), Magnetic materials: Classification of magnetic materials and properties.

Ultrasonics : Introduction, Production of Ultrasonics – Piezoelectric and Magnetostriction methods, acoustic grating, applications of ultrasonics

OPTICS

Interference: Principles of superposition – Young's Experiment – Coherence - Interference in thin films (reflected light), Newton's Rings, Michelson Interferometer and its applications.

Diffraction: Introduction, Differences between interference and diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at a single slit **(**Qualitative and quantitative treatment**)**.

Polarisation: Polarisation by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, Quarter and Half wave plate, circular and elliptical polarization.

LASERS and FIBRE OPTICS

Introduction, characteristics of a laser beam, spontaneous and stimulated emission of radiation, population inversion, Ruby laser, He-Ne laser, Semiconductor laser, applications of lasers

Introduction to optical fibers, principle of propagation of light in optical fibers, Acceptance Angle and cone of a fibre, Numerical aperture, Modes of propagations, classification of fibers,Fibre optics in communications, Application of optical fibers.

MODERN PHYSICS

Introduction, De Broglie concept of matter waves, Heisenberg uncertainty principle, Schrodinger time independent wave equation, application to a particle in a box. Free electron theory of metals, Kronig - Penney model (qualitative treatment), Origin of energy band formation in solids, Classification of materials into conductors, semi conductors and insulators.

Nanophase Materials

Introduction, properties, Top-down and bottom up approaches, Synthesis - Ball milling, Chemical vapour deposition method , sol-gel methods, Applications of nano materials.

TEXT BOOKS :

1. Physics by David Halliday and Robert Resnick – Part I and Part II - Wiley.
2. A textbook of Engineering Physics, Dr. M. N. Avadhanulu, Dr. P.G. Kshirsagar - S. Chand
3. Engineering Physics by R.K. Gaur and S.L. Gupta –Dhanpat Rai

REFERENCE BOOKS:

1. Modern Engineering Physics by A.S. Vadudeva
2. University Physics by Young and Freedman

CH-1203

ENGINEERING GRAPHICS

Course Objectives:

- Understand the basics of Engineering Graphics and BIS conventions.
- Develop the graphical skills for communication of concepts, ideas and design of engineering products through technical drawings
- Demonstrate and practice the various profiles/curves used in engineering practice through standard procedures.
- Demonstrate and practice the orthographic projections of points, lines, planes, solids and section of solids
- Demonstrate and practice the development of surfaces of simple solids
- Familiarize the basic concept of isometric views clearly.

Course Outcomes:

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

- Develop simple engineering drawings by considering BIS standards.
- Able to draw different engineering curves with standard Procedures
- Comprehend the basics of orthographic projections and deduce orthographic projections of points, lines, planes and solids at different orientations in real life environment.
- Visualize clearly the sections of solids.
- Apply the concepts of development of surfaces while designing/analyzing any product.
- Recognize the significance of isometric drawing to relate 2D environment with 3D environment.

Syllabus

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions, and Scales.
Curves: Conic sections: General construction of ellipse, parabola and hyperbola. Construction of involutes of circle and polygons only. Normal and tangent to curves.

Projections of Points: Principal or Reference Planes, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane.

Projections of Straight Line Inclined to Both the Reference Planes: Projections of Planes: Projection of Perpendicular planes: Perpendicular to both reference planes, perpendicular to one reference plane and parallel to other reference plane and perpendicular to one reference plane and inclined to other reference plane. Projection of Oblique planes. Introduction to Auxiliary Planes.

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to other and axes inclined to both the reference planes.

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids (Prism, Pyramid, Cylinder and Cone) in simple position only.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

Isometric Views: Isometric projection, Isometric scale and Isometric view. Isometric view of Prisms, Pyramids, cylinder, cone, and their combinations.

TEXT BOOK:

1. Elementary Engineering Drawing by N.D.Bhatt, Charotar Publishing House.

REFERENCE BOOK:

1. Engineering Graphics by K.L. Narayana and P. Kannaiah, Tata Mc-Graw Hill

CH-1204

MATERIALS SCIENCE & ENGINEERING

Course Objectives:

Materials science and engineering is an important subject to every engineer to understand about the materials' behavior in different environments. Main objectives of the study are as follows:

- To understand the structure of atoms
- To learn something about the crystalline nature of the materials
- To know about the influence of atoms controlling the properties of materials
- To know the equivalency of the materials for replacement
- To learn to prepare alloys, composites for conventional materials
- To find the relation between arrangement an thermodynamic properties of materials

Course Outcomes:

The student will be able to

- Analyze the behavior of crystalline materials w.r.t their atomic arrangement.
- Understand the imperfections in crystalline materials
- Assess the mechanical behavior of the materials
- Explain phase transformations of alloys
- Elaborate the corrosion properties of materials

Syllabus

An introduction to materials, classification of engineering materials, brief review of atomic structure, calculation of energy of electron of Bohr's atomic model, Bonds in materials – classification, properties of ionic, covalent and metallic solids, variation in bonding character and properties. Crystal Geometry and crystal structure – solids- crystalline solids and amorphous solids (non-crystalline), differences between crystalline and non-crystalline materials. Ideal crystal, space Lattice, unit cell, primitive cell, non-primitive cell, lattice co-ordinates, Bravis lattices for crystal systems, crystal systems and their properties, symmetry and elements of symmetry, Atomic packing faction and packing efficiency (SC, BCC, FCC, Diamond cubic and HCP structures), c/a ratio for HCP structure. Miller indices for directions

and linear density calculation, planes in crystals and their representation, planar density calculation, coordination number. Determination of crystal Structure by X-ray diffraction method – Debye method, numerical problems for different cubic structures (SC, BCC and FCC).

Fundamentals of thermodynamics – stability and meta-stability of materials, internal energy (E), enthalpy (H), Gibb's free Energy (G), and thermal entropy and configurational entropy (S). solid solutions-types, crystal imperfections – classification, point defects- classification and estimation of point defects in the crystals; Imperfections (dislocations) – classification (edge and screw); Berger circuits and Burgers Vector, planar defects, volume defects, dislocation reactions, role of dislocations in determining crystal properties; surface defects - types

Mechanical Properties: Stress –types of stresses; Strain-types of strain; true stress and true strain, engineering stress and engineering strain of the materials, relation between engineering strain and true strain, relation between engineering stress and true stress; Hooke's Law; Poisson's Ratio, stress-strain diagram and its uses; different moduli of elasticity – Young's modulus, shear modulus, and bulk modulus; relation between different moduli of elasticity, strain vs stress relationship diagrams for different materials (metals, non-metals, rubbers and plastics and polymers); elastic deformation and plastic deformation and their differences. Critical Resolved shear stress (CRSS). Fracture – types, ductile fracture and its mechanism, brittle fracture and its mechanism (Griffith's criteria), fatigue factors affecting the fatigue, creep and creep failure mechanisms, creep resistance materials. Composite materials – classification, advantages of composite materials over conventional materials, Limitations of composite materials, factors affecting the performance of fibrous composites, factors affecting the performance of matrix in composites,

Phase- time scale for phase changes, Phase diagrams- phase rule, single component systems, Binary phase changes, the lever rule and numerical problems, advantages of phase diagrams, advantages of alloying of metals on the properties of steels, Iron-iron carbide (Fe-Fe_3C) phase diagram, limitations of plain carbon steels, types of steels used in chemical industries,

Corrosion and prevention: Principles and mechanism of corrosion, types of corrosion cells: composition cell, concentration cell, stress cells, Different forms of corrosion, prevention and

control of corrosion: proper selection of materials, proper design and fabrication procedure, application of protective coatings.

TEXT BOOKS:

1. `Materials Science & Engineering' by V.Raghavan, Prentice Hall of India Ltd, New Delhi
2. `Elements of Materials Science & Engineering', 5th Edition, Lawrence H.VanVlack, Addision-Weley Publishing Company

REFERENCE BOOKS:

1. `Science of Engineering Materials', Vols.1-3, by Manas Chanda, McMillan Company of India, Delhi
2. Principles of Materials Science & Engineering', William F.Smith, McGraw-Hill Publishing Co.
3. `Essentials of Materials Science' by A.G. Guy.
4. A textbook of Engineering physics, by Dr.M.N.Avadhanulu and Dr.P.G.Kshirsagar; S.Chand and company pvt Ltd. Chapters 26 and 27.
5. An introduction to corrosion science and engineering By Herbert Uhilig and R. Winston Revie, Published by John Wiley and sons, New York.
6. Corrosion Engineering by Mars.G.Fontana, McGraw-Hill, publication

CH-1205

MECHANICAL ENGINEERING

Course Objectives:

- To be aware of the basics in Thermodynamics
- To get knowledge on applications of steam tables
- To understand the principles and applications of IC engines, compressors and turbines
- To comprehend the principles of belts, chain drives and gears

Course Outcomes:

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

- To Know the thermodynamic laws and various processes
- To make out the applications of steam in boilers and turbines
- To derive the various performance parameters related to IC engines and of air compressors
- To arrive basic needs of working of belts, chain drives and gears

Syllabus

Thermodynamics: Definitions, systems, classification of thermodynamic systems, cycles and zeroth law of thermodynamics, first law of thermodynamics, closed system, flow processes, open systems with steady flow process, applications of steady flow energy equation to engineering systems.

Second law of thermodynamics: Carnot cycle, inequality of Classius-reversible Carnot cycle, entropy, relation between heat and entropy, general expression for entropy change, entropy change of a perfect gas during various thermodynamic processes, air standard cycles, Otto, diesel, dual combustion cycles,

Properties of steam and use of steam tables: Boilers, classification steam boilers, simple vertical, Cochran, locomotive boiler, Babcock and Wilcox boiler, steam generation, Rankine cycle.

Impulse and reaction turbine: Classification of steam turbines, velocity diagram and power produced in impulse turbine, performance of steam turbines, reduction of rotor speed,

I C engines: Classification-main composition of IC engines, carburettor, fuel pump injector, cooling systems for IC engines, working of 2-stroke and 4-stroke petrol and diesel engines, power and efficiency of IC engines.

Reciprocating air-compressors: Single stage, work done during cycle, effect of clearance, two stage compressors, condition for minimum work, effect of inter-cooling, efficiency.

Drives: Belts, expression for the ratios of tension on the slack and tight side, power transmitted – V-belts, chain drives, gears – spur, helical, bevel gear, trains simple and compound.

TEXT BOOKS:

1. A Text Book of Thermal Engineering by R.S.Khurmi and J.K.Gupta
2. 'Theory of Machines' by R.S.Khurmi

REFERENCE BOOKS:

1. 'Engineering Thermodynamics' by P.K.Nag
2. 'Engineering Thermodynamics' by J.B.Jones and R.E.Dugar
3. 'Engineering Thermodynamics' by R.K.Rajput
4. 'Theory of Machines' by Balani

CH-1206

WORKSHOP LAB

Course Objectives:

- Get hands on experience with the working skills in Carpentry trade.
- Know how to work with Sheet Metal tools.
- Get familiar with the working skills of Metal Fitting operations.
- Get hands on experience with house hold electrical wiring.

Course Outcomes:

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

- Can be able to work with Wood Materials in real time applications.
- Can be able to build various parts with Sheet Metal in day-to-day life.
- Can be able to apply Metal Fitting skills in various applications.
- Can be able to apply this knowledge to basic house electrical wiring and repairs.

Syllabus

Carpentry: Any three jobs from – Half lap joint, Mortise and Tenon joint, Half – lap Dovetail joint, Corner Dovetail joint, Central Bridle joint.

Sheet Metal: Any three jobs from – Square tray, Taper tray(sides), Funnel, Elbow pipe joint.

Fitting: Any three jobs from – Square, Hexagon, Rectangular fit, Circular fit and Triangular fit.

House wiring: Any three jobs from – Tube light wiring, Ceiling fan wiring, Stair-case wiring, Corridor wiring.

REFERENCE BOOKS:

1. Elements of workshop technology, Vol.1 by S. K. and H. K. Choudary.
2. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.
3. Engineering Practices Lab Manual, Jeyapoovan, Saravana Pandian, 4/e Vikas.

CH-1207

PHYSICS LAB

Course Objectives:

- To enable the students to acquire skill, technique and utilization of the Instruments
- Draw the relevance between the theoretical knowledge and to imply it in a practical manner with respect to analyze various electronic circuits and its components.
- To impart the practical knowledge in basic concepts of Wave optics, Lasers and Fiber optics.
- To familiarize the handling of basic physical apparatus like Vernier callipers, screw gauge,spectrometers, travelling microscope, laser device, optical fibre, etc.

Course Outcomes:

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

- Design and conduct experiments as well as to analyze and interpret
- Apply experimental skills to determine the physical quantities related to Heat, Electromagnetism and Optics
- Draw the relevance between theoretical knowledge and the means to imply it in a practical manner by performing various relative experiments.

Syllabus

1. Determination of Radius of Curvature of a given Convex Lens By forming Newton's Rings.
2. Determination of Wavelength of Spectral Lines in the Mercury Spectrum by Normal Incidence method.
3. Study the Intensity Variation of the Magnetic Field along axis of Current Carrying Circular Coil.
4. Determination of Cauchy's Constants of a Given Material of the Prism using Spectrometer.
5. Determination of Refractive Index of Ordinary ray μ_o and Extraordinary μ_e ray.

6. Determination of Thickness Given Paper Strip by Wedge Method.
7. Calibration of Low Range Voltmeter.
8. Calibration of Low Range Ammeter.
9. Determination of Magnetic Moment and Horizontal Component of Earth's Magnetic Field.
10. Lees Method - Coefficient of thermal Conductivity of a Bad Conductor.
11. Carey Foster's Bridge – Verification of laws of Resistance and Determination Of Specific Resistance.
12. Melde's Apparatus – Frequency of electrically maintained Tuning Fork.
13. Photoelectric cell-Characteristics.
14. Planks Constants.
15. Laser- Diffraction.

CH-1208

GENERAL ENGINEERING LABORATORY

MECHANICAL ENGINEERING LABORATORY

Course Objectives:

- To be aware of the viscosity, flash point of oil samples and calorific value of a gas
- To get knowledge on calibration of pressure gauge, flywheel and torsional pendulum
- To understand the principles and applications of Air compressors and IC engines

Course Outcomes:

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

- To determine the viscosity, flash point and calorific value of fluids
- To make out the applications of pressure gauge, flywheel and torsional pendulum
- To derive performance parameters related to IC engines and efficiencies ofair compressor

Experiments

1. Find the viscosity of the given sample of oil using Redwood viscometer-1
2. Find the viscosity of the given sample of oil using Redwood viscometer-II
3. Find the flash point of the given sample of oil using Abel's flash point tester
4. To calibrate pressure gauge using standard pressure and standard weights
5. Draw the valve timing diagram of a 4-stroke diesel engine and port timing diagram of a 2-stroke petrol engine
6. Perform load test at full load, half load, ¼ th load on a 4-stroke Ruston engine and draw the performance curves
7. Find the volumetric efficiency, isothermal efficiency of the given compressor
8. To determine the moment of inertia of a fly-wheel and shaft experimentally and compare the values with the calculated values
9. To determine experimentally the calorific value of a gaseous fuel by using Junkers gas calorimeter
10. To determine the modulus of rigidity of the material of the wire by torsional oscillators

ELECTRICAL ENGINEERING LABORATORY

Course Objectives

This course provides

- Insight of fundamental laws in electrical engineering.
- Deals with the constructional and operational details of DC and AC machines.
- Analyze electrical and magnetic circuits using basic laws of electrical engineering

Course Outcomes

After the completion of the course, the student should be able to

- Understand the basic laws of electrical and magnetic circuits.
- Analyze the characteristics of DC generator and motors.
- Design of equivalent circuit of transformer.
- Apply the basic knowledge to solve problems on synchronous machines.

Experiments

1. Study and calibration of ammeter
2. Study and calibration of voltmeter
3. Study and calibration of wattmeter
4. Study and calibration of energy meter
5. Measurement of low resistance (armature)
6. Measurement of medium resistance (field)
7. Measurement of insulation resistance
8. Measurement of filament resistance
9. Verification of KCL and KVC
10. Superposition theorem.
11. Parameters of a choke coil
12. OC and SC tests on transformer
13. Load test D.C. shunt machine
14. OC test on DC,. separately excited machine
15. Swinburne's test
16. 3-phase induction motor (No load and rotor block tests)
17. Alternator regulation by Syn. impedance method

CH-2101

MATHEMATICS-III

Course Objectives:

The objectives, in particular are to learn about:

- Differentiation of vector functions of real variables, curves in space, differential operators, the concept of gradient, divergence and curl and their potential applications.
- The concepts of Line-, Surface and Volume integrals and transformation theorems such as **Green's** theorem in the plane, **Stoke's** theorem, **Gauss Divergence** theorem and their applications.
- Formation of Partial Differential Equations and solution of first order first degree linear, non-linear P**artial Differential Equations**, Homogeneous and Non homogeneous linear partial differential equations with constant coefficients.
- The method of separation of variables and how to use it to find the solution of one dimensional wave (string equation), one-and two-dimensional **Heat flow equations**, **Laplace's equation** in Cartesian and polar coordinates.
- The concept of integral transforms, namely, **Fourier transforms**, **Fourier Sine, Cosine and related inverse transforms, and** their applications in solving several Physical and Engineering problems.

Course Outcomes:

At the end of the course, the students would be able to:

- Understand differential operations and the concepts of Gradient, Divergence and Curl and their applications.
- Apply the concepts of Line integrals, Surface Integrals, Volume Integrals and their potential applications: work done by a force field, circulation and Flux etc. Also, find out the relation between Line, Surface and Volume integrals: Green's theorem in the plane, Stoke's and Divergence theorems.
- Understand the formation of partial differential equations and the solving Linear and Non linear first order partial differential equations. Also, how to find the solution of Linear Partial Differential Equations with constant coefficients by finding the complementary function and particular integrals.

- Apply the method of separation of variables to solve the important governing equations of one dimensional wave equation, One and Two dimensional heat flow equations, Laplace's equations in Cartesian and polar coordinates.
- Apply the knowledge of Fourier transform techniques in solving several Initial and Boundary value problems of Engineering, such as problems in Conduction of heat / Thermodynamics, Hydraulics transverse vibrations of a string, oscillations of an elastic beam, bending of beams, electrical circuits, free and forced vibrations of a membrane and transmission lines , etc.

Syllabus

(Vector Calculus-Differentiation)

Differentiation of vectors, curves in space, velocity and acceleration, relative velocity and relative acceleration, scalar and vector point functions, vector operator ∇ applied to scalar point functions- gradient, ∇ applied to vector point functions- divergence and curl. Physical interpretation of gradient, divergence and culrl (i.e., ∇f, $\nabla.\overline{F}$, $\nabla\times\overline{F}$), Irrotational and Solenoidal fields, the relations obtained after ∇ applied twice to point functions, ∇ applied to products of two functions.

(Vector Integration)

Integration of vectors, line integral, circulation, work done, surface integral-flux, Green's theorem in the plane, Stoke's theorem, volume integral, Gauss Divergence theorem. (All theorems without proofs)

Introduction of orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates

(Partial Differential Equations)

Formation of partial differential equations, solutions of partial differential equations- equations solvable by direct integration, linear equations of first order: Lagrange's Linear equation, non-linear equations of first order, Charpit's method. Homogeneous linear equations with constant coefficients- rules for finding the complementary function, rules for finding the particular integral (working procedure), non- homogeneous linear equations.

(Applications Of Partial Differential Equations)

Method of separation of variables, One dimensional wave equation-vibrations of a stretched string, one dimensional Heat flow equation, Two dimensional heat flow in steady state - solution of Laplace's equation in Cartesian and polar coordinates (two dimensional).

(Integral Transforms (Fourier Transform)

Introduction, definition, Fourier integral, Sine and Cosine integrals, Complex form of Fourier integral, Fourier transform, Fourier Sine and Cosine transforms, Finite Fourier Sine and Cosine transforms, properties of Fourier transforms.

Convolution theorem for Fourier transforms, Parseval's identity for Fourier transforms, Fourier transforms of the derivatives of a function, simple applications to Boundary value problems.

TEXT BOOK:

1. Scope and treatment as in "Higher Engineering Mathematics", by Dr. B.S.Grewal, **43rd Edition**, Khanna Publishers.

REFERENCE BOOKS:

1. Graduate Engineering Mathematics by V B Kumar Vatti, I.K.International publications
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
4. Mathematical Methods of Science & Engineering aided with MATLAB by Kanti B.Dutta, Cengage Learning India Pvt. Ltd.
5. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw Hill Company.
6. Advanced Engineering Mathematics by H.K.Dass. S.Chand Company.

CH-2102

SOLID MECHANICS

Course Objectives:

- To impart knowledge about the behaviour of elastic bodies subjected to different types of external forces.
- To impart skills of analysing the statically determinate beams subjected to different types of loads for shear force, bending moment and their corresponding stress distribution.
- To develop skills to analyse shafts, springs and shells for determining the critical stress distribution

Course Outcomes:

At the end of the course the students will be able to

- Analyse different bodies subjected to different types of loads like axial forces, transverse loads and torsional moment.
- Analyse the statically determinate beams subjected to loads.
- Analyse shafts, springs and shells.

Syllabus

Axial loads: Simple stress and strain, Hook's law, load extension diagram for mild steel, stress in compound assemblies, thermal stresses,

Transverse loads: Shear force and bending moment diagrams for a) cantilevers, b) simply supported beams and c) over-hanging beams due to concentrated loads and U D L s only,

Theory of simple bending: Relation between i) f and y, ii) M and I, iii) E and R, distribution of shear stress in common shapes of cross-section,

Principal stresses and principal planes, maximum shear stress and its plane, Mohar's circle of stress,

Torsion of solid and hollow circular shafts, transmission of horse power, design of flange coupling, closed coil helical spring i) under axial load and ii) under axial twist, riveted joints, design of lap joints,

Stress in thin cylindrical shells and spherical shells, stress in thick cylinders, compound cylinders, pressure due to shrink-fitting,

TEXT BOOK:

1. 'Strength of Materials' by Ramamrutaham

REFERENCE BOOK:

1. 'Elements of Strength of Materials' by S.P.Timoshenko and D.H.Young, East West Press, New Delhi

CH-2103
MANAGERIAL ECONOMICS

Course Objectives:

1. To bring about an awareness about the nature of Managerial Economics and its linkages with other disciplines.
2. To understand the Micro and Macro Environment of Business.
3. To familiarise the prospective engineers with the concepts and tools of Managerial Economics with an objective to understand the real world of business.

Course Outcomes:

Managerial Economics will help the prospective engineers, who are likely to occupy managerial positions in future to understand the various economic activities in business and industry for an effective and efficient running of the organisations.

Syllabus

Significance of Economics and Managerial Economics:

Economics: Definitions of Economics- Wealth, Welfare and Scarcity definition Classification of Economics- Micro and Micro Economics.

Managerial Economics: Definition, Nature and Scope of Managerial Economics, Differences between Economics and Managerial Economics, Main areas of Managerial Economics, Managerial Economics with other disciplines.

Demand Analysis :Demand - Definition, Meaning, Nature and types of demand, Demand function, Law of demand - Assumptions and limitations. Exceptional demand curve.

Elasticity of demand - Definition, Measurement of elasticity, Types of Elasticity (Price, Income, Cross and Advertisement), Practical importance of Price elasticity of demand, Role of income elasticity in business decisions, Factors governing Price Elasticity of demand.

Demand Forecasting - Need for Demand forecasting, Factors governing demand forecasting, Methods of demand forecasting: Survey methods- Experts' opinion survey method and consumers Survey methods.

Utility Analysis: Utility- Meaning, Types of Economic Utilities, Cardinal and Ordinal Utility, Total Utility, Marginal Utility, The law of Diminishing Marginal Utility and its Limitations

Theory of Production and Cost analysis:

Production - Meaning, Production function and its assumptions, use of production function in decision making; Law of Variable Proportions: three stages of the law

Cost analysis - Nature of cost, Classification of costs - Fixed vs. Variable costs, Marginal cost, Controllable vs. Non - Controllable costs, Opportunity cost, Incremental vs. Sunk costs, Explicit vs. Implicit costs, Replacement costs, Historical costs, Urgent vs. Postponable costs, Escapable vs. unavoidable costs, Economies and Diseconomies of scale

Market Structures : Definition of Market, Classification of markets; Salient features or conditions of different markets - Perfect Competition, Monopoly, Duopoly , Oligopoly, Importance of kinked demand curve ;Monopolistic Competition

Pricing Analysis : Pricing - Significance: Different Pricing methods- Cost plus pricing, Target pricing, Marginal cost pricing, Going -rate pricing, Average cost pricing, Peak load pricing , Pricing of joint Products, Pricing over the life cycle of a Product, Skimming pricing Penetration pricing, Mark- up and Mark- down pricing of retailers.

Business cycles, Inflation and Deflation:

Business cycles - Definition , Characteristics , Phases, Causes and Consequences; Measures to solve problems arising from Business cycles

Inflation -Meaning, Types, Demand- pull and Cost push inflation, Effects of Inflation, Anti-inflationary measures.

Deflation- Meaning, Effects of Deflation, Control of Deflation, Choice between Inflation and Deflation.

TEXT BOOKS:

1. Sankaran,S., **Managerial Economics,** Marghan Publications, 2015, Chennai.
2. Aryasri, A.R., **Managerial Economics and Financial Analysis,** MC Graw Hill Education, New Delhi,2015.

CH-2104

ORGANIC CHEMISTRY

Course Objectives:

The student will be able to:

- appreciate the nature and scope of organic chemistry.
- apply key concepts from general chemistry including electronegativity, bonding (ionic and covalent), hybridization of atomic orbitals, and molecular orbital theory to organic systems.
- draw skeletal structures for organic compounds.
- apply acid-base concepts to organic systems; predict ordering of acid or base strength.
- name alkanes, alkenes, polyenes, alkynes, alkyl halides, aromatic compounds, carbonyl compounds, amines and their various derivatives using systematic (IUPAC) nomenclature.
- draw reaction mechanisms for some key reactions.
- recognize stereochemistry and be able to apply the Cahn-Ingold-Prelog system to designation of stereochemistry (E/Z or R/S).
- learn many of the reactions of alkanes, alkenes, polyenes, alkynes, aromatic, carbonyl, and amine compounds, and close related species. Be able to predict reactions involving these functional groups.
- be able to solve problems employing spectroscopic methods including mass spectrometry, infrared and NMR spectroscopy
- understand the basic chemical and structural features of biomolecules, including lipids, carbohydrates, amino acids and proteins, and nucleic acids

Course Outcomes:

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

- Determine the molecular formula for organic compounds
- Differentiate the structure and properties of biomolecules, polymers and heterocyclic compounds
- Identify the role of chemical engineer in modern drug discovery programs

- Separate the racemic mixtures using resolution methods
- Elucidate the structure of organic compounds (small molecules) using spectroscopic methods.

Syllabus

Numerical problems**:** Determination of percentage composition of carbon, hydrogen and nitrogen, molecular weight determination by depression in freezing point and elevation of boiling point methods, molecular weight of acids by silver salt method; molecular weight of bases by chloroplatinate method, determination of molecular formula of a compound, problems relating to reactions of carboxylic acids, functional derivatives of acids, carbonyl compounds, alcohols, amines, phenols, diazonium salts applications, alkenes and their laboratory tests,

Nomenclature of alkanes, alkenes, alkynes, dienes, cyclic aliphatic hydrocarbons, structure of benzene, nomenclature of benzene derivatives, arenas, industrial preparation of ethylene, acetylene; sp, sp^2 and sp^3 hybridization; preparation and chemical reactions; conformational analysis of ethane, propane and butane, Wurtz reaction, Diels-Alder reaction, aromaticityMorkovinkov rule, Clemmensen and Wulf-Kishner reduction,

Electro-philic and nucleo-philic aromatic substitution: Orientation in desubstituted benzenes, mechanism of nitration, halogenation, sulphonation, Friedel-Craft's alkylation and acylation reactions, nomenclature of alkyl halides, preparation and chemical reactions, mechanisms of SN_1, SN_2, E_1, E_2 reactions, nomenclature of aryl halides, preparation and chemical reactions: low reactivity of vinyl and aryl halides, Sandmeyer reaction,

Nomenclature of alcohols; industrial preparation of ethyl alcohol, preparation and chemical reactions, Lucas test, nomenclature of mono, dicarboxylic acids, industrial preparation of formic, acetic, benzoic, phthalic, salicylic acids, preparation and chemical reactions, mechanism of HVZ reaction and Claisen condensation, nomenclature of functional derivatives of acids, preparation and chemical reactions, mechanism of Hoffmann bromamide reaction, acid and base catalyzed hydrolysis of ester, nomenclature of ethers and epoxides, industrial preparation of ether and ethylene oxide, preparation and chemical reactions; Williamson's synthesis,

Nomenclature of aldehydes and ketenes: Industrial preparation of formaldehyde, acetaldehyde, benzaldehyde, salicyaldehyde, acetone; preparation and chemical reactions; mechanisms of Cannizaro, Aldol, Reformatsky and Wittig reactions, reactions without mechanisms -Perkin,

Cope, Knoevenagel and Pinacol-Pinacolone reactions, difference between aldehyde and ketone, nomenclature of phenols, industrial preparation of phenol, preparation and chemical reactions, mechanisms of Fries rearrangement, Kobe reaction, Reimer-Tiemann reaction, classification of carbohydrates, structure of glucose and fructose, reactions of glucose and fructose, Ruff degradation, Wohls degradation, filiani-Fisher synthesis, glucose into fructose, fructose into glucose, glucose to vitamin-C, mechanism of Osazone formation,

Nomenclature of amines, industrial preparation of aniline, preparation and chemical reactions - exhaustive methylation, mechanism of Hoffmann elimination, benzedene rearrangement without mechanism, Hinsberg test, differentiation test using nitrous acid, preparation of diazonium salts and synthetic applications, preparation of sulphanilamide, sulphaguanidine, sulphamerazine, sulphapyridene (sulpha drugs), mode of action of sulpha drugs,

Preparation of soaps and detergents**:** Mode of action of soaps, differences between soaps and detergents; preparation of malonic, acetoacetic ester and their synthetic applications, preparation of Grignard reagents and their synthetic applications, preparation of polyethylene, polystyrene, teflon, PVC, polyvinyl cyanide, rubber-vulcanisation, styrene-butadiene rubber, polychloroprene, bakelite, nylon-6 and nylon 6-6, plexiglas, terylene, Ziegler-Natta polymerization, definition of thermoplastics and thermosetting plastics,

Isomerism**:** Structural and optical isomerism, geometrical isomerism, E Z configuration, sequence rules, R & S configuration, racemic mixture and their separation, asymmetric synthesis - Fischer projection formula, definitions of axial and equatorial bonds, 1-3- diaxial interaction, enatiomers, diastereomers, mesomers, isomerism in cyclic compounds, chair, boat and twisted boat structures (1-methylcyclohexane, 1, 2-cyclohexane diol), sSynthetic applications of - Zn/Hg, Na-$NH_3$$LiAH_4$, $NaBH_4$, diborane and zinc dust, soda lime, OsO_4, hydroxylamine, acetic anhydride, benzoylchloride and PCl_5.

REFERENCE BOOKS:

1. ‘Text Book of Organic Chemistry’ by Morrison & Boyd
2. ‘Text Book of Organic Chemistry’ by Bahl&Tuli
3. ‘Text Book of Organic Chemistry’ by M.K.Jain
4. ‘Text Book of Organic Chemistry’ by I.L.Finar (Vols.1&2 as reference books)

CH-2105

PARTICLE & FLUID PARTICLE PROCESSING

Course Objectives:

Mechanical Operations is one of the core subjects for chemical engineers, where student can learn some of the unit operations necessary for process industry. Main objectives of the inclusion of this subject are:

- To make the students exposed to different geometrical sizes of raw materials used in the industries, area of calculation of the particles w.r.t their sizes
- To get familiarity with the different laws of grinding
- To do the power consumption calculations
- To learn different separation process on their physical properties
- To differentiate between the process such as mixing and agitation
- To know the movement of particles in different liquids (viscous)

Course Outcomes:

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

- Select suitable size reduction equipment based on performance and power requirement.
- Analyze particle size distribution of solids
- Evaluate solid-fluid separation equipment
- Determine the power required for agitation, blending and mixing
- Select conveyers for the transportation of materials in the industry

Syllabus

Characteristics of solid particles – shape, size, differential and cumulative screen analysis, specific surface area, particle population, different mean diameters for a mixture of particles,

Principles of comminution - Laws of crushing, description and working of size reduction equipment - jaw, gyratory and roll crushers, hammer mills, revolving mills, attrition mills,

fluid energy mill, cutting machines, open and closed circuit grinding, wet and dry grinding, grindability index,

Size separation, screening, industrial screens - grizzly, gyratory and vibratory screens, revolving screens, trammels, capacity and effectiveness of screens, magnetic separation, electrostatic separation, froth flotation,

Filtration - description and working of filtration equipment, plate and frame filter press, shell and leaf filters, rotary drum filter, filter aid, centrifugal filtration, top suspended batch centrifuge, theory of filtration, washing of cakes,

Motion of particles through fluids- drag, free and hindered settling, settling velocities, classification, sink and float methods, differential setting methods - jigging and tabling, cyclone separators,

Batch sedimentation, thickeners, flocculation, centrifugal sedimentation, gravity and centrifugal decanters,

Agitation of liquids, power consumption in agitated vessels, scale up of agitation equipment, mixing equipment for mixing of solids and pastes, mixers for dry powders, mixing index,

Conveying, types of conveyors – mechanical, belt, chain and screw conveyors, elevators, pneumatic conveyors, size enlargement - need and applications.

TEXT BOOK:

1. 'Unit Operations of Chemical Engineering' by W.L. McCabe, J.C. Smith and P.Harriot, McGraw- Hill Book Company

REFERENCE BOOKS:

1. 'Chemical Engineering -Vol.2' by J.H.Coulson and J.F.Richardson, Pergaman press and ELBS
2. 'Chemical Engineer's Hand Book' by R.H.Perry {ed}, McGraw-Hill Book Co.
3. 'Unit Operations' by Brown et al., Asian Publishing House

4. ‘Introduction to Chemical Engineering’ by Badger and Banchero, McGraw-Hill Book Company

CH-2106

ORGANIC CHEMISTRY LABORATORY

Course Objectives:

The student will learn to analyze the organic compounds. The students will be exposed to the preparation of various organic chemicals in this laboratory.

Course Outcomes:

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

- Analyze and identify the given organic compound
- Prepare organic compounds like aspirin, benzanilide, m-dinitrobenzene, benzoic acid, phthalimide, methyl orange, parabenzoquinone and nerolin
- Identify extra elements

List of Experiments:

1. Preparation of aspirin
2. Preparation of benzanilide
3. Preparation of m-dinitrobenzene
4. Preparation of benzoic acid
5. Preparation of phthalimide
6. Preparation of methyl orange
7. Preparation of parabenzoquinone
8. Preparation of nerolin
9. Detection of extra elements
10. Analysis of compound -1
11. Analysis of compound -2
12. Analysis of compound -3
13. Analysis of compound -4
14. Analysis of compound -5
15. Analysis of compound -6

CH-2107

PARTICLE AND FLUID PROCESSING LABORATORY

Course Objectives:

Solid processing is an essential component in process industries. In the present day, when the world is facing the challenge of dealing with depleting mineral resources, this subject assumes high importance to the students of chemical engineering. The student is introduced to the concepts of sampling, processing of solid raw materials. The student also gets hands on training on operating various machines used for processing of solids.

Course Outcomes:

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

- Select suitable methods for size reduction of minerals or other intermediates
- Analyze particle size distribution of solids
- Evaluate suitable mechanical separations of powders, solid-liquid and solid-gas mixtures

List of Experiments:

1. To take a representative sample from a bulk by two methods, viz. Riffle and cone & quartering and to find out the average size (volume-surface mean diameter) of the samples
2. To determine the grindability index {GI} of coal by hard groove machine
3. To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen
4. To verify the laws of crushing using any size reduction equipment like crushing rolls, ball mill or vibrating mill and to find out the work Index {WI} of the material
5. To compare open circuit and closed circuit grinding by means of a ball mill
6. To determine the optimum time of sieving for a given sample of material
7. To find the effectiveness of hand screening of a given sample by a given screen

8. To find the screen effectiveness of a trommel
9. To separate a mixture of coal into two fractions using sink and float method
10. To separate a mixture of coal into two fractions using froth flotation technique
11. To find the size analysis of a given fine sample using beaker decantation method
12. To separate a mixture of particles by jigging
13. To concentrate a given material by means of tabling
14. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions
15. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.

CH-2108

MATLAB

Course Objectives:

The student will learn to apply the knowledge of *MATLAB* for solving Chemical Engineering problems.

Course Outcomes:

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

- Apply Matlab to create and print arrays and execute function files
- Solve linear equations using Matlab
- Determine the curve fit equation for the given data
- Draw 2D plots and 3D plots for the given data

Syllabus

Introduction, Tutorial lessons: MATLAB session, working with arrays of numbers, creating and printing simple data, saving and executing a script file, creating and executing function files, working with files and directories.

Interactive computation - Matrices and vectors, matrix and array operations, creating and using inline functions, using built in functions and online help, saving and loading data, plotting simple graphs.

Script files, function files, language specific features, advanced data objects.

Applications - linear algebra, curve fitting and interpolation, data analysis and statistics, numerical integration, ordinary differential equations, nonlinear algebraic equations.

Basic 2D plots, using subplot to layout multiple graphs. 3-D plots, symbolic Math tool box: two useful tools in symbolic Math tool box, using symbolic Math tool box.

TEXT BOOK:

1. `Getting started with MATLAB: A quick introduction for scientists and engineers' by Rudra Pratap, Oxford University press

CH -2109
ENVIRONMENTAL SCIENCE

Course Objectives:

The aim of this course is to make the students better understand the changes in the environment and be given a greater voice and planning conservation through an interdisciplinary environmental science curriculum that is design to enhance scientific enquiry and to strengthen competence.

Course Outcomes:

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

- Understand various types of pollution regulations and their scientific bases.
- Apply knowledge for the protection and improvement of the environment.
- Recognize the major concepts in environmental science and demonstrating in-depth of the environment

Syllabus

Introduction: Definition, scope and importance, measuring and defining environmental development – indicators,

Ecosystems: Introduction, types, characteristic features, structure and functions of ecosystems – forest, grassland, desert, aquatic (lakes, rivers and estuaries),

Environmental and natural resources management: Land resources- land as a resource, common property resources, land degradation, soil erosion and desertification, effects of modern agriculture, fertilizer-pesticide problems,

Forest resources- use and over-exploitation, mining and dams –their effects on forest and tribal people,

Water resources – use and over utilization of surface and ground water, floods, droughts, water logging and salinity, dams-benefits and costs, conflicts over water,

Energy resources- Energy needs, renewable and non-renewable energy sources, use of alternate energy sources, impact of energy use on environment,

Bio-diversity and its conservation: Value of bio-diversity- consumptive and productive use, social, ethical, aesthetic and option values, bio-geographical classification of India - India as a mega diversity nation, threats to biodiversity, hot spots, habitat loss, poaching of wild life, loss of species, seeds etc., conservation of biodiversity - in-situ and ex-situ conservation,

Environmental pollution- local and global issues: Causes, effects and control measures of air pollution, indoor air pollution, water pollution, soil pollution, marine pollution, noise pollution, solid waste management, composting, vermiculture, urban and industrial wastes, recycling and re-use, nature of thermal pollution and nuclear hazards, global warming, acid rain , ozone depletion,

Environmental problems in India: Drinking water, sanitation and public health, effects of activities on the quality of environment, urbanization, transportation, industrialization, green revolution, water scarcity and ground water depletion, controversies on major dams – resettlement and rehabilitation of people: problems and concerns, rain water harvesting, cloud seeding and watershed management,

Economy and environment: The economy and environment interaction, economics of development, preservation and conservation, sustainability: theory and practice, limits to growth, equitable use of resources for sustainable lifestyles, environmental impact assessment,

Social issues and the environment: Population growth and environment, environmental education, environment movements, environment versus development,

Institutions and governance: Regulation by Government, monitoring and enforcement of environmental regulation, environmental Acts, water (prevention and control of pollution) act, air (prevention and control of pollution) act, environment .protection act, wild life protection act, forest conservation act, coastal zone regulations, institutions and policies relating to India, environmental governance,

International conventions: Stockholm conference-1972, Earth summit-1992, World commission for environmental development (WCED),

Case studies: Chipko movement, Narmada bachao andolan, Silent valley project, Madhura refinery and Taj mahal, Industrialization of Pattancheru, Nuclear reactor at Nagarjuna sagar, Tehri dam, Ralegaon siddhi (Anna Hazare), Kolleru lake-aquaculture, Fluorosis in Andhra Pradesh,

Field work: Visit to a local area to document and mapping environmental assets – river/forest/grass land / hill/ mountain, study of local environment-common plants, insects, birds, study of simple ecosystems – pond, river hill, slopes etc, visits to industries- water treatment plants, effluent treatment plants.

TEXT BOOK:

1. Environmental Studies by Anubha Kaushik & C.P. Kaushik, Second Edition, New Age International (P) Limited.

CH-2201

MATHEMATICS-IV

Course Objectives:

The student should be able to learn the concepts:

- Function of complex variables, differentiation and integration of complex functions. Evaluation of complex integration using Cauchy's theorem and Cauchy's integral formula.
- Conformal mappings, Expansion of complex functions as Taylor's and Laurent's series. Evaluation of some real definite integrals using Cauchy's Residue Theorem.
- Z-transforms, inverse Z-transforms and applications of these transforms to solve the difference equations.
- Correlation, Regression and some discrete and continuous distributions.
- Sampling, Testing of hypothesis for large samples and small samples.

Course Outcomes:

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

- Understand the concepts of function of complex variables, differentiation and integration of complex functions. Evaluation of complex integration using Cauchy's theorem and Cauchy's integral formula.
- know about conformal mappings, Expansion of complex functions in terms of Taylor's and Laurent's series. Evaluation of some real definite integrals using Cauchy's Residue Theorem.
- Understand the concept of difference equations and their formation, solution. Evaluate of Z-transforms, inverse Z-transforms and applications of these transforms to solve difference equations.
- Apply the concepts of Correlation, Regression and some discrete and continuous distributions.
- Understand the Sampling theory: Sampling, Testing of hypothesis for large and small samples.

Syllabus

(Functions of Complex Variables)

Introduction-Limit and continuity of f(z)- Derivative of f(z), Cauchy-Reimann Equations, Analytic Functions, Harmonic functions, Orthogonal systems, Applications to flow problems, Geometrical representation of f(z).

Integration of complex functions, Cauchy's theorem, Cauchy's integral formula and their applications.

(Conformal Mappings and Contour Integration)

Introduction to Conformal transformation, Bilinear transformation $w = \frac{az+b}{cz+d}$, Series of complex terms -Taylor's and Laurent's series (without proofs), Zero's and Singularities of analytic functions.

Residues and Calculations of residues, Cauchy's Residue Theorem, Evaluation of real definite integrals: Integration around unit circle, semi circle.

(Difference Equations & Z-transforms)

Introduction - Formation of difference equations - Linear difference equations - Rules for finding complementary function - Rules for finding particular integral - simultaneous difference equations with constant coefficients - Applications to deflection of a loaded string.

Introduction to Z-Transforms - Some standard Z-transforms - Linear Property - Damping Rule - Shifting U_n to the right and to the left-multiplication by n-Two basic theorems - Some useful Z-transforms - Inverse Z-transformation - Convolution theorem - Convergence of Z-transform - Two sided Z-transform - Evaluation of inverse Z-transform - Application to Difference equations.

(Correlation, Regression and Distributions)

Introduction - correlation - coefficient of correlation -Lines of regression.

Introduction to Discrete and Continuous Random Variables - Distributions: binomial distribution, Poisson distribution, exponential distribution, normal distribution.

(Sampling Theory)

Introduction - Testing of hypothesis - Level of significance - Confidence limits - Test of significance of large samples - comparison of large samples- Test of significance for means of two large samples.

Student t-distribution - Significance test of sample mean - Significance test of difference between sample means - Chi square test - Goodness of fit - F-distribution.

TEXT BOOK:

1. Scope and treatment as in "Higher Engineering Mathematics", by Dr.B.S.Grewal, 43rd Edition, Khanna Publications.

REFERENCE BOOKS:

1. Graduate Engineering Mathematics by V B Kumar Vatti, I.K.International publications
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics by N.P. Bali and Dr.Manish Goyal; Lakshmi publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.
6. Engineering Mathematics series by Chandrica Prasad.

CH-2202
MATERIAL & ENERGY BALANCES

Course Objectives:

To give intensive quantitative training in the practical applications of the principles of physical chemistry to the solution of complicated industrial problems and in methods of predicting missing physicochemical data from generalized principles.

Course Outcomes:

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

- Convert physico-chemical quantities from one system of units to another
- Identify basis and degrees of freedom
- Perform material and energy balances on single units without and with chemical reactions
- Solve the material and energy balance problems on multi-unit processes with recycle, purge and bypass
- Analyze the ideal and real behavior of gases, vapors and liquids

Syllabus

Stoichiometry and composition relationships- the gram-mole and pound-mole, limiting reactant, excess reactant, degree of completion, basis of calculation, weight percent, volume percent and mole percent, density and specific gravity- Baume and API gravity scales,

Behavior of ideal gases- application of the ideal-gas law, Dalton and Amagat laws to gaseous mixtures, composition of gases on dry basis and on wet basis,

Vapor pressures- Effect of temperature on vapor pressure, Antoine equation, reference substance vapor pressure plots, vapor pressure of immiscible liquids, ideal solutions and Raoult's law, non-volatile solutes,

Humidity - Percentage saturation, relative saturation or relative humidity, dew point, vaporization, condensation, wet and dry bulb temperatures, adiabatic vaporization and adiabatic saturation temperature,

Material balances- Tie substance, yield, conversion, processes involving chemical reactions, material balance- calculations involving drying, dissolution, and crystallization, processes involving recycle, bypass and purge,

Heat capacities of gases and gaseous mixtures- effect of temperature on heat capacity of gas, mean heat capacity of gas, Kopp's rule, latent heats, heat of fusion, heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids, estimation of latent heat of vaporization using Classius-Clayperon equation, enthalpy of humid air and humid heat capacity,

Standard heat of reaction - Standard heat of formation, laws of thermochemistry, standard heat of combustion, calculation of heat of formation from heats of combustion, calculation standard heat of reaction from heats of formation and from heats of combustion, standard integral heat of solution, effect of temperature on heat of reaction, Kirchoff's equation, adiabatic and non-adiabatic reactions, theoretical and actual flame temperatures.

TEXT BOOK:

1. 'Chemical Process Principles, Part-I - Material and Energy balances' by Olaf A Hougen, K.M. Watson and R.A.Ragatz, CBS Publishers and Distributors (1995)

REFERENCE BOOKS:

1. 'Basic principles and Calculations in Chemical Engineering' by David M. Himmelblau, Prentice Hall of India Pvt Ltd, 1995
2. 'Stoichiometry' by B.I. Bhatt and S.M. Vora, 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi (1996)
3. 'Stoichiometry for Chemical Engineers' by Williams and Johnson, McGraw Hill Publishers.

CH-2203

HEAT TRANSFER

Courses Objectives:

- To study the fundamental concepts of heat transfer viz., conduction, convection, radiation
- To use these fundamentals in typical engineering applications (Heat exchanger and Evaporator, boiling and condensation.) and current research

Course Outcomes:

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

- Analyze problems involving steady state heat conduction in simple geometries
- Develop equations for different types of convection and solve for heat transfer rate by convection in flow through pipes and flow over a flat plate
- Design of shell and tube heat exchangers using LMTD and effectiveness method
- Estimate the rate of radiation heat transfer with and without participating medium and ability to identify the roll of radiation shields
- Estimate steam economy, capacity of single and multiple effect evaporators
- Understand the concepts of boiling and condensation

Syllabus

Nature of heat flow: Conduction, convection, natural and forced convection, radiation.
Heat transfer by conduction : Basic laws of conduction, thermal conductivity; Steady-state conduction – compound resistances in series, heat flow through a cylinder; Unsteady-state conduction – one dimensional heat flow with constant surface temperature, het flow with variable surface temperature, semi-infinite solid;
Heat transfer by convection: Principles of heat flow in fluids – Typical heat exchange equipment, countercurrent and parallel flows, energy balances, heat flux and heat transfer coefficients, overall heat transfer coefficients, integration over total surface, LMTD, individual heat transfer coefficients.

Heat transfer to fluids without phase change : boundary layers, laminar flow heat transfer, correction for heating and cooling, heat transfer in turbulent flow, estimation of wall temperature, cross-sections other than circular, analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids outside tubes, natural convection.

Heat transfer to fluids with phase change: heat transfer from condensing vapors, heat transfer to boiling liquids.

Radiation heat transfer: Fundamental facts concerning radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, radiation to semitransparent materials, combined heat transfer by conduction-convection-radiation.

Heat-exchange equipment: General design of heat exchange equipment, shell and tube heat exchangers, plate-type exchangers, extended surface equipment, heat pipes, scraped-surface exchangers, condensers and vaporizers, heat transfer in agitated vessels, heat transfer in packed beds.

Evaporation: Evaporation, types of evaporators, performance of tubular evaporators, multiple-effect evaporators, methods of feeding, vapor compression.

TEXT BOOK:

1. Unit Operations of Chemical Engineering, 7th Ed. by W. L. McCabe, J. C. Smith and P. Harriot, McGraw Hill International Edition, Singapore (2005).

REFERENCE BOOK:

1. Process Heat Transfer, by D. Q. Kern, Tata McGraw Hill, New Delhi.

CH-2204

FLUID MECHANICS

Course Objectives:

To provide

- Knowledge on pressure distribution in static fluids.
- Knowledge on rheological behavior of fluids, types of fluid flow, boundary layers and basic equations of fluid flow.
- Knowledge of incompressible & compressible fluid flow in pipes
- Knowledge on fluid flowing past solid surfaces
- Knowledge on pipes, fittings, transportation and metering devices.

Course Outcomes:

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

- Derive dimensionless groups by using dimensional analysis.
- Solve problems related to manometers and decanters using the principles of fluid statics.
- Determine the pipe size / flow rate / power requirements under laminar and turbulent flow conditions.
- Solve problems involving motion of particles in fluid, fluid–solid operations in packed beds and fluidized beds.
- Select machinery and measuring devices for fluid flow.

Syllabus

Dimensional Analysis: Units and Dimensions, Dimensional Homogeneity, Dimensional Analysis, Buckingham π theorem, Geometric similarity, kinematic similarity, and dynamic similarity.

Fluid statics and applications: Nature of fluids, Hydrostatic Equilibrium, Applications of fluid statics – Manometers, continuous gravity decanter and centrifugal decanter.

Fluid Flow phenomena: Laminar flow, shear rate, shear stress. Rheological properties of fluids – Newtonian fluids, Non Newtonian fluids, time dependent flow, viscoelastic fluids. Viscosity, Reynolds number, Turbulence - nature of turbulence, deviating velocities, intensity and scale of turbulence, Reynolds stresses and eddy viscosity. Boundary layers - boundary layer formation over flat plate, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes, boundary layer separation and wake formation.

Basic Equations of Fluid Flow: Continuity equation (Mass Balance in a flowing fluid), equation of motion (Differential Momentum Balance), Navier - stokes equations, Euler's equation, Couette flow, Macroscopic Momentum Balance, layer flow with free surface, Bernoulli equation (Energy equation), corrections for effect of solid boundaries and pump work.

Incompressible flow in pipes and channels : Shear Stress and skin friction in pipes, Relation with skin friction and wall shear, Friction factor, relations between skin friction parameters, equivalent diameter, laminar flow in pipes and channels, velocity distribution, average velocity, Kinetic energy correction factor and momentum correction factor for laminar flow, Hagen-Poiseuille equation, laminar flow of non-Newtonian liquids, laminar flow in annulus. Turbulent flow in pipes and channels, Velocity distribution for turbulent flow, universal velocity distribution equations, its limitations, flow quantities for turbulent flow in smooth round pipes, Reynolds number- friction factor law for smooth tubes, effect of roughness, friction factor chart, drag reduction, friction from changes in velocity or direction – sudden expansion, sudden contraction, pipe fittings, friction losses in Bernoulli equation, velocity heads, separation of boundary layer in diverging channel, minimizing losses.

Flow in compressible fluids: Definitions and basic equations, processes of compressible flow, isentropic flow through nozzles, Adiabatic friction flow, Isothermal friction flow

Flow past immersed objects: Drag and drag coefficients, flow through bed of solids, Motion of particles through fluids - mechanics of particle motion, equation for one-dimensional motion of particles through fluid, terminal velocity, criterion for settling, free and hindered settling. Fluidization – conditions, minimum fluidization velocity, types of fluidizations and its applications.

Transportation and Metering of Fluids: Pipes, fittings, valves. Positive displacement Pumps – reciprocating, rotary and peristaltic pumps. Centrifugal pumps - theory, construction,

performance, single and multistage pumps. Fans, Blowers and Compressors. Vacuum pumps – jet ejectors.

Metering of fluids: Full bore meters – Venturi meter, Orifice meter, Rotameters, Vortex-Shedding meters, Magnetic meters and Coriolis meters. Insertion meters – Pitot Tube, Thermal meters, notches and weirs.

TEXT BOOK:

1. "Unit Operations of Chemical Engineering" Seventh Edition, by W.L. McCabe, J C Smith and P Harriot, Mc Graw Hill

REFERENCE BOOKS:

1. "Chemical Engineering" Volume I by Coulson J.M. and Richardson J.F, Elsevier

"Fluid Mechanics" 2nd edition by Noel de Nevers, Mc Graw Hill

CH-2205

INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

Course Objectives:

1. To familiarise the students with the concepts of Management.
2. To relate the concepts of Management with Industrial Organisations.
3. To explain the factors affecting productivity and how productivity can be increased with effective utilization of inputs in an industrial undertaking.
4. To set forth a basic framework for understanding Entrepreneurship.

Course Outcomes:

An engineer with his/her fundamental knowledge of Industrial Management, will be in position to take appropriate decisions in the corporate environment. The concepts of Entrepreneurship acts as a motivating factor to launch new enterprises and translate one's dream into realty.

Syllabus

Basic Concepts of Management:
Management **:-** Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations**:**Introduction, Types of Business organizations**:**

Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations**;** Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and operations Management**:** Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance

Entrepreneurship : Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

TEXT BOOKS:

1. Sharma,S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.
2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management(Planning for future Sustainable growth), HImalayan Publishing House, 2018.

REFERENCE BOOKS:

1. Aryasri , A.R., Management Science**,** McGraw HIll Education (India Private Limited , New Delhi 2014.
2. Sheela, P. , and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur, Andhra Pradesh, 2017.

CH-2206
HEAT TRANSFER LABORATORY

Course Objectives:

The student will calculatethe thermal resistance and calculation of heat transfer coefficients for both natural and forced convection scenarios. The student will conduct experiments to calculate emissivity of the given plate, radiation constant of the given rod and Stefen Boltzman constant.

Course Outcomes:

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

- Determine thermal conductivity of composite solids and thermal conductivities of lagging material in lagged pipe apparatus
- Determineheat transfer coefficients in forced and natural convection
- Determine the StefenBoltzman constant and emissivity of the given plate
- Calculate radiation constant for hot rodloosing heat to the infinite stagnant ambient
- Analyze the heat exchanger performance(double pipe) for co-current and counter-current flows and determine overall heat transfer coefficient

List of Experiments:

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of total thermal resistance and thermal conductivity of Lagged pipe.
3. Determination of the natural convective heat transfer coefficient for a vertical tube.
4. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
5. Determination of over-all heat transfer coefficient in double pipe heat exchanger.
6. Study of the temperature distribution along the length of a pin fin under natural and forced convection conditions.
7. Estimation of unsteady state film heat transfer coefficient between the medium in which the body is cooled.
8. Determination of Stefan-Boltzmann constant.

9. Determination of emissivity of a given plate at various temperatures.
10. Determination of radiation constant of a given surface.
11. Determination of the thermal conductivity of a metal rod.
12. Determination of critical heat flux point for pool boiling of water

CH-2207

FLUID MECHANICS LABORATORY

Course Objectives:

The student will be exposed to various fluid measuring devices. The pressure drop calculation experimentally across the pipe fittings, valves, packed bed, fluidized bed and annulus will also be dealt in this lab.

Course Outcomes:

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

- Distinguish laminar and turbulent flows.
- Determine the characteristics of flow meters
- Determine the characteristics of packed & fluidized beds and centrifugal pumps
- Calculate pressure drop across a pipe, valves and fittings.

List of Experiments:

1. Identification of laminar and turbulent flows (Reynolds apparatus)
2. Measurement of point velocities (Pitot tube)
3. Verification of Bernoulli equation
4. Calibration of rotameter
5. Variation of orifice coefficient with Reynolds number
6. Determination of venturi coefficient
7. Friction losses in fluid flow in pipes
8. Pressure drop in a packed bed for different fluid velocities
9. Pressure drop and void fraction in a fluidized bed
10. To study the coefficient of contraction for a given open orifice
11. To study the coefficient of discharge in a V - notch
12. To study the characteristics of a centrifugal pump

CH-2208

ASPEN PLUS (Process Design)

Course Objectives:

- To familiarize students with basic programming skills required for solving chemical engineering problems.
- To analyze the data obtained from simulation with theoritcal concepts.
- To compare different thermodynamic property estimation methods and analysing the results.
- To familiarize students with fundamental applications of chemical engineering in ASPEN PLUS.

Course Outcomes:

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

- Carry out thermodynamic property estimations using Aspen
- Simulate Mixer, splitter, pumps, compressors and flash units
- Apply sensitivity, design specification and case study tools in Aspen
- Design heat exchangers, reactors and distillation columns
- Optimize process flowsheets using sequential modular and equation oriented approaches.

Syllabus

Solve the following steady state simulation exercises using Aspen:

1. Physical property estimations.
2. Simulation of individual units like, mixers, splitters, heat exchangers, flash columns and reactors
3. Design and rating of heat exchangers
4. Design and rating of distillation columns.
5. Mass and Energy balances.
6. Handling user specifications on output streams – Sensitivity and design Spec tools.
7. Simulation of a flowsheet

8. Simulation exercises using calculator block
9. Optimization Exercises
10. Simulation using equation oriented approach

TEXT BOOKS:

1. Lab manuals / Exercise sheets
2. A.K.Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall India, 3rd Edition, 2018.

CH-2209

PROFESSIONAL ETHICS AND MORAL VALUES

Course Objectives:

- To inculcate Ethics and Human Values into the young minds.
- To develop moral responsibility and mould them as best professionals.
- To create ethical vision and achieve harmony in life.

Course Outcomes:

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

- Understand the importance of ethics and moral values in life and society.

Syllabus

Ethics and Human Values: Ethics and Values, Ethical Vision, Ethical Decisions, **Human Values** – Classification of Values, Universality of Values.

Engineering Ethics: Nature of Engineering Ethics, Profession and Professionalism, Professional Ethics, Code of Ethics, Sample Codes – IEEE, ASCE, ASME and CSI.

Engineering as Social Experimentation: Engineering as social experimentation, Engineering Professionals – life skills, Engineers as Managers, Consultants and Leaders, Role of engineers in promoting ethical climate, balanced outlook on law.

Safety Social Responsibility and Rights: Safety and Risk, moral responsibility of engineers for safety, case studies – Bhopal gas tragedy, Chernobyl disaster, Fukushima Nuclear disaster, Professional rights, Gender discrimination, Sexual harassment at work place.

Global Issues: Globalization and MNCs, Environmental Ethics, Computer Ethics, Cyber Crimes, Ethical living, concept of Harmony in life.

TEXT BOOKS:

1. Govindharajan, M., Natarajan, S. and Senthil Kumar, V.S., Engineering Ethics, Prentice Hall of India, (PHI) Delhi, 2004.
2. Subramainam, R., Professional Ethics, Oxford University Press, New Delhi, 2013.

REFERENCE BOOKS:

1. Charles D, Fleddermann, "Engineering Ethics", Pearson / PHI, New Jersey 2004 (Indian Reprint).

CH-2210

SUMMER INTERNSHIP PROGRAM (2MONTHS)

All the students have to undergo Summer Internship / Community Service for two months in the industries / nearby villages and report the same in the Department.

CH-3101

CHEMICAL ENGINEERING THERMODYNAMICS

Course Objectives:

Knowledge of thermodynamics helps student compute heat and work requirements of a process.

The student would also learn

- how to estimate data in case of absence of experimental data,
- Solution thermodynamics and its applications
- Concept of Phase & Chemical reaction equilibrium.

Course Outcomes:

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

- Apply the first and second laws of thermodynamics to chemical processes and Compute the properties of ideal and real gas mixtures.
- Evaluate heat effects involved in industrial chemical processes
- Evaluate the efficiency of expansion and compression flow processes and analyze refrigeration and liquefaction processes.
- Determine thermodynamic properties of gaseous mixtures and solutions, Estimate Bubble-P & T, Dew-P & T for binary and multi-component systems and Calculate vapor-liquid equilibrium (VLE) composition for ideal and non-ideal systems
- Determine equilibrium constant and composition of product mixture for single and multiple reactions

Syllabus

The first law and other basic concepts Introduction to Basic laws and Terminologies in Thermodynamics- Statement of First law, the steady-state, steady-flow process, the reversible process. **Volumetric properties of pure fluids:** PVT behavior of pure substances, the ideal gas, virial equations and its applications, cubic equations of state, generalized correlations for gases and liquids.

Heat effects: Latent heats of pure substances, Temperature dependence of heat effects of chemical reactions. **The Second law of thermodynamics:**Statements of second law- Clausius Inequality-Mathematical Statement of Second law, Third law of thermodynamics.

Thermodynamic properties of pure fluids: Property relations for homogeneous phases, residual properties, thermodynamic diagrams, generalized property correlations for gases. **Thermodynamics of flow processes:**Applications to Laws of Thermodynamics - Flow processes: Flow in pipes, Flow through nozzles, turbines (expanders), compression processes. **Refrigeration:** vapor compression cycle, absorption refrigeration, heat pump.

Solution Thermodynamics: chemical potential, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for a pure species and species in solution, generalized correlations for the fugacity coefficients, the ideal solution, excess properties.**VLE-**Duhem's theorem, VLE- qualitative behavior, Raoults law and modified Raoults law, dew point and bubble point calculations, flash calculations.VLE for Ideal solutions, Calculation of activity coefficients.

Phase and Chemical Reaction Equilibria: Criteria for phase equilibrium, Criterion of stability, Phase equilibria in single and multiple component systems. criteria for chemical reaction equilibrium, the standard Gibbs energy change and the equilibrium constant, Effect of temperature, pressure, composition and other factors- Simultaneous Reactions.

TEXT BOOK:

1. `Introduction to Chemical Engineering Thermodynamics' by J.M.Smith, H.C.Van Ness and M.M.Abbott., 6th Edition, Tata McGraw-Hill Edition 2003.

REFERENCE BOOKS:

1. `Chemical Engineering Thermodynamics' by B.F.Dodge, McGraw-Hill Book Co.,
2. `Schaum Outline of Theory and Problems of Thermodynamics' by Michael M. Abbott and Hendrick C.VanNess, McGraw-Hill International Book Co., Singapore, 1981.
3. `Chemical Engineering Thermodynamics' by Y.V.C.Rao, University Press (India) Ltd., Hyderabad 1997.
4. K.V.Narayanan, A Textbook of Chemical Engineering Thermodynamics, PHI Learning, 2004.

CH-3102

MASS TRANSFER –I

Course Objectives:

- To explain the students with the basic principles of mass transfer operations and other separation processes with examples.
- To impart knowledge on how certain substances undergo the physical change with diffusion/mass transfer of components from one phase to other phases.
- To describe the students with equipment used in operations involving mass transfer and other separation processes and their advantages and disadvantages.
- To focus on absorption and distillation operations and the process design aspects of the same operations.
- To provide the knowledge on humidification and dehumidification operations and their applications in real situations

Course Outcomes:

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

- Identify diffusion phenomena in various chemical processes
- Determine diffusivity coefficient in gases and liquids.
- Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems
- Understand the VLE concepts and application to different distillations
- Understand the importance of humidification and dehumidification processes and their industrial applications
- Design equipment for gas-liquid mass transfer operations

Syllabus

Introduction: Mass transfer Operations.

Molecular diffusion in fluids: Binary solutions, Fick's law, equation of continuity, Steady state equimolal counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion.

Mass transfer coefficients: Mass transfer coefficients in turbulent flow, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, correlations for mass transfer coefficients in simple situations, diffusion in solids.

Interphase mass transfer: Concept of equilibrium, diffusion between phases, two resistance theory, material balances in steady state co-current and counter-current stage processes, Murphy stage efficiency.

Equipment for gas-liquid operations: Sparged vessels, mechanically agitated vessels for single phase liquids and gas-liquid mixtures, tray towers, sieve tray for absorption and distillation, venturi scrubbers, spray towers and spray chambers, packed towers for absorption and distillation, tray towers versus packed towers.

Humidificationoperations: Definition of fundamental terms, Psychrometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, gas-liquid contact operations, water cooling with air, dehumidification of air-water-vapor mixture, cooling towers, evaporative cooling.

Absorption: Solubility's of gases in liquids, two component systems, multi-component systems, ideal and non-ideal solutions, choice of solvent for absorption, single component absorption material balances, counter current multistage operations, dilute gas mixtures, on-isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU, NTU concepts for single operation absorption with chemical reaction.

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation, steam distillation, continuous distillation, McCabe-Thiele method, Ponchon-Savarit method, tray efficiencies, introduction to multi-component distillation, azeotropic and extractive distillations.

TEXT BOOK:

1. Mass transfer Operations, Robert E. Treybal, 3rd edition, McGraw-Hill Book Co.,

REFERENCE BOOKS:

1. ”Unit Operations in Chemical Engineering” by McCabe,W.L.,Smith,J.C.and Harriot,P., 5th Edition, McGraw-Hill Book Co.,
2. “Chemical Engineering Hand Book” by J.H. Perry.

CH-3103
CHEMICAL REACTION ENGINEERING – I

Course Objectives:

- To learn principles of rate law and stoichiometry. Isothermal reactors- Batch, plug flow reactor and mixed flow reactor. Design of single and multiple reactors.
- To endow with the knowledge on thermal characteristics of various reactions

Course Outcomes:

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

- Derive the rate law for non-elementary chemical reactions and determine the kinetics of chemical reaction using integral, differential and fractional life methods.
- Design reactors for homogenous reactions under isothermal conditions for single and multiple reactions
- Select optimal sequence in multiple reactor systems

Syllabus:

Introduction and overview of chemical reaction engineering – Variables affecting a chemical reaction – Kinetics of homogeneous reactions – Concentration dependent term of rate equation – Elementary and nonelementary reactions – Temperature dependent term – Arrhenius law, activation energy, collision theory, transition state theory Searching for a mechanism.
Interpretation of batch reactor data – Methods of analysis, integral, differential and half life methods – Analysis of different types of reactions, irreversible and reversible – Variable volume reactor.
Ideal reactors for a single reaction – Performance equations for batch, mixed flow and plug flow reactors – Space time, space velocity and mean residence time.
Design for single reactions – Size comparison of reactors – Multiple reactor systems – Recycle reactor.
Design for parallel reactions – Qualitative and quantitative discussion about product distribution.
Design for series reactions – Qualitative and quantitative discussion about product distribution.

TEXTBOOK:

1. "Chemical Reaction Engineering"., Levenspiel, O. 3rd Edition, John Wiley and Sons.

REFERENCE BOOKS:

1. "Chemical Engineering Kinetics"., Smith, J.M, 3rd Edition. McGraw Hill Inc.
2. "Elements of Chemical Reaction Engineering"., Fogler, H.S, 3rd Edition, Prentice Hall India Ltd.

CH-3104

CORROSION ENGINEERING (OPEN ELECTIVE-I)

Course Objectives:

- Basic aspects of electrochemistry relevant to corrosion phenomena,
- Importance and forms of corrosion.
- Knowledge on corrosion rate expressions and measurement techniques.
- Basic knowledge on remedial measures for corrosion.

Course Outcomes:

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

- Identify various forms of corrosion.
- Determine corrosion rates for metals from their polarization curves
- Analyze corrosion rate characteristics from electrochemical impedance spectroscopy
- Select suitable corrosion resistant coatings, oxide layers for various applications

Syllabus

Introduction and scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and corrosion potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system,

Various forms of corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and anodic protection.

TEXT BOOKS:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi
2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

REFERENCE BOOKS:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company
2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited

CH-3105(A)
GENERAL CHEMICAL TECHNOLOGY (CORE ELECTIVE-I)

Course Objectives:

- To provide the student understanding of importance of chemical process industries over the other manufacturing industries.
- To provide the brief introduction of chemical process equipments, the application of thermodynamics, the chemical process principles, the equipment design and also the corrosion and the safety aspects to consider in the chemical manufacturing processes.
- To provide basic inorganic chemistry background required for the undergraduate students of engineering.
- To provide an overview of chemical properties of inorganic chemicals and the manufacturing processes.
- To provide an overview of applications of materials which the engineers are likely to use during their professional career.

Course Outcomes:

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

- Selection of a process for manufacture of chemicals
- Draw process flow diagrams
- Identify the engineering problems in chemical processes
- List chemical reactions and their mechanism involved

Syllabus

Water: Sources of water, hardness, treatment for different end uses, municipal water conditioning, industrial waste water treatment.

Sulphur and sulphuric acid: Sources of sulphur-sulphuric acid, different processes of manufacturing-contact process, DCDA process for sulphuric acid manufacture.

Nitrogen industries: Manufacture of ammonia, nitric acid, urea and ammonium nitrate.

Phosphorous and phosphoric acid industries: Methods for production of phosphorous and phosphoric acid, manufacture of super phosphate and triple super phosphate.

Chloro-alkali industries: - Manufacture of soda ash, caustic soda and chlorine.

Cement: Types of cement, manufacture of ordinary portland cement [opc], slag cement.

Fuel and industrial gases: Production of water gas, producer gas and coke oven gas, production of acetylene, oxygen and nitrogen.
Metallurgy: Manufacture of pig iron, cast iron, methods of making steel, open hearth process, production of aluminium by electrolytic process.

TEXTBOOKS:

1. "Dryden's Outlines of Chemical Technology" by M.Gopala Rao & Marshall Sitting (Editors). Affiliated East West Press Pvt. Ltd.
2. "Shreve's Chemical Process Industries" by G.T.Austin, McGraw Hill Books

REFERENCE BOOKS:

1. "Encyclopedia of Chemical Technology" by R.E.Kirk & D.F.Othmer (Editors)Interscience.

CH-3105(B)

PETROLEUM REFINERY ENGINEERING (CORE ELECTIVE – I)

Course Objectives:

- To introduce the basics of refinery engineering subject for petroleum specialization students to gain knowledge of the overall refinery operations, refinery products and its test methods.
- To learn various primary and secondary cracking process available to produce normal and value added products.
- Further, to learn the treatment process available to remove the impurities in the crude and finished products and its test methods for quality check.

Course Outcomes:

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

- Compare various theories on origin and formation of petroleum, to explain and summarize the composition of crude oil, to prepare a report on the world wide scenario of reserves and deposits and the Indian petroleum refining industry scenario.
- Describe and summarize various petroleum products, to know various analytical tests available for estimating various physico chemical properties and classify the crude into different classes.
- Classify the crude processing methods and describe the treatment process i.e. Desalting and Dehydration and infer the preliminary process i.e. Atmospheric Distillation and Vacuum Distillation Units.
- Summarize and infer various secondary cracking process to produce value added products and to design the equipment in the refining industry.

Syllabus

Origin and formation of Petroleum. Reserves and deposits of the world, Composition of crudes, Refinery introduction and Indian petroleum refining industry scenario.

Refinery products and test methods, Evaluation of crudes, Crude pretreatment- Dehydration and desalting, Pipe still heater. Atmospheric and Vacuum distillation of crude oil.

Thermal Conversion Process- Vis Breaking, Delayed Coking.

Catalytic Conversion Process- Fluid Catalytic Cracking, Hydrocracking, Hydrotreating, Alkylation, Isomerization, Polymerization and Reforming.

Lube Oil Process – Solvent deasphalting, solvent Extraction, Solvent Dewaxing and Hydro finishing.

Treatment of kerosene, additives, blending of gasoline, Asphalt and air blown asphalt.

TEXTBOOKS:

1. Petroleum Refining Technology by Dr. Ram Prasad
2. Modern Petroleum Refinery Engineering by B K Bhaskar Rao
3. Gary, J.H., Handwerk, G.E. and Kaiser, M.J. (2007) Petroleum Refining: Technology and Economics. 5th Edition, CRC Press, Boca Raton, 488 p.
4. Petroleum Refining. Vol. 3 Conversion Processes, Pierre Leprince (Editor).

CH-3105 (C)

CERAMIC RAW MATERIALS (CORE ELECTIVE – I)

Course Objectives:

- To procure knowledge about the earth
- To gain knowledge regarding the rocks which are most useful ores.
- To know about the physical and optical properties of the minerals and ores
- To gain acquaintance with formation of different raw materials.
- To collect information about the different types of clays
- To put on the knowledge regarding other raw materials used in the ceramics
- To get information regarding the distribution of the deposits

Course Outcomes:

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

- Identify the sources/ availability of raw materials for ceramics
- Examine different clays as raw materials for various ceramic products
- Explain the behavior of silicates as ceramic raw materials
- Acquire knowledge about accessory ceramic raw materials.

Syllabus

General geology and mineralogy: Formation of rocks, their characteristics, classification into igneous, sedimentary and metamorphic groups, formation of mineral deposits, physical and mineral characteristics of minerals – composition, color, streak, luster, fracture, cleavage, hardness, density and tenacity, elements of optical mineralogy.

Clays: Clay minerals, clay structure – kaolinite and montmorillonite groups, geology of clay deposits, their classification - china clay, ball clay, fire clay, building clay etc., beneficiation of clays, mica chlorite, illite group, talc, pyrophyllite, wollastonite group, chemical properties, physical properties.**Fluxes:** Soda and potash feldspar, other feldspars, nephlinesyenite, geology of formation, physical and chemical properties, beneficiation.

Silica and silicate materials: Silica, polymorphic modification, silica structure, physical and chemical properties of silica, silicate chemistry, minerals, sillimanite, kyanite, and alusite, availability in India and their uses in ceramic industry.

Other raw materials: Geology of bauxite, magnesite, dolomite, chrome, limestone, rutile, zircon, beryllia minerals, alumina, carbides, nitrides, properties and uses.

TEXTBOOKS:

1. 'Fine Ceramics Technology and Applications' by F.H.Norton, McGraw Hill Publishers, New York,
2. 'Ceramic Raw Materials' by W.E.Worrall, Pergamon press, New York.

REFERENCE BOOKS:

1. 'Forming Minerals' by W.A.Deer, R.A. Howie &J.Rock, Longman Publishers, London
2. 'Properties of Ceramic Raw Materials' by W.Ryan, Pergamon press, 2nd Edition
3. 'Clay Mineralogy' by M.J.Wilson, Chapman & Hall.

CH-3105(D)

FUEL CELL TECHNOLOGY (CORE ELECTIVE – I)

Course Objectives:

- To provide deeper knowledge, a wider scope and improved understanding of theory, analysis, performance, design and the operational principles of various fuel cell components and systems.
- To provide the design and analysis emphasis on the thermodynamics and heat transferfor all thermal systems of a fuel cell stack.

Course Outcomes:

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

- Understand fuel cell fundamentals.
- Analyze the performance of a fuel cell and stack.
- Demonstrate the operation of fuel cell stack and fuel cell system
- Apply the modeling techniques for fuel cell systems

Syllabus

Introduction – fuel cell; brief history of fuel cells, types of fuel cells and fuel cell applications. Thermodynamics and Electrochemical kinetics – Engineering thermodynamics, conversion efficiencies of heat engines and fuel cells, chemical reactions, chemical thermodynamics and electrochemical kinetics.

Fuel cell components and their impact on performance – General design features, fuel cell performance: the MEA and the current/voltage curve, MEA components and the fuel cell stack. Stack design – Sizing of a fuel cell stack, stack configuration, uniform distribution of reactants inside each cell, heat removal from a fuel stack and stack clamping.

Fuel cell modeling – Theory and governing equations, modeling domains and modeling examples.

Fuel cell system design – Hydrogen-air system, fuel cell systems with fuel processor, electrical subsystems and system efficiency.

Fuel cell applications – Transportation applications, stationary power, backup power and fuel cells for small portable power.

TEXT BOOKS:

1. For chapters 1 to 3: Fuel Cell Technology Hand Book, Edited by Gregor Hoogers, CRC Press.
2. For Chapters 4 to 7: PEM Fuel Cells: Theory and practice By Frano, Elsevier Academic Press

REFERENCE BOOKS:

1. Fuel cells principles and applications by B.Viswanathan and M. Aulice Scibioh, Universal Press. (India) Private Limited, Hyderabad.
2. Fuel Cell Systems Explained, second edition, by James Larminie and Andrew Dicks, John Wiley & Sons Ltd.

CH-3105(E)

POLYMER TECHNOLOGY (CORE ELECTIVE – I)

Course Objectives:

- To make a thorough understanding of the classification, characterization of the polymers and their structure and its applications
- To introduce the manufacturing methods of different polymers and different additives, blends and composites used in the process

Course Outcomes:

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

- Classify polymers and determine molecular weight of the polymer
- Understand thermodynamics of polymer structures
- Select polymerization reactor for a polymer product.
- Characterize polymers.
- State polymer additives, blends and composites
- Understand polymer rheology
- Identify suitable polymer processing methods

Syllabus

Introductory concepts and fundamentals: Definitions and concepts of plastics and polymers, comer, co-monomer, mesomer, co-polymer, functionality, visco-elasticity,

Classification of polymers, methods of determining molecular weights of polymers-

(i) Methods based on colligative properties
(ii) Sedimentation velocity method
(iii) Sedimentation equilibrium method
(iv) Gel-chromatography method
(v) Light scattering analysis method

(vi) End-group analysis method

Natural polymers- brief study of rubber, shellac, rosin, cellulose, proteins, Lignin's,

Chemistry of polymerization: Elementary concepts of addition polymerization, condensation polymerization and co-polymerization, glass transition temperature of polymers, methods of determining Tg, degradation of polymers due to mechanical, hydrolytic, thermal and backbone effects,

Relation of the mechanical, thermal, electrical, physical and chemical properties with the structure of the polymer,

Methods of polymerization: Mass, solution, emulsion and suspension, role of the initiators, catalysts, inhibitors, solvents, fillers, reinforcing agents, stabilizers, plasticizers, lubricants, blowing agents, coupling agents, flame retardants, photo-degradants and bio-degradable on polymerization,

Methods of manufacture, properties and uses of the following addition products;

Polyethylene (LDPE and HDPE) , polypropylene, PVC and its copolymers, Polystyrene and its copolymers, acetals and PTFE (polytetraflouroethylene),

Methods of manufacture, properties and uses of the following condensation products: (i)Polyesters-PMMA, PET and ALKYO, (ii) PF-, UF- and MF-resins (iii) epoxy resins, polyurethanes and silicones,

Description of the following processing methods: (with the principles involved and equipment used) Mixing and compounding, extrusion, calendaring, laminating, moulding-compression, transfer, injection and blow moulding.

TEXT BOOKS:

1. `Plastic Materials' by J.A.Brydson, Newnes-Butterworths (London) 1989
2. `Textbook of Polymer Science', Billymeyer, F.W.Jr., 3rd edition, John Wiley & Sons,

REFERENCE BOOKS:

1. 'Introduction to Plastics' by J.H.Briston and C.C. Gosselin, Newnes, London
2. 'Polymeric Materials' by C.C.Winding and G.D.Hiatt, McGraw-Hill Publishers

CH-3106

MASS TRANSFER-I LABORATORY

Course Objectives:

The student will be made familiarised with distillation process and will be able to determine liquid and vapour diffusion coefficient. The student will be able to calculate VLE, HTU, HETP and rate of evaporation by conducting experiments.

Course Outcomes:

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

- Determine separation performance of batch distillation, steam distillation, sieve plate and packed bed distillation
- Estimate the diffusion coefficient of vapour in gas
- Estimate the diffusion coefficient of liquid
- Determine the rate of evaporation

List of Experiments:

1. Steam distillation
2. Differential distillation
3. Height equivalent to a theoretical plate
4. Vapor-liquid equilibria
5. Determination of liquid diffusion coefficient
6. Determination of vapor diffusion coefficient
7. Surface evaporation
8. Height of a transfer unit

CH-3107(A)
GENERAL CHEMICAL TECHNOLOGY LABORATORY

Course Objectives:

The student will be made familiar with analysis of water, oils, coal, lime stone, bleaching powder saw dust etc. and preparations of soap, copper and chrome yellow pigments, Phenol formaldehyde resins.

Course Outcomes:

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

- Synthesize products such as soap, phenol formaldehyde resin, Chrome yellow pigment, and Copper pigment
- Estimation of total solids, dissolved solids,pH, chlorides, sulphates, temporary and permanent hardness in water
- Analyse acid value, Iodine value and sopanification value of oil
- Estimate the purity of various materials

List of experiments:

A. Analysis of water:

1. Total solids, dissolved solids,pH
2. Chlorides and sulphates
3. Temporary, permanent and total hardness.

B. Analysis of oils:

4. Acid value

5. Iodine value

6. Saponification value

C. Miscellaneous analysis:

7. Analysis of coal: Proximate analysis

8. Analysis of lime: Estimation of acid insoluble's, available lime and calcium carbonate

9. Analysis of bleaching powder: Estimation of chlorine content.

10. Analysis of starch/glucose: Estimation of total reducing sugars

11. Analysis of saw dust: Estimation of total cellulose and –cellulose

E. Miscellaneous preparations:

12. Preparation of soap

13. Preparation of copper pigment

14. Preparation of chrome yellow pigment

15. Preparation of phenol formaldehyde resin

CH-3107(B)

PETROLEUM ENGINEERING LABORATORY

Course Objectives:

The student will be made familiar with the testing methods employed in quality control of hydrocarbon products.

Course Outcomes:

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

- Understand ASTM methods
- Evaluate the crude petroleum and petroleum products
- Determine the flash and fire points, cloud and pour points, smoke point of the petroleum
- Estimation of viscosity index and carbon residue
- Determine Aniline point and diesel index, drop point, penetration number, softening point

List of experiments:

1. Evaluation and test methods for crude petroleum

2. Evaluation and test methods for products

3. ASTM distillation

5. Flash and fire points

6. Viscosity index

7. Smoke point

8. Cloud and pour points

9. Carbon residue

10. Aniline point and diesel index

11. Drop point

12. Penetration number

13. Softening point

14. Water content and melting point

CH-3107(C)

CERAMIC TECHNOLOGY LABORATORY

Course Objectives:

The student will be made familiar with the handling of equipment employed in the preparation of ceramic raw materials.

Course Outcomes:

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

- Determine slip specific gravity and slip viscosity
- Evaluate the effect of water and deflocculant on viscosity of slip
- Prepare ceramic slip in a pot mill
- Determine residue in a slip
- Demonstrate making of solid slip, drain slip, plaster cloud making and biscuit firing

List of experiments:

1. Preparation of ceramic slip in a pot mill
2. Determination of slip specific gravity
3. Determination of slip viscosity
4. Effect of water on viscosity of slip
5. Effect of deflocculant on viscosity of slip
6. Determination of residue in a slip
7. Plaster mould making
8. Making of solid slip cast article
9. Making of drain slip cast article
10. Biscuit firing

CH-3108

SEMINAR/MINOR PROJECT

Course Objectives:

- To make the student to think about the new methodologies for the Chemical Engineering problems and implement them either experimentally or theoretically.
- To enhance communication skills of the student to present his/her work and to interact with the students/ faculty/ industry people.

Course Outcomes:

At the end of the seminar/ Minor project, the student will be able to

- Conduct an independent research project involvingexperimentation/modelling/simulation/optimization in chemical engineering
- Analyze the results
- Communicate the research results orally to an audience
- Present a detailed written report

CH-3109

INDIAN CONSTITUTION

Course Objectives:

- The student learns about the scope and scheme of fundamental duties and fundamental rights.
- The student understands federal structure and distribution of legislative and financial powers and the parliamentary form of government of India.

Course Outcomes:

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

- Identify the scope and scheme of fundamental rights and fundamental duties
- Understand the features and characteristics of the Constitution of India
- Explain the Federal structure and distribution of legislative and financial powers betweenthe Union and the States
- Explain Parliamentary Form of Government in India
- Describe Emergency Provisions

Syllabus

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure

10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.

CH-3110

SUMMER INTERNSHIP EVALUATION

All the students have to undergo Summer Internship for two months in the industries at the end of the second year second semester. Evaluation of the same will be conducted in this semester by the Department.

CH-3201
MASS TRANSFER –II

Course Objectives :

To explore about different mass transfer operations and its applications in industrial scale.

Course Outcomes:

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

- Analyze VLE, LLE, and SLE data
- Select a suitable mass transfer operation for a given separation
- Determine number of stages in distillation, extraction and adsorption operations
- Estimate the height of packed column in distillation, extraction and adsorption operations
- Calculate drying rates and moisture content for batch and continuous drying operations

Syllabus

Liquid-liquid operations: Extraction: Introduction, liquid-liquid equilibria, analytical and graphical solutions for single and multistage operations, continuous counter current operation without and with reflux, fractional extraction, equipment for liquid-liquid contacting operations, single stage, multistage and continuous contacting equipment,

Leaching: Preparation of solid, steady and unsteady state operation, equipment, analytical methods both theoretical and problematic approaches for single and multistage operations,

Adsorption: Theory of adsorption, Industrial adsorbents, adsorption equilibria, Freundlich equation, single and multistage operations, unsteady state adsorption, equipment for single stage and continuous contact, ion-exchange,

Drying: Equilibria, drying rate curve, batch and continuous drying, time of drying and calculations, mechanism of batch drying, equipment's for batch and continuous drying operations,

Crystallization: Equipment and analytical methods, factors governing nucleation and crystal growth rates, controlled rate of crystals, incorporation of principles into the design of the equipment,

Less conventional operations: Dialysis, thermal diffusion, mass diffusion,

Membrane separation processes: Separation of gases, separation of liquids, dialysis, membranes for liquid extraction, pervaporation, reverse osmosis.

TEXT BOOK:

2. 'Mass Transfer Operations', by Robert E.Treybal, III Edition, McGraw-Hill Book Co.

REFERENCE BOOKS:

1. 'Unit Operations in Chemical Engineering' by McCabe,W.L., Smith, J.C. and Harriot, P., 5th Edition, McGraw-Hill Book Co.
2. 'Chemical Engineering Hand Book' by J.H.Perry

CH-3202

CHEMICAL REACTION ENGINEERING-II

Course Objectives:

- To endow with the knowledge on thermal characteristics of various reactions
- To accomplish knowledge on non-ideal reactors
- To impart the knowledge on heterogeneous reacting systems
- To study the design aspects of heterogeneous catalytic systems
- To impart the knowledge on mass transfer with reaction situations

Course Outcomes:

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

- Explain the thermal characteristics and design of adiabatic reactors for single and multiple reactions
- Apply the non-ideality concepts in the reacting system for better understanding the deviations from ideality
- Apply the tanks-in-series model, and the dispersion (single parameter) models for a first-order reaction, to account for the non ideality
- Develop the progressive conversion model and shrinking core model for explaining the fluid particle reaction
- Understand the principles and mechanism involved in heterogeneous catalysis and analyze the data of heterogeneous catalytic reactions.
- Understand the rate controlling mechanisms in heterogeneous catalysis and their rate determinations

Syllabus:

Temperature and pressure effects – Heats of reaction and temperature – Equilibrium constants from thermodynamics – Equilibrium conversion – General graphical design procedure – Optimum temperature progression – Adiabatic operations.
Non ideal flow – Basics – C,E and F curves – Conversion in non ideal flow reactors – Dispersion model – Tanks-in-series model.
Heterogeneous catalysis – Physical adsorption – Chemisorption – Catalytic properties – Estimation of surface area, pore volume and porosity – Catalyst preparation – Catalyst poisons – Catalytic deactivation.
Solid catalysed reactions – Rate equations – Pore diffusion combined with surface kinetics – Thiele modulus – Effectiveness factor – Performance equations for reactions containing porous catalyst particles – Experimental methods for finding rates – Determining controlling resistances.
Noncatalytic systems – Design of fluid-fluid reactors – Factors to consider in selecting a contractor – Various contractors and contacting patterns for G/L reactions.

Design of fluid particle reactions – Progressive Conversion Model (PCM), Shrinking Core Model (SCM) – Comparison – Controlling mechanisms – Determination of rate controlling step.

TEXT BOOK:

1. 'Chemical Reaction Engineering' Levenspiel O, 3rd Edition, John Wiley & Sons.

REFERENCE BOOKS:

1. "Chemical Engineering Kinetics' by Smith, J.M. 3rd Edition, McGraw Hill Inc.
2. "Elements of Chemical Reaction Engineering" by Fogler, H.S, 3rd Edition, Printice Hall India Ltd.

CH-3203
PROCESS INSTRUMENTATION AND CONTROL

Course Objectives:

In studying this course Chemical Engineering students will come to know the measurement of various process variables and acquire the knowledge of the operation of various process control systems effectively. The students learn

- how physical quantities are measured and how they are converted to electrical or other forms.
- to use various types of instruments.
- represent the processes in terms of mathematical equations
- the concept of stability and know how to operate a control system in a stable way.
- to deal with various controllers and their functions and applications.

Course Outcomes:

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

- Recommend suitable instrument for the measurement temperature
- Select a method of measurement for pressure,composition, flow and level
- Develop transfer functions for the processes
- Examine the stability of various control systems
- Apply advanced control schemes for processes and identify the characteristics of control valves

Syllabus

Qualities of measurement: The elements of instruments, static and dynamic characteristics, dynamic response of first order and second order instruments.

Expansion thermometers: Temperature scales, constant-volume gas thermometer, bimetallic thermometer, pressure spring thermometer, theory of volumetric and pressure thermometers, static accuracy of thermometer, comparison of pressure-spring thermometers.

Thermoelectric temperature measurement: Thermoelectricity, industrial thermocouples, thermocouple lead wires, thermal wells, response of thermocouples, the mill voltmeter.

Resistance thermometers: Thermal coefficient of resistance, industrial resistance thermometer bulbs, resistance thermometer circuits, null-bridge resistance thermometers, deflectional resistance thermometers.

Radiation temperature measurement: Introduction, blackbody devices and radiation receiving elements, radiation pyrometers, photoelectric pyrometers and optical pyrometers.

Methods of Composition analysis: Spectroscopic analysis, absorption, Emission and Mass spectroscopy- IR, UV absorption and mass spectrometers, Gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture in paper, textile and lumber.

Measurement of pressure and vacuum: Pressure, vacuum and head, liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measurement of pressure in corrosive fluids, static accuracy of pressure gauges.

Measurement of Head and Level: Density and specific gravity, direct measurement of liquid level, pressure(level) measurement in open vessels, level measurement in pressure vessels, density measurement, level measurement by weighing.

Introduction to process dynamics and control, Response of First Order Systems - Physical examples of first order systems.

Response of first order systems in series, higher order systems: Second order and transportation lag.

Control systems Controllers and final control elements, Block diagram of a chemical rector control system.

Closed loop transfer functions, Transient response of simple control systems.

Stability Criterion, Routh Test, Root locus. Transient response from root locus, Application of root locus to control systems Introduction to frequency response, Control systems design by frequency response.

Advanced control strategies, Cascade control, Feed forward control, ratio control, Smith predictor, dead time compensation, internal model control. Controller tuning and process identification. Control valves.

TEXT BOOKS:

1. Donald P Eckman. Industrial Instrumentation, CBS Publishers, New Delhi, 2004.
2. D.R. Coughanowr. Process Systems Analysis and Control, Mc Graw Hill, 1991

REFERENCE BOOKS:

1. Hand Book of Instrumentation and control, Considine.
2. Chemical Process Control, G. Stephanopolous, Prentice Hall, 1984.

CH-3204 (A)
PROCESS MODELING & SIMULATION (CORE ELECTIVE-II)

Course Objectives:

- To introduce different types of models along with examples related to chemical engineering
- To instruct how to develop empirical models using different tools and the use of numerical methods for solution of Non- Linear Algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration and differentiation.
- To impart knowledge on modelling of various equipment and their simulation using different numerical techniques.
- To guide selection of the solution method based on the computational requirements of various solution options.
- To elucidate process simulation using modular and equation based solving approaches.

Course Outcomes:

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

- Classify different types of mathematical models
- Develop mathematical model for the given chemical engineering problem from basic engineering principles.
- Identify the appropriate numerical method for solving a given model.
- Solve ODEs and PDEs using different numerical methods.
- Simulate binary distillation column, gravity flow tank, batch reactor, Non-isothermal CSTR, and counter-current heat exchanger.
- Compare and contrast modular approaches with equation oriented approach

Syllabus

Mathematical models for chemical engineering systems: classification of mathematical models- steady state vs dynamic models, lumped vs distributed parameter models, deterministic vs stochastic models. **Examples of mathematical models**- Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

Empirical model building- method of least squares, linear, polynomial and multiple regression, non-Linear regression. **Solution of Non- Linear Algebraic equations**- bisection, false position, Quasi Newton and Newton- Raphson methods.

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Numerical integration- Trapezoidal rule, Simpson's rule and Newton– Cotes formula.

Numerical solution of differential equations- Euler's method, Runge- Kutta methods, predictor corrector methods.

Numerical solution of partial differential equations- elliptic, parabolic and hyperbolic equations, finite difference methods, Leibman's method, Crank Nicholson method. Applications to steady state and Unsteady state heat conduction and temperature distribution problems.

Process Simulation examples: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.

Process simulation using modular and equation based solving approaches: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

TEXTBOOKS:

1. Process modelling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

REFERENCE BOOKS:

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
3. Process Modelling and Simulation, Amiya K. Jana, 2012.

CH-3204 (B)

PETROCHEMICALS (CORE ELECTIVE-II)

Course Objectives:

- To make a thorough understanding of the availability of petroleum resources, technical and financial constraints of all the elementary problems.
- To know the development of petrochemical industries and methodolically furnishes the conversion of petroleum feedstock's to chemical and intermediates.

Course Outcomes:

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

- Understand Petrochemical industry-Feedstock, various important Chemicals produced from ethylene and C_3, C_4 and higher carbon atoms.
- Explain the methods of polymerization: high pressure polyethylene (LDPE)& low pressure polyethylene (HDPE),
- Explain the production of Petroleum aromatics, synthetic fibers, Synthetic rubber, Plastics and Synthetic detergents.
- Understand all the production processes along with safety measures and hazards in industry and remedial methods to arrest the accidents immediately in industries..

Syllabus

Petrochemical industry-Feedstocks: Petrochemical industry in India, feed stocks for petrochemicals.

Chemicals from ethylene: Vinyl chloride monomer, vinylacetate monomer, ethylene oxide, ethylene glycol, acetaldehyde.

Chemicals from C_3,C_4 and higher carbon atoms: Isopropylalcohol, acrylonitrile, acrylic acid, phenol, bisphenol-A, iso and n-butanol, methyltertbutylether, methacrylic acid, malic anhydride.

Polymers of olefins: Polymer structure, methods of polymerization, high pressure polyethylene (LDPE), low pressure polyethylene (HDPE), polypropylene, polyvinylchloride, polystyrene.

Petroleum aromatics: Benzoic acid, caprolactum, terephthalic acid, phthalic anhydride,

Synthetic fibres: Production techniques of synthetic fibres, production of polyester, nylon-6,6, nylon-6, acrylic fibers.

Synthetic rubber: Styrene butadiene rubber (SBR), butyl rubber, synthesis of polyurethane.

Plastics: Phenol formaldehyde resins, urea formaldehyde resins, polycarbonates.
Synthetic detergents: Classification of detergents, general manufacture of sulphonates, keryl benzene sulphonate (Surf).

TEXTBOOK:

1. `A Text on Petrochemicals' by B.K.Bhaskara Rao, 3rd Edition, Khanna Publishers, NewDelhi.

REFERENCE BOOKS:

1. `Petrochemical processes', Vol.2, 2nd edition, by A.Chanvel and G. Lefebvre, Gulf publishing company.
2. `Shreve's chemical process industries', 5th edition, by George T. Austin, Mc Graw Hill Publishers

CH-3204 (C)

WHITEWARE AND HEAVY CLAYWARE (CORE ELECTIVE - II)

Course Objectives:

- The applications for advanced ceramics have received major attention in recent years, particularly for use as parts in a future ceramic heat engine.
- The properties like corrosion resistance, chemical inertness, thermal shock resistance and other properties made both traditional and advanced ceramics highly attractive in a large number of applications.

Course Outcomes:

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

- Classify whiteware products
- Identify raw materials for heavy clayware and products of heavy clayware
- Importance of fine ceramics.
- How to use resources more efficiently.
- Demonstrate the tests and quality control measuresof clay ware products

Syllabus

Classification of whiteware products: Body formulation and properties, tableware, earthenware talc bodies, vitreous bodies, high alumina bodies, porcelain, bone china, sanitary ware, stoneware, majolica, terracotta, art ware, physical properties of mixtures, role of water.

Whiteware: Classification, body composition, white wares at home, construction, electrical appliances, industrial uses, manufacturing and properties.

Heavy clayware: Raw materials, methods of winning and handling, classification of building materials, manufacture of building bricks, hollow bricks and other bricks, roof tiles, paving tiles, sewer pipes.

Fine ceramics: Packing of two component system, porosity, effect of grain size, unfired porosity, experimental verifications, wet to dry contraction, unfired strength, permeability and casting rate, dry to fired contraction.

Tests and quality control: IS inspection, LOI, plasticity, strength, MOR, thermal shock resistance, abrasion resistance, porosity, acid and alkali resistance, chipping resistance, chemical analysis, electrical and thermal conductivity.

TEXT BOOKS:

1. 'Pottery Science: Materials, Processes and Products' by Allen Dinsdale, Ellis Horwood Ltd., New York,
2. 'Ceramic White Ware' by Sudhir Sen, Oxford& IBH Publishing Co., New Delhi

REFERENCE BOOK:

1. 'Industrial Ceramics' by F. Singer and S. Singer, Oxford & IBH Publishing Company,

CH-3204 (D)

COMPUTATIONAL FLUID DYNAMICS (CORE ELECTIVE - II)

Course Objectives:

- The course provides an introduction to computational fluid dynamics.
- The students will train the numerical solution of model problems.
- The students will learn to assess the quality of numerical results and the efficiency of numerical methods for basic fluid flow model problems.

Course Outcomes:

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

- Solve numerically ordinary differential equations with initial condition
- Discretize the equations using Finite difference and volume formulation
- Solve the discretized equations using different techniques
- Understand the concept of finite volume method and discretization procedure
- Understand grid generation techniques

Syllabus

Numerical solution of ordinary differential equations: Initial value problems of first order, Runge-Kuta methods, linear multi-step and predictor-corrector methods, R-K method for two simultaneous first order equations,

Finite difference discretization of first and second derivatives: Implementation of finite difference equations, explicit and implicit methods, errors and stability analysis,

Selected examples for finite difference applications in heat conduction: Heat dissipation through a constant area fin, two-dimensional steady heat conduction in rectangular geometry, one dimensional transient heat conduction in a slab, Crank-Nicolson method, Thomas algorithm,

Fundamentals of fluid flow modeling: Upwind scheme, transportive property, second upwind differencing, hybrid scheme,

Solution of unsteady Navier-Stokes equations for incompressible flows: Staggered grid, introduction to MAC method, MAC formulation of momentum balance equation, pressure correction equation,

Introduction to SIMPLE method: One-dimensional convection, diffusion equation, formulation of flow problem, discretized continuity and momentum equations, pressure correction equation,

Concept of finite volume method: Regular finite volumes, discretization procedure for continuity equation.

TEXT BOOK:

1. 'Computational Fluid Flow and Heat Transfer' 2nd edition by K. Muralidharan and T. Sundararajan, Narosa Publishing House, New Delhi, 2003

REFERENCE BOOK:

1. 'Computational Fluid Dynamics - The Basics and Applications' by John D. Anderson, Jr., McGraw-Hill Inc., New Delhi, 1995.

CH-3204 (E)

MULTI COMPONENT SEPARATION PROCESSES (CORE ELECTIVE - II)

Course Objectives:

- Provide an introduction to design methods of equilibrium and non-equilibrium multi-component mass transport processes
- The student will learn how to solve different shortcut and rigorous models
- The student will make use of conceptual design methods in designing and troubleshooting industrial mass transport processes

Course Outcomes:

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

- Predict multi component VLE data from the model constants of constituent binaries
- Determine high pressure equilibria
- Understand flash vapourization and multicomponent differential distillation
- Interpret the design considerations of fractionating process
- Design of distillation column for azeotropic and extractive distillation
- Differentiate tray design and operation versus packing design and operation

Syllabus

Multi component vapor –liquid equilibria: Ideal mixtures at low pressures, non-ideal mixtures, activity coefficient models - Wilson, NRTL, UNIQUAC and UNIFAC equations, evaluation of model constants from binary experimental data, prediction of multicomponenet VLE from the model constants of the constituent binaries,

High pressure equilibria: Vaporization constants, K, Thermodynamic method for K, graphical charts, chao-Seader correlation,

Equilibrium and Simple Distillation: Multicomponent equilibrium, flash vaporization(EFV), multicomponent differential distillation,

Design considerations in fractionating process: Quantitative relationships, temary and multicomponent system fractionation, key fractionation concepts, selecton of key components, column pressure, material balance, rigorous and approximate minimum reflux calculations, recommended short-cut methods for minimum reflux minimum plates at total reflux, FUG methods, Smith Brinkley method,

Multicomponent fractionation rigorous design procedures: Sorel method, Lewi Metheson method, Thiele-Geddes method and its versions in distillation column design, techniques of separating azeotropic and close boiling mixtures by fractional distillation, azeotropic and extractive distillation, selection of solvents, design considerations, pseudo binary methods, solvent recovery,

Tray design and operation: The common tray types, tray capacity limits, tray hydraulics parameters, flow regies on trays, column sizing, tray efficiency, fundamentals, tray efficiency prediction,

Packing design and operation: Packing types, packing hydraulics, comparing packings and trays, packing efficiency and scale-up.

TEXT BOOKS:

1. 'Distillation' by M.Van Winkle, McGraw Hill Book Company
2. 'Phase Equilibria in Chemical Engineering' by S.M.Wales, Butterworth publishers, 1985
3. 'Distillation Design' by Henery Z Kister, McGraw Hill Book Company

CH-3204 (F)

CHEMICAL ENGINEERING MATHEMATICS (CORE ELECTIVE - II)

Course Objectives:

- To learn various computational techniques for analyzing and solving chemical engineering problems.

Course Outcomes:

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

- Understand the fundamental mathematics and to solve problems of algebraic and differential equations, simultaneous equations and partial differential equations.
- Evaluate problem solving strategies to procedural algorithms and to write program structures.
- Solve engineering problems using computational techniques

Syllabus

Mathematical formulation of the physical problems: i). Application of the law of conservation of mass, salt accumulation in stirred tank, starting an equilibrium still, solvent extraction in N stages, diffusion with chemical reaction and ii). application of the law of conservation of energy, radial heat transfer through a cylindrical conductor, heating a closed kettle, flow of heat from fin,

Analytical (explicit) solution of ordinary differential equations encountered in Chemical engineering problems: i). First order differential equations, method of separation of variables, equations solved by integration factors, certain examples involving mass and energy balances and reaction kinetics and ii). second order differential equations, non-linear equations, linear equations, simultaneous diffusion and chemical reaction in a tubular reactor, continuous hydrolysis of tallow in a spray column,

Partial differential equations: i). Formulation of partial differential equations, unsteady-state heat conduction in one dimension, mass transfer with axial symmetry, continuity equation, ii). boundary conditions- function specified, derivative specified and mixed conditions and iii).

particular solutions of partial differential equation- compounding the independent variable into one variable, superposition of solutions, the method of images and particular solution suggested by the boundary conditions,

Finite differences: i). The difference operator, properties of the difference operator, difference tables, other difference operators, ii). linear finite difference equation, complementary solution, particular solution, simultaneous linear difference equations and iii). non-linear finite difference equations, analytical solutions,

Solutions for the following type of problems by finite difference method: a). Calculation of the number of plates required for an absorption column, b). calculation of the number of theoretical plates required for distillation column and c). calculation of number of stages required for a counter current extraction and leaching operation,

Application of statistical methods: i). Propagation of errors of experimental data, ii). parameter estimation of algebraic equations encountered in heat and mass transfer, kinetics and thermodynamics by method of averages, linear least squares and weighted linear least squares methods and iii). design of experiments - factorial and fractional factorial methods.

TEXT BOOK:

1. 'Mathematical Methods in Chemical Engineering' by V.G.Jenson and G.V.Jeffreys, Academic Press, London

REFERENCE BOOKS:

1. 'Applied Mathematics in Chemical Engineering' by Harold S. Mickley, Thomas S. Sherwood and Charles E. Reed, Tata McGraw Hill Publications.
2. 'Introductory Methods of Numerical Analysis' By S.S. Sastry, Prentice Hall of India Private Limited, New Delhi.

CH-3205(A)

NANO SCIENCE & TECHNOLOGY(OPEN ELECTIVE-II)

Course Objectives:

- To give foundational knowledge of the Nano scienceand related fields.
- To make the students acquire an understanding the Nano science and Applications
- To help the students understand in broad outline of Nanoscience and Nanotechnology.

Course Outcomes:

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

- Understand the properties of nanomaterials and their applications
- Synthesize nanoparticles
- Characterize nanomaterials
- Scale up the production of nanoparticles
- Understand applications of nanoparticles in nanobiology and nanomedicine

Syllabus

General Introduction: Basics of quantum mechanics, harmonic oscillator, magnetic phenomena, band structure in solids, Mossbauer and Spectroscopy, optical phenomena bonding in solids, anisotropy,

Silicon Carbide: Application of silicon carbide, nano materials preparation, sintering of SiC, X-ray diffraction data, electron microscopy sintering of nano particles, nano particles of alumina and zirconia, nano materials preparation, characterization, wear materials and nano composites,

Mechanical properties: Strength of nano crystalline SiC, preparation for strength measurements, mechanical properties, magnetic properties,

Electrical properties: Switching glasses with nanoparticles, electronic conduction with nano particles,

Optical properties: Optical properties, special properties and the coloured glasses

Process of synthesis of nano powders, electro deposition, important nano materials

Investigaing and manipulating materials in the nanoscale: Electron microscope, scanning probe microscope, optical microscope for nano science and technology, X-ray diffraction

Nanobiology: Interaction between bimolecules and naoparticle surface, different types of inorganic materials used for the synthesis of hybrid nano-bio assemblies, application of nano in biology, naoprobes for analytical applications - a new methodology in medical diagnostics and biotechnology, current status of nano biotechnology, future perspectives of nanobiology, nanosensors,

NanoMedicines: Developing of nano-medicines, nanosytems in use, protocols for nanodrug administration, nanotechnology in diagnostics applications, materials for used in diagnostics and therapeutic applications, molecular nanomechanics, molecular devices, nanotribology, studying tribology at nanoscale, nanotribology applications.

TEXT BOOKS:

1. 'Nano Materials' by A.K.Bandyopadhyay, New Age Publishers
2. 'Nano Essentials'by T.Pradeep, TMH.

CH-3205 (B)

INDUSTRIAL SAFETY & MANAGEMENT (OPEN ELECTIVE-II)

Course Objectives:

- To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models
- To understand about fire and explosion, preventive methods, relief and its sizing methods
- To analyse industrial hazards and its risk assessment.

Course Outcomes:

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

- Analyze the effects of release of toxic substances
- Select the methods of prevention of fires and explosions
- Understand the methods of hazard identification and prevention.
- Assess the risks using fault tree diagram
- Explain safety management in general and in industry specific
- Plan emergency preparedness and understand the occupational health hazards

Syllabus

Introduction : Industrial Safety, Incident, accident, near miss, hazard, risk, emergency, disasters, risk criteria, Safety at work.

Pediction and evaluation of unsafe conditions :
Identification of unsafe areas, unsafe acts, manifestation of unsafe conditions to emergency situation, lessons from accidents and disasters, safety audit and its elements, safety in plant layout, equipment design. Construction, erection, commissioning, material handling.

Hazards – chemical hazards, thermodynamic hazards, electrical & electromagnetic hazards, mechanical hazards.

Risk – Definition, causes, potential and adverse effects.

Hazard Analysis – incident scenarios, residual risk, Concept Hazard Analysis (CHA), Preliminary Process Hazard Analysis PPHA, HAZOP, Fault Tree Analysis (FTA), Event Tree Analysis (ETA).

Risk Assessment – Risk criteria, causes of death/damage, individual risk, societal risk, criteria for acceptable risk tolerable risk, application of risk assessment, computation of fatality rates, severity rates, vulnerability analysis, introduction to computerized risk assessment techniques.

Safety Management (General) – safety policy perceptions, safety organization, safety audit techniques, project and **Construction Safety** – welding & cutting operations, fabrication, material handling, equipment spacing, safe plant layout procedures, storage tanks, erection & commissioning works, housekeeping methods, maintenance of storage yards, erection & maintenance of electrical panels and MCC rooms, electrical & mechanical safe guarding.

Emergency Preparedness – onsite & offsite emergency preparedness, emergency preparedness plans, site specific action plans and contingency plans, emergency facilities, rehabilitation & rescue operations, post emergency actions.

Safety Management (Industry Specific)

Chemical Manufacturing Plants, Fertilisers, Steel Plants, Petrochemical Plants, Metallurgical Plants, Mineral Process Industries, Sugar plants, semiconductor industry, Polymer manufacturing plans, Paper industry, Pharmaceutical and bulk drug industries, Vessel manufacturing industry, LPG bottling plants, Power Plants, tanneries and textiles.

Statutory framework – key provisions of Factories Act, Environmental Protection Act, Manufacture, Storage and Import of Hazardous Chemical rules, Static and Mobile Pressure Vessels rules, NFPA specifications, OSHA regulations.

Occupational health management – occupational health perspectives, pre-employment & periodical medical examinations, diseases, causes, consequences, **Occupational health hazards in various industries** – aluminium industry, asbestos, battery manufacturing, sugar,

cement, coke ovens, cotton ginning, dairy, electro plating, fish canning, poultries, irrigation, lead smelting, mining, pesticides, power plants, refineries, pulp & paper industry, PVC processing, steel plants, fertilizers, sulphuric acid plants, tanneries and textiles.

International standards – British council's five star rating systems, International Safety Rating Systems (ISRS), ISO 14001 EMS, ISO 18001 OHSAS, BIS 14489 Code of Conduct for conducting safety audits.

TEXT BOOKS:

1. "Hazards in Chemical industries, 3rd edition" – Authored by Frank P.Lees
2. "Hazard identification and risk assessment" – Authored by Geoff Wells; Published by Institution of Chemical Engineers, Davis Building, 165-189 Railway Terrace, Rugby, Warwickshire CV21 3HQ, UK.

REFERENCE BOOKS:

1. "Safety Management 5th edition" – Authored by John V. Grimaldi and Rollin H. Simonds; Published by A.I.T.B.S. Publishers & Distributors, J-5/6, Krishna Nagar, Delhi – 110051.
2. "Environmental Health and Safety Management" – Authored by Nicholas P. Cheremisinoff and Madelyn L. Graffia; Published by Jaico Publishing House, Hyderabad.

CH-3205 (C)

ENVIRONMENTAL POLLUTION CONTROL ENGINEERING
(OPEN ELECTIVE-II)

Course Objectives:

To understand the types of emissions from chemical industries and their effects on environment, methods of analysis of air pollutants, general methods of control like primary, secondary, tertiary treatment methods, solid waste management and Industrial safety.

Course Outcomes:

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

- Analyze the effects of pollutants on the environment
- Distinguish air pollution control methods
- Assess treatment technologies for wastewater
- Identify treatment technologies for solid waste
- Explain the hazards and safety measures in waste treatment
- Propose treatment methods for various industrial effluents

Syllabus

Types of emission from chemical industries and their effects on environment, Environmental legislation, noise pollution, occupational health hazards, meteriological factors in pollution dispersion (ALP and ELP), plume behaviour and characteristics, chimney design considerations: Plume raise, effective stack height,

Methods of analysis of air pollutants, particulate matter, SO_x, NO_x, CO_x analysis, removal of particulate matters: principles and design of setting chambers, solid traps, cyclone separators, fabric and design of fibre filters, scrubbers and electrostatic precipitators,

General methods of control and removal of sulphur dioxide, oxides of nitrogen, organic vapors from gaseous effluents with design aspects, sources of waste waters, effluent guidelines

and standards, characterization of effluent streams, oxygen demanding wastes, oxygen sag curve, BOD curve, analysis of water pollutants,

Methods of primary treatment: Screening, sedimentation, floatation and neutralization, biological treatment, bacteria and bacterial growth curve, aerobic processes suspended growth processes, activated sludge process, extended aeration, contact stabilization, aerated lagoons and stabilization ponds, attached growth process with design aspects, trickling filters, rotary drum filters, fluidized bed contactors, anaerobic processes,

Methods of tertiary treatment: Carbon adsorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation & sonozone process, sludge treatment and disposal,

Solid waste management: solid waste collection, transportation, solid waste processing and recovery, hazards in waste management, risk assessment and safety measures, types of hazardous wastes, health effects, safety measures, risk assessment response measures, case studies or pollutants removal and safety measures in fertilizer, petrochemical, paper, pharmaceutical industries and petroleum refinery,

TEXT BOOK:

1. 'Environmental Pollution Control', by C.S. Rao, Wiley Eastern Limited

REFERENCE BOOK:

1. 'Environmental Engineering' by Arcdio P.Sincero and Geogoria Sincero

CH-3206

MASS TRANSFER-II LABORATORY

Course Objectives:

- The student will learn about the LLE, dynamics and mass transfer in spray tower, packed tower and sieve tray tower.
- The students will learn the drying characteristics of the given solid material.

Course Outcomes:

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

- Determine the LLE
- Determine the critical moisture content in drying
- Determine separation performance and mass transfer coefficients of sieve plate
- Identify the axial mixing characteristics in packed bed
- Evaluate the dynamics of liquid drops

List of experiments:

1. Ternary liquid equillibria (Binodal curve)
2. Liquid-liquid equilibria.
3. Limiting flow rates in spray tower
4. Hydrodynamics of perforated plate tower
5. Volumetric mass transfer coefficients in perforated plate tower
6. Dynamics of liquid drops (Single drop extraction tower)
7. Studies of axial mixing characteristics in a packed bed
8. Gas-liquid mass transfer in packed tower
9. Drying characteristics of a given material

CH-3207

CHEMICAL REACTION ENGINEERING LABORATORY

Course Objectives:

- To familiarize students with main type of chemical reactors
- To analyze the experimental data to obtain the reaction rate expression (reaction order and specific reaction rate constant)
- To compare the conversion of reactants for a specific reaction in various types of reactor.
- To understand the concept of residence time distribution in reactor systems.
- To determine mass transfer coefficient of systems with chemical reaction

Course Outcomes:

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

- Determine the kinetics of a reaction in a batch reactor, CSTR, & PFR
- Determine the mass transfer coefficient (solid-liquid reacting system)
- Determine the kinetics by fractional conversion method
- Determine the temperature dependency of a reaction
- Evaluate the performance of reactors through RTD studies
- Compare the performance of single reactor with combination of reactors

List of experiments:

1. Determination of the order of a reaction using a batch reactor and analyzing the data by
   (a) differential method and (b) integral method
2. Determination of the activation energy of a reaction using a batch reactor
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR

4. To determine the specific reaction rate constant of a reaction of a known order using a batch reaction.
5. To determine the order of the reaction and the rate constant using a tubular reactor
6. Determination of RTD and dispersion number in a tubular reactor using a tracer
7. Mass transfer with chemical reaction (solid-liquid system) – Determination of mass transfer coefficient
8. Axial mixing in a packed bed - Determination of RTD and the dispersion number for a packed bed using tracer
9. Langmuir adsorption isotherm - Determination of surface area of activated charcoal.
10. Performance of reactors in series: (i) A plug flow reactor followed by a CSTR and (ii) A CSTR followed by a plug flow reactor.

CH-3208

PROCESS INSTRUMENTATION & CONTROLLABORATORY

Course Objectives:

- To understand the dynamic behavior of the systems
- To evaluate response of fist and higher order characteristics.
- Study the installed characteristics of the valve.
- Study if there is a hysteresis in the control valve and sensor.
- Evaluate the tuning of a PID control via manual and automatic tuning.

Course Outcomes:

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

- Identify the dynamics of first order, second order, interacting and non-interacting processes
- Determine control valve characteristics
- Evaluate the hysteresis characteristics of Bourdon pressure gauge
- Implement PID controller on a level control, temperature control and pressure control process
- Demonstrate PID control trainer

List of experiments:

1. Response of mercury-in glass thermometer
2. Response of mercury-in glass thermometer with thermal well.
3. Calibration & response of resistance thermometer
4. Response of manometer
5. Calibration of thermocouples
6. Response of single-tank liquid level system
7. Response of two-tank non-interacting liquid level system
8. Response of two tank interacting liquid level system
9. Study of on-off control – Control let off position.

10. Valve characteristics of equal % control valve
11. Valve characteristics of linear control valve
12. On-off control – controller on position
13. Studies on hysteresis characteristics of Bourdon pressure gauze
14. Hysteresis characteristics of equal % control valve
15. Studies on hysteresis characteristics of linear control valve
16. Response studies for different types of controller (P, PI, PID) using PID control trainer.
17. Level control trainer
18. Pressure control trainer
19. Temperature control trainer

CH-3209
INTELLECTUAL PROPERTY RIGHTS

Course Objectives:

- To introduce fundamental aspects of intellectual property rights.
- To disseminate knowledge on copyrights and its related rights and registration
- To provide comprehensive knowledge to the students regarding Indian position of patent law, procedure for granting patent, Infringement
- To provide knowledge to the students regarding registration of trade mark , Infringement of trade mark

Course Outcomes:

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

- Identify the types of IP and the importance of protection of IP
- Differentiate the foundation and patent laws in India and developed countries
- Explain how to obtain copy right and law of copy rights
- Learn the purpose and function of trade marks and registration of trade mark
- Describe risks involved and legal aspects of Trade Secret Protection
- Understand IP Infringement issue and enforcement

Syllabus

Introduction to Intellectual Property: Historical Perspective, Different Types of IP, agencies and treaties, Importance of protecting IP, international organizationsInnovations in products, processes, services and procedures - product life cycles, favorable and unfavorable aspects in innovation; Inventions as intellectual property.

Patents : Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India, Foundation of patents and patent laws, procedures in India and developed countries; study of patents indifferent fields and their innovative content;patent searching process, ownership rights and transfer.

Copyrights: Introduction, How to obtain a copy right and Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law, Differences of copyrights from Patents.

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Trade Marks: Introduction to trademarks, Purpose and function of trademarks, acquisition of trade mark rights,protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Trade secrete law, Risks involved and legal aspects of Trade Secret Protection, Determination of trade secrete status, liability formisappropriations of trade secrets, protection for submission, trade secrete litigation, Unfair competition: Misappropriation right of publicity, false advertising.

New developments and Infringement Issues of IP:

New development of intellectual property: New developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law, motivating and encouraging innovative attitude in individuals and organizations; entrepreneurial qualities and skills, learning and training.

IP Infringement issue and enforcement– Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Human attitudes, risks, hardships, examples of failure, case studies of inventors; Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

REFERENCE BOOKS:

1. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
2. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
3. Acharya, N.K. Textbook on intellectual property rights, Asia Law House (2001).
4. Miller, A.R. & Davis, M.H. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
5. Watal, J. Intellectual property rights in the WTO and developing countries, Oxford University Press, New Delhi.

CH -3210
ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

Course Objectives:

- To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To make the students understand the traditional knowledge and analyse it and apply it to their day to day life

Course Outcomes:

At the end of the Course, Student will be able to:

CO 1:Identify the concept of Traditional knowledge and its importance.

CO 2:Explain the need and importance of protecting traditional knowledge.

CO 3:Illustrate the various enactments related to the protection of traditional knowledge.

CO 4:Interpret the concepts of Intellectual property to protect the traditional knowledge.

CO 5:Explain the importance of Traditional knowledge in Agriculture and Medicine.

Syllabus

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

TEXT BOOKS:

1. Traditional Knowledge System in India, by Amit Jha, 2009.

REFERENCE BOOKS:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino.

SUMMER INTERNSHIP PROGRAM (2MONTHS)

All the students have to undergo Summer Internship for two months in the industries at the end of the third year second semester.

CH-4101
TRANSPORT PHENOMENA

Course Objectives:

- To make students understand the use of basic laws of mass, momentum and energy transport in the engineering analysis.
- Momentum transport deals with evaluation of velocity distributions in steady and unsteady laminar flow problems in simple geometries of Newtonian and non-newtonian fluids.
- Energy transport deal with the evaluation of steady/ unsteady temperature distributions in solids and in laminar flow.
- Mass transport deals with the evaluation of steady state concentration profiles with or without chemical (Homogeneous/ heterogeneous) reaction.

Course Outcomes:

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

- Identify the transport properties of solids, liquids and gases
- Formulate a mathematical representation of flow / heat / mass transfer phenomena
- Solve steady state flow/heat/mass transfer problems for simple geometries analytically
- Solve unsteady flow/ heat problems for simple geometries

Syllabus

PART-A

Momentum transport: Viscosity and the mechanism of momentum transport- i). Newton's law of viscosity, ii). Non-Newtonian fluids and iii). pressure and temperature dependence of viscosity,

Velocity distributions in laminar flow: i). Shell momentum balances boundary conditions, ii). flow of a falling film, iii). flow through a circular tube and iv). flow through an annulus,

The equations of change for isothermal systems: i). The equations of continuity, motion and mechanical energy in rectangular and curvilinear coordinates, ii). use of the equations of change to set up steady flow problems and iii). dimensional analysis of the equations of change,

Velocity distributions with more than one independent variable and unsteady viscous flow,

PART-B

Energy transport: Thermal conductivity and the mechanism of energy transport- i). Fourier's law of heat conduction and ii). temperature and pressure dependence of thermal conductivity in gases and liquids,

Temperature distributions in solids and in laminar flow: i) Shell energy balances-boundary conditions, ii). heat conduction with an electrical heat source, iii). heat conduction with a viscous heat source, iv). heat conduction through composite walls, v). forced convection and vi). free convection,

The equationsof change for non-isothermal systems: i). The equation of energy in rectangular and curvilinear coordinates, ii). the equations of motion for forced and free convection in non-isothermal flow, iii). use of the equations of change to set up steady state heat transfer problems and iv). dimensional analysis of the equations of change,

Temperature distribution with more than one independent variable: Unsteady state heat conduction in solids,

PART-C

Mass transport: Diffusivity and mechanism of mass transport- i). Definitions of concentrations, velocities and mass fluxes, ii). Fick's law of diffusion and iii). temperature and pressure dependence of mass diffusivity,

Concentration distribution in solids and in laminar flow: i). Shell mass balances – boundary conditions, ii). diffusion through a stagnant gas film, iii). diffusion with heterogeneous chemical reaction, iv). diffusion with homogeneous chemical reaction and v). diffusion into a falling liquid film,

The equations of changefor multicomponent systems: i). The equations of continuity for a binary mixture, ii). the equations of continuity of A in curvilinear coordinates and iii). dimensional analysis of the equations of change for a binary isothermal fluid mixture,

TEXT BOOK:

1. 'Transport Phenomena' by R. Byron Bird, W.E. Steward and Edwin N. Lightfoot, John Wiley& Sons Inc., New York

REFERENCE BOOKS:

1. Transport phenomena' by Robert S. Brodkey & Haryr C. Hershey, McGraw Hills Company, New York
2. Transport Phenomena-for engineers' byLouis Theodore, International Book Compnay, London
3. 'Transport Phenomena' by W.J.Book and K.M.K.Multzall, JW&Sons Ltd.
4. 'Fundamentals of Momentum, Heat and Mass Transfer' by Mames R Welty, Charlese Wicks and Robert E Wilson, J W & Sons Inc., New York
5. Fluid Dynamics and Heat Transfer' by James G. Knudsen and Donald L.Katz., McGraw Hills Company Inc., New York.

CH-4102

PROCESS ENGINEERING& ECONOMICS

Course Objectives:

- To introduce types of interests, annuity, perpetuity, bond, debenture
- To introduce depreciation and cost accounting methods
- To introduce cash flow tree diagram, methods of cost estimation.
- To introduce profitability, profitability evaluation
- To introduce optimization in industries
- To introduce economic balance of various operations.

Course Outcomes:

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

- Determine costs involved in process plants.
- Estimate depreciation costs and various ratios to tell about financial status of the company
- Perform economic analysis and optimum design of the processes
- Evaluate project profitability.

Syllabus

Value of money - equivalence: Value of money, equations for economic studies, equivalence, types of interest- discrete and continuous, annuities - relation between ordinary annuity and the periodic payments, continuous cash flow and interest compounding, present worth of an annuity, perpetuities and capitalized costs, bonds and debentures, value of a bond and yield rate,

Depreciation: Types and various methods of calculating depreciations, depreciation accounting,

Cost accounting: Basic relationship in accounting, balance sheet and income statement, various ratios to study the balance sheet and income statements,

Cost estimation: Cash flow for industrial operations, factors affecting investments and production costs, estimation of capital investment, cost indices, cost factors in capital investment, methods of estimating capital investment, estimation of total product cost-manufacturing costs and general expenses,

Profitability: Alternate investments and replacements. mathematical methods for profitability evaluation, economic production charts for plants operating below 100%, above 100% and under dumping conditions, general procedure for determining optimum conditions, break even chart for production schedule and its significance for optimum analysis,

Economic balance in fluid flow, heat transfer and mass transfer operations; optimum economic pipe diameter in fluid dynamics, optimum flow rate of cooling water in condenser in heat transfer and optimum reflux ratio in distillation operation,

Economic balance in cyclic operations and semi continuous cyclic operations, economic balance in yield and recovery, economic balance in chemical reactors, batch and flow reactors.

TEXT BOOKS:

1. `Plant Design and Economics for Engineers' by Max S. Peters and K.D.Timmerhans, McGraw Hill Book Company,
2. `Process Engineering Economics' by Herbest E. Schweyer, McGraw Hill Book Company.

CH-4103

CHEMICAL PROCESS EQUIPMENT DESIGN

Course Objectives:

This subject introduces the student to the science and art of chemical engineering design. By applying all the knowledge acquired so far, the student will be trained to develop project reports and to carryout design calculations of various process equipment. Finally the student will be able to come out the investment needed for a particular process and also finds out the returns on investment.

Course Outcomes:

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

- Develop process design
- Enumerate general design consideration
- Design incompressible/compressible flow systems and estimate cost of filters
- Select high and low pressure vessels
- Design of distillation column, heat exchangers and evaporators

Syllabus

Introduction of plant design and costs,

Process design development: Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, materials of construction,

General design considerations: Health and safety hazards, fire and explosion hazards, personnel safety, loss prevention, thermal pollution control, noise pollution and control, plant

location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication selection.

Material transfer, handling and treatment equipment design and costs: Pumps and piping, frictional effects due to end losses, fittings, orifices and other installations, piping standards, pumps, tanks, pressure vessels and storage equipment, filters.

Mechanical design of process equipment: Design and selection of storage vessels and low pressure vessels, design of roofs, bottom plates, formed heads, flat plate and conical closures, tall vertical columns, supports to process vessels, distillation columns, heat exchanges, evaporators.

Heat transfer equipment design and costs: Basic theory of heat transfer, consideration in selection of heat transfer equipment, General methods for process design of heat exchangers, evaporators.

Mass transfer equipment design: Finite stage and continuous contactors, plate and column efficiencies, other design factors for finite stage contactors, packed towers, relative merits of plate and packed towers, mass transfer equipment costs, reactors.

TEXT BOOKS:

1. 'Plant design & Economics for Chemical Engineers', 4th edition, M.S.Peters&K.D.Timmerhaus, McGraw Hills Publishing Company
2. 'Process Equipment Design', 3rd Edition, M.V.Joshi, MacMillan India Ltd 1981

REFERENCE BOOKS:

1. 'Process-Plant-Design' by J.R.Backhurst&J.H.Harker, Heieman Education London
2. 'Chemical Engineering' Volume-VI (An introduction to Chemical Engineering Design) by J.M.Coulson & J.F.Richardson

CH-4104(A)
COMPUTER AIDED DESIGN (CORE ELECTIVE -III)

Course Objectives:

To revise the basic concepts in Fluid Mechanics, Heat Transfer, Mass Transfer and Chemical Reaction Engineering and apply the numerical methods with the aid of computer in designing such systems.

Course Outcomes:

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

- Elaborate the need of computer aided design and advantages of simulation
- Design the size of the pipe for a given pressure drop for Newtonian and non-newtonian fluids
- Evaluate pressure drop in compressible fluid flow, pipe line networks and two phase flow
- Develop the rating and design calculations in heat exchangers, distillation columns, extraction cascades, plate/packed bed absorbers and isothermal flash.
- Design ideal reactors, packed bed and fluidized bed reactors
- Estimate rate of extent of reaction vector for simultaneous reactions

Syllabus

CAD of fluid flow system:
Flow of Newtonian fluids in pipes
Pressure drop in compressible flow
Flow of Non-Newtonian fluids in pipes
Pipe network calculations
Two phase flow system,**CAD of Heat transfer equipment:** Shell and tube exchangers without phase change,Condensers, Reboilers,Furnaces,**CAD of Mass transfer equipment:** Distillation,Gas absorption ,Liquid extraction,**CAD of chemical Reactors:** Chemical reaction equilibrium ,Analysis of rate data, Ideal reactor models,Non-ideality in chemical

reaction,Performance analysis using residence time distribution,Temperature effects in homogeneous reactors,Heterogeneous systems, Fluidized bed reactors.

TEXT BOOK:

1. Chemical Process Computations by Raghu Raman.Elsevier Scientific Publishers, London, 1987

REFERENCE. BOOKS:

1. Fundamentals and Modelling of Separation process by C D Holland, rentice Hall Inc. New Jercey, 1975
2. Catalytic Reactor Design by Orhan, Tarhan, Mc Graw Hill, 1983
3. Chemical Engineering, Vol 6 by Sinnot, Pergamon Press, 1993

CH-4104(B)
INDUSTRIAL POLLUTION AND CONTROL ENGINEERING
(CORE ELECTIVE -III)

Course Objectives:

1. To understand the types of emissions from chemical industries and their effects on environment, remedial measures.
2. To enable the students to design water treatment system & to acquire knowledge on proper management of solid wastes.
3. To provide a general idea about safety in chemical industries.

Course Outcomes:

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

- Analyze the effects of pollutants on the environment
- Distinguish air pollution control methods
- Assess treatment technologies for wastewater
- Identify treatment technologies for solid waste
- Identify and manage industrial hazards

Syllabus

Types of emission from chemical industries and their effects on environment, Environmental legislation, noise pollution, occupational health hazards, meteriological factors in pollution dispersion (ALP and ELP), plume behaviour and characteristics, chimney design considerations: Plume raise, effective stack height,

Methods of analysis of air pollutants, particulate matter, SO_x, NO_x, CO_x analysis, removal of particulate matters: principles and design of setting chambers, solid traps, cyclone separators, fabric and design of fibre filters, scrubbers and electrostatic precipitators,

General methods of control and removal of sulphur dioxide, oxides of nitrogen, organic vapors from gaseous effluents with design aspects, sources of waste waters, effluent guidelines and standards, characterization of effluent streams, oxygen demanding wastes, oxygen sag curve, BOD curve, analysis of water pollutants,

Methods of primary treatment: Screening, sedimentation, floatation and neutralization, biological treatment, bacteria and bacterial growth curve, aerobic processes suspended growth processes, activated sludge process, extended aeration, contact stabilization, aerated lagoons and stabilization ponds, attached growth process with design aspects, trickling filters, rotary drum filters, fluidized bed contactors, anaerobic processes,

Methods of tertiary treatment: Carbon adsorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation & sonozone process, sludge treatment and disposal,

Solid waste management: solid waste collection, transportation, solid waste processing and recovery, hazards in waste management, risk assessment and safety measures, types of hazardous wastes, health effects, safety measures, risk assessment response measures, case studies or pollutants removal and safety measures in fertilizer, petrochemical, paper, pharmaceutical industries and petroleum refinery,

Industrial safety: Why safety, accidents, causes and remedial measures, safety aspects of site selection, plant layout and unit plot planning, hazards of commercial chemical operations and reactions, safety aspects of process design, instrumentation for safe operations, safety aspects in design and inspection of pressure vessels, effect of toxic agents, toxicity vs hazards, respiratory hazards, safe experimentation and testing of reactions, materials for safety,

Flamable materials: Fire extinguishing agents and their applications, eye safety in chemical processing, personnel protective equipment, permit systems, hazard evaluation techniques, modern safety management systems, safety effectiveness.

TEXT BOOKS:

1. 'Environmental Pollution Control', by C.S. Rao, Wiley Eastern Limited
2. 'Safety and Accident Prevention in Chemical Operations' by Fawcett and Wood

REFERENCE BOOKS:

1. 'Environmental Engineering' by Arcdio P.Sincero and Geogoria Sincero

2. 'Loss Prevention in Chemical Industries' by Frank P.Lees

CH-4104(C)
PROCESS OPTIMIZATION
(CORE ELECTIVE -III)

Course Objectives:

Optimization of Chemical Process is an important of subject for Chemical Engineers. It deals with various optimization techniques in reducing cost of production ,energy consumption, maximum throughput and minimum labour cost etc. Onstudying the course one can understand how to write a model of the process optimize the process using the model

Course Outcomes:

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

- Understand the definition of Optimization and how to write an Objective function
- Understand various types of Objective functions like Concave and Convex functions and its properties
- Study the Optimization of uni&multi dimensional search problems
- Solve the Optimization problems by Linear and Non-Linear Programming methods

Syllabus

Definition of optimization Applications of optimization optimal insulation thickness Requirements for an optimization technique, Writing an objective function Production schedule ,material balance requirements , six steps of solving an optimization problem

Basic concepts of optimization continuous and discontinuous , unimodal and multi modal functions concave and convex functions, Finding the optimal point, definition of maximum, minimum and saddle points with examples

Unconstrained unidimensional search , Newton method Quasi Newton method and Secant method, Speed of iterations linear ,order p and super linear, Quadratic interpolation, cubic interpolation, Region elimination method, Fabonacci and Golden section method

Multivariable unconstrained optimization ,direct methods Powell method,Conjugate searchdirection, Gradient and conjugate Gradient, Fletcher Reeves method , Positive definite of Hessian matrix Marquadt method

Linear programming ,definition , solving the refinery schedule problem by linear programming method using graph, Simplex method and definition

Non linear programming , Lagrange multiplier method, Iterative linearization and Quadratic programming method, Necessary and sufficient condition for a minimum value ,Kuhn-tucker conditions

TEXT BOOKS:

1. Optimization of Chemical Process by Edgar and Himmelblau, 2nd edition, Mc GrawHill Publications.
2 Optimization Theory and Applications by S.S. Rao, 2nd Edition, Wiley Eastern Limited.
3 Formulation and optimization of Mathematical Models by C.L.Smith, R.W. Pike and P.W.Mur.

CH-4104(D)

RESERVOIR ENGINEERING (CORE ELECTIVE -III)

Course Objectives:

To know the fundamental concepts of reservoir engineering, basic properties of reservoir rocks, various types of reservoirs and driving mechanisms for the production of Oil and gas from an oil reservoir.

Course Outcomes:

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

- Identify the type of oil reservoirs by knowing the characteristics and mechanisms.
- Predict the reservoir performance by knowing the past performance history of the oil reservoir.

Syllabus

Fundamental concepts of Reservoir Engineering: Porosity, fluid saturation, permeability, flow through layered beds, flow through series beds, Klinkenberg effect, effective permeability data, phase behavior.

Oil reservoirs: Reservoir driving mechanisms, basic equation and tools, volatile oil reservoirs, identification of volatile oil reservoirs, ultimate recovery, predicting reservoirs behavior, performance, mechanics of reservoir performance, prediction procedure, limitations of predictions, relating reservoir performance to time, factors affecting ultimate recovery, analysis of gas oil ratio history.

Depletion drive reservoirs: Producing characteristics and methods of identification, detailed procedure for predicting reservoir performance, limitations of predictions, factors affecting ultimate recovery.

Water drive reservoirs: Effect of free gas saturation on recovery, predicting reservoirs performance, calculating water influx, use of the unsteady state equation in predicting reservoir performance, validity of performance prediction, limitations in predicting reservoir performance, the material balance equation as a straight line.

Gravity drainage reservoirs: Permeability in the direction dip, dip of the reservoir, reservoir producing rates, oil viscosity, relative permeability characteristics, fundamental recovery process, predicting reservoir performance, apparent relative permeability, oil saturation method.

Combination of drive reservoirs: Index of drives, equations used, material balance equations, instantaneous gas- oil ratio equation.

Pressure maintenance: Pressure maintenance by gas injection, condensing gas drive, predicting performance by gas injected gas drive index, pressure maintenance by water injection, predicting performance by water injection, index of injected water drive, control of the gas cap, typical water injection pressure maintenance operations.

Improving oil recovery: Improving oil recovery by fluid immiscible gas–water, miscible fluid injection thermal oil recovery, predicting recovery from fluid injection products, Stiles's method of water flood prediction, derivation of water cut and recovery equations, frontal advance techniques for prediction result of either water or gas injection, well arrangements, peripheral water flooding, predicting behavior of peripheral water floods, special consideration involved in water flooding, water flood case history, predicting the results of water flooding.

TEXT BOOK:

1. 'Reservoir Engineering Manual' – 2nd Edition by Frank W. Cole, Gulf Publishing Company, Houstan, Texas, 1969.

CH-4104(E)

FUELS, REFRACTORIES AND FURNACES (CORE ELECTIVE - III)

Course Objectives:

The main objective of this course is to study the different minerals used for the manufacturing of different types of refractories and its large scale applications in industries**.**

Course Outcomes:

At the end of the course, the students will be able to

- Understand the importance, types of refractories, properties, design and installation and different types of coatings on refractories.
- Explain about special refractories
- Describe refractories for iron & steel industry, Glass industry and cement & nonferrous industry

Syllabus

INTRODUCTION OF REFRACTORIES

Production, demand and growth of refractories in India – layout of modern refractory plant – fundamental properties of refractories – Indian and international standards – factors for selection and use of refractories – test and quality control procedures.

SILICA REFRACTORIES

Raw materials and composition – manufacturing process steps – quality of raw materials and process parameter on quartz inversion – glassy phase and other micro structural features – porosity, strength, RUL dependence on micro structure – specifications of silica refractories.

ALUMINA – SILICA REFRACTORIES

Al_2O_3 – SiO_2 phase diagram – clay, pyrophyllite, sillimanite, grog, bauxite and diaspore as raw materials – manufacturing processes – micro structure and properties

BASIC PROPERTIES

Magnesite, forsterite, dolomite and chrome based refractories – raw materials and composition – manufacturing processes – micro structure and properties.

SPECIAL REFRACTORIES

Oxide based, carbide based and nitride based refractories – cordierite – zirconia – carbon – fusion cast refractories, slide gate, purging refractories, and continuous casting refractories – ceramic fibres.

REFRACTORIES FOR IRON AND STEEL INDUSTRY

Coke oven, blast furnace, twin hearth, LD converter – continuous casting – electric arc furnace, induction furnaces – reheating furnaces – slide plate system – nozzle, shroud/ SDN – ladle and tundish lining practices – monolithic - gunning techniques – refractor, slag and metal interactions.

REFRACTORIES FOR CEMENT AND NON FERROUS INDUSTRY

Wet/ dry process for cement making – preheater and pre calcinatory and zone lining – alkali and wear resistance – refractory requirement and use in copper, aluminum and hydro carbon industry – use of monolithic.

REFRACTORIES FOR GLASS INDUSTRY

Design of glass tank for container, sheet, lamp, float glasses, refractory practices in side wall, throat, forehearth, and roof of glass tanks – regenerator systems – alumina and AZS fused cast refractories – glass corrosion resistance, oxidation, seed potential tests – glass defects and analysis – feeder expendables

REFRACTORIES FOR CERAMIC INDUSTRY

Kiln furniture – types – properties of requirement - silicon carbide, mullite, corderite, alumina, zirconia – mullite, zirconia types – kiln design – LTM concept – fast firing technology

REFRACTORIES FOR ENERGY CONSERVATION

Insulation refractories – types- ceramic fiber product – design and installation – ceramic coatings – case studies in ceramic fiber usage.

TEXTBOOK:

1. B. M. Coop and E. M Piekson, Raw Materials for the refractory industries and industry materials and consumer survey, 1981.

REFERENCE BOOKS:

1. J. H. Eheslers Refracrtories: production and Properties. Iron and Steel Institute, London, 1972.
2. Akira Nistrikawa, Technology of monolithic refractories, Plibrico japan co. Tokyo 1984
3. D.N. Nandi, Hand Book Refractory's, Tata Mc Graw hill publishing Co. New Delhi 1991
4. K.Shaw, Refractories and thick uses ADP sciences publisher U K 1972
5. Keishi GOTON, Powder Technology Hand Book, Marcel Dekker Inc. 1997
6. Chester J.H., Steel Plant Refractories, 2nd Edition, 1973, United Steel Companies Limited, Sheffield UK
7. Advances in Refractory Technology, Ed. Robert E Fisher, Ceramic Transaction Vol 4., American Ceramic society, 1990, Westerville, Ohio, USA.

CH-4104(F)

BIOCHEMICAL ENGINEERING (CORE ELECTIVE - III)

Course Objectives:

- To apply the chemical engineering principles in biological systems.

Course Outcomes

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

- Understand cell and enzyme kinetics
- Discuss methods of immobilization
- Calculate volume of a fermentor
- State sterilization methods
- Select downstream process to separate the products
- Estimation using various Bioanlytical techniques

Syllabus

Introduction to Biochemical engineering and Biotechnology: Overall view of biotechnology since its practice–to date, enzyme kinetics, derivation of M.M. equation of single as well as multiple substrates, enzyme inhibition, determination of M.M. parameters, industrial applications of enzymes,

Cell cultivation & kinetics: Microbial, animal and plant cell cultivation, cell immobilization, batch growth of cells, yield coefficient, monod growth kinetics,

Analysis and design of fermenters: Batch fermenter, mixed flow fermenter (chemostat), plug flow fermenter, mixed flow fermenters in series, and cell recycling,

Genetic engineering: DNA and RNA, cloning of genes, stability of recombinant microorganisms, gene manipulation,

Sterilization: Sterilization of media and air, thermal death kinetics, design criterion, continuous sterilization methods,

Aeration and agitation in fermenters: Correlations of mass transfer coefficient, measurement of interfacial area and gas holdup, power consumption, scale up concepts,

Bioanalytical techniques: Gas chromatography, thin layer and paper chromatography, HPLC, affinity, gel, adsorption and ion exchange chromatography.

TEXT BOOK:

1. 'Biochemical Engineering Fundamentals' 2nd edition by J.E.Bailey and D.F.Ollis, McGraw-Hill Publishers, Newyork, 1986

REFERENCE BOOKS:

1. 'Chemical Engineering' volume-3, 3rd Edition by J.F Richardson and D.G. peacock, (Chapter-5: Biochemical Reaction Engineering), Pergomon Press, U.K, 1994
2. 'Bioprocess Engineering: Basic Concepts' 2nd edition by M.L.Shuler and F.Kargi, Prentice Hall India, New Delhi, 2003
3. 'Biochemical engineering' by D.G. Rao, Tata McGraw-Hill Publishers, New Delhi,
4. 'Biochemical Engineering' by J.M. Lee, Prentice Hall, Englewood Clifts, 1992.

CH-4105

OPEN ELECTIVE –III

Open Elective –III and Open Elective-IV are MOOCS courses
(To be specified/ approved by BOS)

CH-4106

OPEN ELECTIVE-IV

Open Elective –III and Open Elective-IV are MOOCS courses
(To be specified/ approved by BOS)

CH-4107

CHEMICAL PROCESS EQUIPMENT DESIGN LABORATORY
(Open book practical examination)

Course Objectives:

The objective of the course is to design the heat exchangers and to check the suitability of the given heat exchanger and to learn how to formulate problems involving use of "new" and "old" equipment. The students will solve problems mass transfer equipments and chemical reactors

Course Outcomes:

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

- Design double pipe heat exchanger and shell and tube heat exchanger with/ without phase change
- Evaluate the suitability of given heat exchanger for the process
- Design the plate column absorption/ distillation tower
- Evaluate the performance and design of continuous/batch reactors

Syllabus

The following equipment are to be designed in detail:

1. Double pipe Heat Exchangers
2. Sensible heat exchangers (1-2 or 2-4),
3. Condenser and reboiler,
4. Multiple effect evaporator
5. Fractionating / Absorption column-Plate and packed columns,
6. Packed bed absorber,
7. Continuous and Batch reactors (homogeneous and heterogeneous)

CH-4108
SUSTAINABLE PROCESS ENGINEERING

Course Objectives: This subject attempts to address the gap existing between industry and institute. The student is introduced to various terminology and practices that are followed in the industry. This subject also deals with the application of core chemical engineering knowledge to the modern aspects of chemical engineering such as sustainability, green engineering, process safety and enterprise resource planning.

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

- Explain the sustainability concepts
- Summarize waste minimization in reactors, separation processes and operations
- Identify waste in utility systems
- Identify hazards and implement safety management
- Plan enterprise resource and sustainable industries

Syllabus

Sustainability concepts – the concept of sustainable development, sustainability in the context of the process industries, some temporal characteristics of sustainability, the sustainable project or industry, conflicts in achieving sustainability objectives.

Cleaner production – introduction, the concept of cleaner production, the product life cycle, hierarchy of waste management, concepts and sources of waste, impacts of waste, driving forces for cleaner production, resistances to introducing cleaner production.

Industrial ecology – basic concepts, energy and materials recovery from waste streams, resource flow through the economy, transport and storage of raw materials and products, integrated site manufacture, some examples of industrial ecology initiatives.

Waste minimization in reactors – introduction, a checklist for reaction systems and reactors, chemistry of process route, impurities in reactor feed stocks, mixing of reactants, minimizing secondary reactions, recycle of unreacted feed from reactor outlet, reversible reactions, catalysis, agent materials, case studies.

Waste minimization in separation processes – classification of separation processes, sources of waste in separation processes, distillation, gas absorption, adsorption, filtration, drying, evaporation and condensation, extraction, use of extraneous materials, case studies.

Identification of waste in utility systems – introduction, fuels, fuel combustion, common fuels, environmental impacts of flue gases, theoretical flame temperature, furnaces, flare stacks, steam generation, steam use, water sources and uses, recirculated cooling water from cooling towers, sea water cooling, air cooling, refrigeration, electricity demand and supply, distribution and use of electricity, compressed air, inert gas, vacuum.

Energy conservation – introduction, energy consumption in compression of gases and pumping of liquids, pressure losses in piping and through equipment, agitation and mixing, heat recovery, energy recovery from high pressure streams, insulation, plant layout.

Materials recycling – introduction, recycling of materials in chemical processes, closed loop and open loop recycling, onsite and offsite recycling, producer and consumer waste, hierarchical approach to materials recycling, plastics recycling, glass recycling, recycling of materials from products, waste treatment option, aqueous effluent treatment and water recycling, disposal of wastes.

Waste minimization in operations – non-flow sheet emissions from a process plant, plant startup, shut down of a plant, abnormal operation, plant maintenance, cleaning of plant and equipment, fouling, transport and storage of raw materials and products, fugitive emissions, environmental risks resulting from storm water, risks in mining and extraction of materials.

Life cycle assessment – introduction, product and process applications, basic steps, goal definition, inventory analysis, example of inventory data estimation, classification, improvement analysis, some challenges and uncertainties in LCA, alternative or supplementary approaches to LCA, LCA software, LCA case studies

Planning for sustainable process industries – introduction, forecasting, scenario development, technology innovation transition to renewable feed stocks, site selection, integration of process plants and process industries, distributed manufacture, government legislation, stakeholder engagement, lifestyle implications.

Process safety management- Process safety basics, The need for process safety, Process safety for engineering disciplines, Process safety in design, Process safety in work place

Hazard Identification and Risk Assessment – Introduction – concept hazard analysis – Preliminary process hazard analysis – critical analysis of system safety – HAZOP – FTA – Task Analysis – Task Analysis and Hazard Identification – Risk criteria – Risk assessment – Development of P&I diagrams – Hazchek list – A HAZOP study – Hazard Identification techniques – HAZID – LOPA – RAST – Whatif – Checklists – FMEA – ETA – Bow tie.

Environmental management in the chemical industry – Introduction – preamble – environmental communication – stakeholder's reaction – Impact of legislation – voluntary action by industry – standardization and certification of EMS – International aspects of environmental management.

Enterprise resource planning – Introduction to business functions and business processes, functional areas of operation, business processes, marketing and sales, supply chain management, accounting and finance, human resources, Information systems in functional areas, Development of ERP system, ERP soft wares and implementation, choosing consultants and vendors, significance and benefits of ERP software and systems.

Statutes and codes – Factories act 1948, The air (prevention and control of pollution) act 1981, The water (prevention and control of pollution) act 1974, The Environment (Protection) act 1986, Factories act 1948, ISO 9000 (QMS), ISO 14000 (EMS).

TEXT BOOKS:

1. David Brennan, Sustainable Process Engineering, 2012, CRC Press. (Chapters 1 to 11, 14 and 15)

2. Introduction to process safety for undergraduates and engineers by CCPS of AIChE, Wiley, 2016.
3. Geoff Wells, Hazard Identification and Risk Assessment, Antony Rowe Ltd, UK
4. Frank Crawley, A guide to hazard identification methods, 2/e, Elsevier, 2020.
5. Ullman's encyclopaedia of industrial chemistry
6. Ellen F Monk, Bret J Wagner, Concepts in enterprise resource planning, 4/e, 2013, Course Technology. (Chapters 1 and 2)

CH-4109

SUMMER INTERNSHIP EVALUATION

All the students have to undergo Summer Internship for two months in the industries at the end of the third year second semester. Evaluation of the same will be conducted in this semesterby the Department.

CH-4201

PROJECT WORK

(6 months Project Work/ Internship shall be carried out in the Industry)

Course Outcomes:

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

- Carry out literature review
- Formulate the problem involving manufacture of a chemical product/ experimentation/modelling/simulation/optimization/design
- Carry out the project involving manufacture of a chemical product/ experimentation/ modelling/simulation/optimization/design/industrial problem
- Discuss the results
- Communicate results orally to audience
- Present the detailed written report

B.TECH. (HONORS)

CHH-1001

PROCESS MODELING AND SIMULATION

Course Objectives:

Deals with writing various process models based on basic physical process. It also deals with solving the various models by means of numerical methods by computer simulation. By studying this course, one can simulate various chemical processes by computer simulation.

Course Outcomes:

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

- Understand the writing of a model of a process based on basic physical processes like mass, momentum and energy balances.
- Develop a model equation for Tanks, Isothermal and Non-Isothermal Systems
- Understand the models for binary distillation column, batch reactors, etc.
- Solve the model equations by numerical methods.

Syllabus

Principles of formulation - Continuity equations – Energy equation – Equation of motion – Equations of state – Transport equations – Chemical Kinetics – Algebraic and Integral / differential equations, Explicit and Implicit equations –Numerical Integration,Feed forward and feed backward control.

Basic modeling for tank system, mixing vessel – Simultaneous mass and energy balances – Models for boiling, batch distillation, and partial condenser.

Models for Reactor – Model for heterogeneous catalysis – Models for pumping system – Model for heat exchanger.

Operational blocks in simulation- Simulation Programming – Simulation examples of three CSTR's in series, gravity flow tank, binary distillation column, non–isothermal CSTR.

Implicit function convergence ,Internal–halving convergence, Newton–Raphson method, False position convergence, Explicit convergence methods, Numerical Integration, Euler Integration, Runge - Kutta (fourth order) method.

TEXTBOOKS:

1. Process Modeling, Simulation and Control for Chemical Engineers by Luyben, W.L., McGraw Hill Books Co.
2. Mathematical Modeling in Chemical Engineering by Roger, G.E. Franks – John Wiley Sons Inc.

REFERENCE BOOKS:

1. Mathematical Methods in Chemical Engineering by V.G. Jenson and G.V. Jefferys, Academic Press – 2nd Edition.

CHH-1002

ADVANCED MASS TRANSFER

Course Objectives:

- To develop skills in the process design of mass transfer operations
- To understand problems involving mass transfer using the principles of material and energy balances.

Course Outcomes:

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

- Design process equipment for various mass transfer operations.
- Demonstrate the use of equations of change for multi-component systems.
- Solve problems of mass transfer in laminar and turbulent regimes.
- Solve problems of interphase transport in non-isothermal systems.

Syllabus

Flux Definition

- Mass and molar transport by convection
- Summary of mass and molar fluxes
- Fick's law

Differential Equations of Mass transfer

- Differential equation for mass transfer
- Boundary conditions

Molecular diffusivities

- Diffusivities in gases
- Diffusivities in liquids

Molecular diffusion

- Steady state molecular diffusion

- Steady-State Equimolal counter diffusion in gases
- Steady state Equimolal unidirectional diffusion in gases
- Molar diffusion in liquids
- Diffusion through a stagnant gas film
- Diffusion with a moving interface
- Diffusion through a Nonisothermal Spherical film
- Diffusion with a homogeneous Chemical reaction
- Diffusion with a slow Heterogeneous Chemical reaction
- Diffusion with a Heterogeneous Chemical reaction
- Unsteady state diffusion in a slab
- Unsteady state diffusion in a Cylinder
- Unsteady state diffusion in a sphere

Mass Transfer coefficients

- Individual Mass transfer coefficients
- Overall Mass Transfer coefficients
- Mechanism of Mass transfer
- The two-film theory
- The penetration theory
- The theory of penetration with Random surface renewal

Mass transfer in Laminar Flow

- Mass transfer in the laminar boundary layer on a flat plate (Integral Solution)
- Mass transfer in laminar Natural convection on a vertical plate
- Mass transfer in a falling liquid film in a laminar flow
    - Mass transfer between a gas phase and a falling liquid film (gas absorption)
    - Mass transfer between an inclined plate and a falling liquid film (Solid dissolution)
    - Gas absorption with rapid reaction

Mass Transfer in turbulent flow

- Mass transfer in the turbulent boundary layer on a flat plate
- Mass transfer in turbulent Natural convectionon a vertical plate
- Mass transfer between inclined plate and a falling liquid film in turbulent flow
- Analogies between momentum, heat and mass transfer
    - Reynolds analogy
    - Prandtl analogy
    - Von Karman analogy
    - Analogies in terms of j factor

TEXTBOOKS:

1. "Transport phenomena" R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.
2. 'Mass Transfer Operations' Robert E. Treybal, third edition, Mc Graw-Hill International Edition, Chemical Engineering Series.

REFERENCE BOOKS:

1. "Transport Processes and separation Processes Principles" Geankoplis, Prentice-Hall of India, New Delhi
2. "Fundamentals of Momentum, Heat and Mass Transfer" James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.
3. "Principles of Mass Transfer and Separation Processes" Dutta B.K, Prentice-Hall of India, New Delhi

CHH-1003

POLLUTION CONTROL

Course Objectives:

- Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Course Outcomes:

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

- Identify the sources, effects and analysis of air/ solids/ water pollutants
- Evaluate the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.
- Importance of environmental legislation
- Propose control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

Syllabus

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle

Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx).

Limits of pollutants, Environmental Legislation.

Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration,bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

TEXT BOOKS:

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.
2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering
3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

CHH-1004

CORROSION ENGINEERING

Course Objectives:

- Basic aspects of electrochemistry relevant to corrosion phenomena,
- Importance and forms of corrosion.
- Knowledge on corrosion rate expressions and measurement techniques.
- Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.
- Basic knowledge on remedial measures for corrosion.

Course Outcomes:

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

- Understand basic principles of electrochemistry, importance of corrosion, corrosion tendency and electrode potentials.
- Identify the nature of corrosion and form in which it attacks(Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage .
- Estimate corrosion rates using polarization
- Understand the mechanism and propose viable remedial measures.

Syllabus

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity.

Forms of Corrosion: Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing, mechanisms, testing and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy.

Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

TEXTBOOKS :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.
2. Corrosion Engineering by Mars F Fontana, McGraw Hill.
3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

REFERENCE BOOKS :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

CHH-1005

PETROLEUM REFINERY ENGINEERING

Course Objectives:

To introduce the basics of refinery engineering subject for petroleum specialization students to gain knowledge of the overall refinery operations, refinery products and its test methods. To learn various primary and secondary cracking process available to produce normal and value added products. Further, to learn the treatment process available to remove the impurities in the crude and finished products and its test methods for quality check.

Course Outcomes:

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

- Classify and understand the methods available for quality check
- Evaluate crudes and crude pretreatment
- Describe various treatment processes available to increase the quality of the product.
- Select the heat transfer equipment for refineries
- Design atmospheric / Vacuum distillation column and catalytic cracking units

Syllabus

Origin and formation of petroleum: Reserves and deposits of the world – Indialn petroleum industry – Composition of crudes.

Refinery products specifications and test methods: Evaluation of crudes. Crudes Pretreatment dehydration and desalting. Physical properties of petroleum oils and products.

Introduction to processing- Refinery distillation – processes – catalytic cracking, Reforming Hydro cracking , and hydro treating, hydrosulfurization.

Chemical treatments & Extraction Processes :Alkylation, polymerization Lube oil processing.

De-waxing :Asphalt and air blown asphalt.

Treatment of products, additines, blending of gasoline, treatment of gasoline, Kerosene etc.,

Heat transfer equipment in Refinery– Heat exchangers and pipe still heaters.

Design – atmospheric distillation tower and Vacuum distillation tower, catalytic cracking units.

TEXT BOOKS:

1. Petroleum Refinery Engineering – Nelson.
2. Refinery distillation - Watkins.

CHH-1006

ENERGY ENGINEERING

Course Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.
To learn various design and operational aspects of solar energy collection and storage.
To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.
To learn theory and application of Photovoltaic cells

Course Outcomes:

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

- Estimate the availability of solar radiation
- Design of various equipment operated on solar energy
- Explain he principles and practice of Photo voltaic cells
- Classify collectors and analyze their performances
- Describe the production of solar thermal power generation
- Select thermal power storage methodologies

Syllabus

The Solar Energy option

Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation

Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry

Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors

Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters

Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage

Sensible heat storage – Latent heat storage – Thermochemical storage

Solar Pond

Description – Performance analysis – Experimental studies – Operational Problems.

Solar Air Conditioning and Refrigeration

Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation

Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion

Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

TEXT BOOKS:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)
2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

CHH-1007

TRANSPORT PHENOMENA-II

Course Objectives:

- To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Course Outcomes:

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

- Understand the chemical and physical transport processes and their mechanism.
- Analyze heat, mass and momentum transfer problemswith relevant approximations and boundary conditions.
- Develop steady and time dependent velocity/ temperature/ concentration distributionsfor laminar and turbulent flow.
- Calculate friction factor/ heat transfer coefficient / mass transfer coefficient

Syllabus

Momentum Transport

1.1 The Equations of change for isothermal systems.

1.2 Velocity distributions with more than one independent variable.

1.3 Velocity distributions in turbulent flow.

1.4 Inter phase transport in isothermal systems.

Energy Transport

1.1 The Equations of change for non – isothermal systems.

1.2 Temperature distributions with more than one independent variable.

1.3 Temperature distributions in turbulent flow

1.4 Interphase transport in nonisothermal systems.

Mass Transport

1.1 The Equations of Change for multicomponent systems.

1.2 Concentration distribution with more than one independent variable.

1.3 Concentration distribution in turbulent flow.

TEXTBOOK:

1. “Transport phenomena” R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.

REFERENCE BOOKS:

1. “Transport Processes and separation Processes Principles” Geankoplis, Prentice-Hall of India, New Delhi
2. ”Fundamentals of Momentum, Heat and Mass Transfer” James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.
3. “Boundary – Layer Theory”, Dr.H.Schlichting, McGraw – Hill Book Company, New York.

CHH-1008
CHEMICAL REACTION ENGINEERING-III

Course Objectives:

- To focus on the thermal characteristics of various reactions and the design aspects of non isothermal and adiabatic reactors
- To focus on Heterogeneous data analysis and design
- To focus on CVD reactors
- To study the design aspects of heterogeneous catalytic systems
- To impart the knowledge on mass transfer with reaction in process catalysts

Course Outcomes:

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

- Understand the design aspects of non isothermal and adiabatic reactors
- Analyze heterogeneous data and design aspects of heterogeneous catalytic systems
- Derive the rate laws for CVD
- Develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

Syllabus

Review of Fundamentals Rate laws and stiochiometry, reactions with phase change (Scope: Chapter 3 of Fogler) Least squares Analysis of rate data: differential reactors: Laboratory reactors (Scope: sections 5.4 to 5.6 of Fogler) Multiple reactions (Scope: Chapter 9 of Fogler).

Isothermal reactor design (Scope: Chapter 4 of Fogler) Batch reactor, PFR, CSTR design. Pressure drop in reactors, Reversible reactions, unsteady state operation of reactors, Simultaneous reaction and separation

Catalysis and catalytic reactors (Scope: Chapter 6 of Fogler) Steps in catalytic reaction: derivation of rate laws, design for gas-solid reactions, heterogeneous data analysis and design; Chemical vapour deposition, catalyst reactivation, moving bed reactions.

Diffusion and reaction in process catalysts (Scope: Chapter 11 of Fogler).

Diffusion and reaction in spherical catalyst.

Internal effectiveness factor, falsified kinetics; estimation of diffusion and reaction limited regimes. Mass transfer and reaction in packed bed. Determination of limiting situations from reaction data, CVD reactors.

Non-isothermal reactor design (Scope: Chapter 8 of Fogler), Energy Balance, equilibrium conversion under adiabatic conditions unsteady state operation, multiple steady states.

TEXTBOOK:

1. Fogler. H.S: Elements for Chemical Reaction Engineering 2nd Edition, Prentice Hall, New Delhi, 1992.

REFERENCE BOOK:

1. Smith J.M: 'Chemical Engineering Kinetics' 3rd Edition, McGraw Hill, 1981.

CHH-1009
ADVANCED PROCESS DYNAMICS AND CONTROL

Course Objectives:

The main purpose of teaching Process Dynamics & Control for first year postgraduate students is to take the student from basic mathematics to a variety of design applications in a clear, concise manner. This course is focused on the use of the digital computer in complex problem solving and in process control instrumentation. For chemical engineering problem solving students need more advanced mathematical preparation like partial differential equations, linear algebra and Fourier series all are introduced in this course.

Course Outcomes:

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

- Understand sampled data control systems with Z- transforms.
- Describe the process in which the flow of the signals is interrupted periodically like in chromatograph.
- Calculate the open loop and closed loop response of a sampled data system
- Develop a pulse transfer function
- Identify nonlinear systems and explain phase plane analysis
- Demonstrate the control of heat exchangers, distillation columns and chemical reactors

Syllabus

Review of time domain, Laplace domain and frequency domain dynamics of process and control system.

Sampled data control system – sampling and Z–Transforms , open loop and closed loop response, Stability.

State space methods – representation of physical systems – transfer function matrix – Multivariable systems – Analysis and control.

Non linear control –examples of non linear systems – Methods of phase plane analysis.

Control of heat exchangers, distillation columns and Chemical Reactors.

TEXTBOOKS:

1. Process system Analysis and control, 2nd edition, Donald R Coughanower and Koppel.
2. Automatic process Control by Peter Harriot.
3. Process Modeling, Simulation and control for Chemical Engineers by W.L. Luyben.

CHH-1010

ANALYTICAL TECHNIQUES

Course Objectives:

To understand the different types of analysis methods used in chemical industries. The course consists of both chemical and instrumental methods and also both qualitative and quantitative methods of analysis. In this course, the chemical methods of quantitative analysis include all the aspects such as: selection and sampling of materials, preparation of solutions, and analysis of various chemical raw materials and products. In instrumental methods colorimetric, spectrophotometric, spectrographic, flame emission, photo meter have been discussed.

Course Outcomes:

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

- Understand the selection and preparation of the sample.
- Select sophisticated instruments for the analysis of mineral ores and chemical samples.
- Make use of instruments like X- Ray, flame emission spectroscopy.
- Describe instrumental methods for mineral investigation.
- Explain electrochemical methods of analysis

Syllabus

Theory of sampling, sampling of ores, minerals and coals, proximate and ultimate analysis of coal; coking index, calorific value of coal, its determination and calculation, analysis of ash,

Wet assaying of ores of iron, copper, lead, zinc and manganese, dry assaying process, fire saving methods for gold and silver,

Instrumental methods of mineral investigation: Theory and techniques of colorimetry and absorptiometry, photometer, spectrophotometers, atomic absorption spectrophotometer,

Electrochemical methods of analysis, Electrogravimetry methods, potentiometric titration, polarography, DTA,

X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction, flame emission spectroscope - source, equipment and application of emission spectroscopy.

REFERENCE BOOKS:

1. 'An Introduction to Metallurgical Analysis: Chemical & Instrumental' by S.K. Jain, Vikas Publishing House
2. A Text Book of Metallurgical Analysis' by B.C.Agarwal& S.P.Jain, Khanna Publications.
3. 'A Text Book of Quantitative Inorganic Analysis' by A.I.Vogel, ELBS Edition