B.Tech. CHEMICAL ENGINEERING

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FOREWORD

Chemical Engineering involves the design and maintenance of chemical plants and the development of chemical processes for converting raw materials and chemicals into valuable products. It combines knowledge of chemistry and engineering for the production of chemicals and related by-products. This branch of engineering is a varied field, covering areas of energy engineering, environmental engineering, mineral processing, pharmaceuticals, polymer engineering, petroleum engineering etc. Chemical Engineers operate chemical plants and improve methods of production and productivity as well.

The primary function of chemical engineers is to study raw materials for their consistency/properties, their conversion into products, the process and equipments involved in conversion and safety aspects. Chemical engineering addresses problems in health care, including technology and medicine. It also helps to develop processing systems for waste management and food processing, in a more affordable and healthy fashion. Chemical Engineers also play a major role in national defense with their involvement in the handling, development and disposal of high-tech chemical weapons and ammunition.

In the early 21st century, societal demands for better energy conservation and environmentally safe business practices changed the nature of chemical engineering in a larger way.

B.Tech. programme of Chemical Engineering is aimed at offering the knowledge and skills of invention, development, design, operation and management of processes in chemical industries. It combines the work of several fields such as chemistry, industrial engineering, materials science as well as mechanical engineering.

In the new curriculum of R22, skill-oriented activities are included to enable the students to acquire hands-on experience of technology to make them better suited for industry requirements..

R22 curriculum comprises of:

- *Revision in tune with National Education Policy 2020*
- *Various exit options*
- *Regular Degree along with Honours / Minor Degree*
- *The reduction in total credits*
- *Module wise course syllabus*
- *Advanced courses like Green Energy Technologies, Electric Vehicles and EV Charging Inferastructure.*

In R22 curriculum, every care has been taken to accommodate the knowledge and skill requirements of industry through proper activities for practice. While making the graduates industry ready, it also enables them to be successful in competitive examinations like GATE. The focus area of each unit in every course is clearly defined. The Board of Studies consisting of eminent personalities along with experienced faculty members of the university have designed the curriculum to offer knowledge and skill of chemical engineering on above mentioned areas. The curriculum includes concepts with skill based tasks through integrated laboratory and activities combined with theory. The department aims to make graduates ready for the industrial needs.

External BoS Members:

1. Dr. Y. PydiSetty, Professor, NIT Warangal.
2. Dr. S.V. Satyanarayana, Professor, JNTU Anantapur
3. Dr. K. Krishnaiah, Professor, IIT Tirupathi.
4. Dr. G. S. Venkata ratnam, Senior Principal Scientist (Retired), CLRI, Chennai

I thank all the BoS Members, Academic Council Members and University authorities for encouraging and supporting us in designing this innovative curriculum for our students.

Dr. M. Ramesh Naidu
HOD, CHEM

VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be UNIVERSITY)
-Estd. u/s 3 of UGC Act 1956

VISION

To evolve into a Centre of Excellence in Science & Technology through creative and innovative practices in teaching – learning, towards promoting academic achievement and research excellence to produce internationally accepted, competitive and world class professionals who are psychologically strong & emotionally balanced, imbued with social consciousness & ethical values.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry - institute interaction aimed at promoting employability, entrepreneurship, leadership and research aptitude among students and contribute to the economic and technological development of the region, state and nation.

Department of
CHEMICAL ENGINEERING

VISION of the department

To attain global recognition in research and training students for meeting the challenging needs of chemical and allied industries and society.

MISSION of the department

M_1: Providing high quality undergraduate and graduate education in tune with changing needs of industry.

M_2: Generating knowledge and developing technology through quality research in frontier areas of chemical and interdisciplinary fields.

M_3: Fostering industry-academia relationship for mutual benefit and growth.

B.Tech in Chemical Engineering

Program Educational Objectives (PEOs)

PEO1: Attain excellence in engineering and design through education in the principles and practices of Chemical Engineering.

PEO2: Enable the students to become future leaders in engineering practices for the overall betterment of society and instill in them a work culture based on foundations of ethics, scientific temperament and team work.

PEO3: Equip the students with knowledge, understanding and applications of Chemical Engineering tools for enabling them to pursue innovative research.

Program Specific Outcomes (PSOs)

PSO1: Equip the students with knowledge, understanding and applications of Chemical Engineering tools for enabling them to pursue innovative research.

PSO2: Acquire and apply the new knowledge with professional responsibility and ethics towards the ancement of academic and research pursuits in chemical and allied disciplines in the societal contexts.

PSO3: Design, develop and modify the chemical processes and to analyze these by applying the physic chemical and biological techniques.

Program Outcomes (POs)

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

COURSE STRUCTURE - R22

I Year I Semester

Course Code	Course Title	L	T	P	C
22CH101	IT Workshop and Chemical Engineering Products	1	-	4	3
22EE101	Basics of Electrical and Electronics Engineering	2	-	2	3
22TP103	Programming in C	2	-	4	4
22CT101	Applied Chemistry	2	-	2	3
22MT103	Linear algebra and Ordinary differential equations	3	2	-	4
22EN102	English Proficiency and Communication Skills	-	-	2	1
22SA101	Physical Fitness, Sports & Games – I	-	-	3	1
22TP101	Constitution of India	-	2	-	1
Total		**10**	**4**	**17**	**20**
		31 Hrs			

I Year II Semester

Course Code	Course Title	L	T	P	C
22ME101	Engineering Graphics	2	-	2	3
22TP104	Basic Coding Competency	-	1	3	2
22MT112	Partial Differential Equations and Vector Calculus	3	2	-	4
22PY102	Engineering Physics	2	-	2	3
22EN104	Technical English Communication	2	-	2	3
22CT105	Organic Chemistry for Chemical Engineers	3	-	2	4
22SA103	Physical Fitness, Sports & Games – II	-	-	3	1
22SA102	Orientation Session	-	-	6	3
Total		**12**	**3**	**20**	**23**
		35 Hrs			

Department Subject is extension of Basic sciences

COURSE STRUCTURE - R22

R22 B.Tech. 4 YEAR DEGREE PROGRAMME

II Year I Semester

Course Code	Course Title	L	T	P	C
22TP201	Data Structures	2	2	2	4
22ST202	Probability and Statistics	3	2	-	4
22CH201	Chemical Engineering Thermodynamics -I	2	2	-	3
22CH202	Chemical Process Calculations	3	2	-	4
22CH203	Momentum Transfer	2	2	2	4
22CH204	Mechanical Unit Operations	2	2	2	4
22SA201	Life Skills-I	-	-	2	1
	Total	14	12	8	24
	NCC / NSS / SAC / E-cell / Student Mentoring/ Social activities/ Publication	-	-	-	1
	Total	**14**	**12**	**8**	**25**
		34 Hrs			

II Year II Semester

Course Code	Course Title	L	T	P	C
22TP203	Advanced Coding Competency	-	-	2	1
22CT201	Environmental Studies	1	1	-	1
22MS201	Management Science	2	2	-	3
22TP204	Professional Communication	-	-	2	1
22CH205	Chemical Engineering Thermodynamics - II	2	2	-	3
22CH206	Process Heat Transfer	2	2	2	4
	Department Elective – 1	2	2	-	3
	Open Elective – 1	2	2	-	3
22SA202	Life Skills-II	-	-	2	1
	Total	**11**	**11**	**8**	**20**
	Minor / Honours - 1	3	2	-	4
		14	**13**	**8**	**24**
	Total	**35 Hrs**			

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

COURSE STRUCTURE - R22

III Year I Semester

Course Code	Course Title	L	T	P	C
22TP301	Soft Skills Lab	-	-	2	1
22CH301	Chemical Reaction Engineering - I	2	2	2	4
22CH302	Mass Transfer Operations - I	2	2	2	4
22CH303	Process Dynamics and Control	2	2	2	4
	Department Elective – 2	2	2	-	3
	Open Elective – 2	2	2	-	3
22CH304	Inter-Disciplinary Project- Phase I	-	-	2	-
	Total	**10**	**10**	**10**	**19**
	NCC/ NSS/ SAC/ E-cell/ Student Mentoring/ Social activities/ Publication.	-	-	-	1
	Minor / Honors – 2	3	2	-	4
	Total	**13**	**12**	**10**	**24**
		35 Hrs			

III Year II Semester

Course Code	Course Title	L	T	P	C
22TP302	Quantitative aptitude and Logical Reasoning	1	2	-	2
22CH305	Chemical Reaction Engineering - II	2	2	2	4
22CH306	Mass Transfer Operations - II	2	2	2	4
	Department Elective – 3	2	2	-	3
	Department Elective – 4	2	2	-	3
	Open Elective – 3	2	2	-	3
22CH307	Inter-Disciplinary Project- Phase II	-	-	2	2
	Total	**11**	**12**	**6**	**21**
	Minor / Honors – 3	3	2	-	4
	Total	**14**	**14**	**6**	**25**
		34 Hrs			

COURSE STRUCTURE - R22

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

IV Year I Semester

Course Code	Course Title	L	T	P	C
22CH401	Chemical Engineering Plant Design and Process Economics	2	2	-	3
22CH402	Chemical Technology	2	2	2	4
	Department Elective – 5	2	2	-	3
	Department Elective – 6	2	2	-	3
	Department Elective – 7	2	2	-	3
	Department Elective – 8	2	2	-	3
	Total	**12**	**12**	**2**	**19**
	Industry Interface Course (Modular course)	1	-	-	1
	Minor / Honors – 4	3	2	-	4
	Total	**16**	**14**	**2**	**24**
		32 Hrs			

IV Year II Semester

Course Code	Course Title	L	T	P	C
22CH403 / 22CH404	Project Work / Internship	-	2	22	12
	Total	**24**			**12**
	Minor / Honours – 5 (for project)	-	2	6	**4**
	Total	**32**			**16**

for interaction between Guide and students

R22 B.Tech. 4 YEAR DEGREE PROGRAMME

COURSE STRUCTURE - R22

Department Electives

Course Code	Course Title	L	T	P	C
22CH801	Conventional Energy Sources	2	2	-	3
22CH802	Energy Integration	2	2	-	3
22CH803	Energy Management and Auditing	2	2	-	3
22CH804	Green Fuels	2	2	-	3
22CH805	Non-Conventional Energy Resources	2	2	-	3
22CH806	Waste Heat Recovery	2	2	-	3
22CH807	Waste to Energy Conversion	2	2	-	3
22CH808	Air Pollution and Control	2	2	-	3
22CH809	Environmental Engineering	2	2	-	3
22CH810	Environmental Regulations and Impact Analysis	2	2	-	3
22CH811	Industrial Effluent Treatment Methods	2	2	-	3
22CH812	Solid Waste Management and Treatment	2	2	-	3
22CH813	Health, Environment and safety Management	2	2	-	3
22CH814	Industrial Safety Engineering	2	2	-	3
22CH815	Natural Gas Engineering	2	2	-	3
22CH816	Natural Gas Hydrates and Coal Bed Methane	2	2	-	3
22CH817	Petrochemicals	2	2	-	3
22CH818	Petroleum Refinery Engineering	2	2	-	3
22CH819	Surface Production Operation	2	2	-	3
22CH820	Aspen Plus: Chemical Engineering Application	2	2	-	3
22CH821	Computational Fluid Dynamics	2	2	-	3
22CH822	Fundamentals of Nanotechnology	2	2	-	3
22CH823	Industrial Instrumentation	2	2	-	3
22CH824	MATLAB Programming for Chemical Engineers	2	2	-	3
22CH825	Novel Separation Processes	2	2	-	3
22CH826	Optimization In Chemical Engineering	2	2	-	3
22CH827	Transport Phenomena	2	2	-	3

Honours - Petro Chemical Engineering

Course Code	Course Title	L	T	P	C
22CH951	Natural Gas Engineering	3	2	-	4
22CH952	Natural Gas Hydrates and Coal Bed Methane	3	2	-	4
22CH953	Petrochemicals	3	2	-	4
22CH954	Petroleum Refinery Engineering	3	2	-	4
22CH955	Surface Production Operations	3	2	-	4
	Total	**15**	**10**	**-**	**20**

I

YEAR

B.Tech.

CHEMICAL ENGINEERING

I SEMESTER

22CH101	-	IT Workshop and Chemical Engineering Products
22EE101	-	Basics of Electrical and Electronics Engineering
22TP103	-	Programming in C
22CT101	-	Applied Chemistry
22MT103	-	Linear Algebra and Ordinary Differential Equations
22EN102	-	English Proficiency and Communication Skills
22SA101	-	Physical Fitness, Sports & Games – I
22TP101	-	Constitution of India

II SEMESTER

22ME101	-	Engineering Graphics
22TP104	-	Basic Coding Competency
22MT112	-	Partial Differential Equations and Vector Calculus
22PY102	-	Engineering Physics
22EN104	-	Technical English Communication
22CT105	-	Organic Chemistry for Chemical Engineers
22SA103	-	Physical Fitness, Sports & Games – II
22SA102	-	Orientation Session

COURSE CONTENTS

I SEM & II SEM

22CH101 IT WORKSHOP AND CHEMICAL ENGINEERING PRODUCTS

https://www.aiche.org/sites/default/files/images/cep/inline/2018-04-01-Feature/2018-04-01-Best-Practices-for-Pilot-Plant-Layout/images/fig_43.jpg

Hours Per Week :

L	T	P	C
1	-	4	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with different IT tools and Mechanical trades. The objective of this course is giving hands on practice on assembling and disassembling, productivity tools like Latex, word, spread sheets and presentations and to develop models using Carpentry, Fitting, Tinsmity, House wiring.

MODULE-1

UNIT-1 **4L+0T+16P=20 Hours**

IT WORKSHOP:

Computer Hardware: Peripherals of a computer, components in a CPU and its functions, block diagram of the CPU.

Tools for Report writing and Presentation: Overview and Installation of Microsoft Word, Excel and PowerPoint Presentation.

UNIT-2 **4L+0T+16P=20 Hours**

Computer Hardware: Disassemble and Assemble the PC back to working condition.

Tools for Report writing and Presentation: Creating project, creating a Newsletter using Microsoft Word and LaTeX.

Creating a Scheduler, Calculating GPA, Performance Analysis, Conditional Formatting, Charts and Pivot Tables using MS Excel; Power Point utilities and tools, Master Layouts, Design Templates, Background and textures using Power Point Presentation.

PRACTICES:

- Troubleshooting of a computer Hardware.
- Assembly and Disassembly of a Computer.
- Creation of projects and Newsletter using MS Word and LaTeX.
- Spreadsheet basics, modifying worksheets, formatting cells, formulas and functions, sorting and filtering, charts using MS Excel.
- Power point screen, working with slides, add content, work with text, working with tables, graphics, slide animation, reordering slides, adding sound to a presentation using MS PPT.

MODULE-2

UNIT-1 **4L+0T+16P=20 Hours**

BASIC ENGINEERING:

Engineering Materials: Introduction, Classification, Ferrous & non-ferrous metals and alloys.

Trades: Introduction and Materials used in Carpentry, Fitting, Tin smithy and House Wiring. Cutting Tools, Holding Tools, Marking Tools used and types of joints made in Carpentry, Fitting, Tin smithy and House Wiring.

SKILLS:

- ✓ *Design and develop various sheet metal products.*
- ✓ *Analyze the functioning & troubleshoots of household appliances.*
- ✓ *Create products by using different trades for Industrial applications.*

UNIT-2 **4L+0T+16P=20 Hours**

CHEMICAL ENGINEERING PRODUCTS:

Bricks: General, Qualities and Classification of bricks, Tests for bricks, Size and Weight of bricks.

Cements: Types and composition of Cement, Setting of cement, Tests for physical properties of cement, Different grades of cement.

Steel: Types of steel, Physical properties and Mechanical properties of steel, Simple layout design.

Working Principle of Ac, Refrigerator, Pumps, IC Engines and Screw Jack: Working principle of Air - Conditioner and Refrigerator, Components, Assembly and disassembly; Working principle of Centrifugal and Reciprocating pumps - Types, Parts and applications, Working principle of Screw jack and its components, Working principle of IC engines- 2 stroke and 4 stroke.

PRACTICES:

- Fabrication of T-lap joint using carpentry tools.
- Fabrication of V-fit using fitting tools.
- Fabrication of truncated cylinder using tin smith tools.
- Performance of 1 lamp controlled by one way switch using house wiring.
- Performance of 2 lamp controlled by one way switch using house wiring.
- Demonstration of modelling & functioning of air-conditioners.
- Demonstration of modelling & functioning of refrigerators.
- Functioning and assembly of power screw jack.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Fabricate different models using workshop trades.	Apply	1	1, 2, 3, 5, 9, 10
2	Assemble and disassemble of a computer.	Analyze	1	1, 2, 4, 5, 9, 10, 12
3	Analyse the functioning of home appliances.	Analyze	2	1, 2, 4, 5, 9, 10, 12
4	Develop methodology for fabrication as per specifications of the product.	Evaluate	2	1, 2, 5, 9, 10, 12
5	Create documents, spread sheets and presentations using LaTeX and MS Tools.	Create	1	1, 2,3, 5, 9, 10

TEXT BOOKS:

1. Peter Norton, “Introduction to Computers”, Tata Mc Graw Hill Publishers, 7th Edition, 2017.
2. Felix W “Basic Workshop Technology: Manufacturing Process”, 1st Edition, 2019.

REFERENCE BOOKS:

1. T.V.Gopal, T.Kumar and G. Murali, “A first Course on Workshop Practice: Theory, Practice and Work Book”, Suma Publication, 2005.
2. K.V.N.Pakirappa, “Workshop Technology”, 5th edition, Radiant Publishing House, 2011.
3. S.K Hazra Choudhury, “Elements of Work Shop Technology”, 11th edition, Media Promoters, 1997.

22EE101 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Source : https://vita.vision.org.in/emerging-technologies-in-electrical-engineering/

Hours Per Week :

L	T	P	C
2	-	2	3

PREREQUISITE KNOWLEDGE: Electrostatics and Electromagnetism.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides an insight into the functioning of basic electrical components like resistor, inductor and capacitor. It deals with the constructional and operational details of AC machines. It also deals with the basic electronic components like P-N junction diode, Zener diode, Transistor and their characteristics.

MODULE–1

UNIT-1 **8L+0T+8P=16 Hours**

FUNDAMENTALS OF ELECTRIC CIRCUITS:

DC Circuits: Concept of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Ohm's Law, Kirchhoff's Laws, Application to simple series, Parallel circuits, Mesh and nodal analysis of resistive circuits with DC source.

AC circuits: Generation of AC voltage, Frequency, Average value, R.M.S. value, Form factor, Peak factor for sinusoidal only.

UNIT-2 **8L+0T+8P=16 Hours**

SEMICONDUCTOR DEVICES:

Classification of semiconductors, P-N junction diode -operation and its characteristics, Half wave rectifier - operation, efficiency; Full wave rectifiers -types, operation, efficiency; Zener diode and its characteristics, Zener diode as Voltage regulator.

Bi polar junction transistor- operation, types (NPN & PNP).

PRACTICES:

- Verification of Ohm's law.
- Verification of Kirchhoff's current law.
- Verification of Kirchhoff's voltage law.
- Determination of R.M.S. Values of sinusoidal waveform.
- Verification of PN junction diode characteristics under both forward and reverse bias.
- Verification of Zener diode characteristics under reverse bias.

MODULE–2

UNIT-1 **8L+0T+8P=16 Hours**

ANALYSIS OF AC CIRCUITS:

Analysis of single- phase ac circuits consisting of R, L, C, RL, RC (series and parallel) (simple numerical problems). Introduction to three phase system, Relation between phase and line quantities of voltages

SKILLS:

- ✓ *Distinguish between linear and nonlinear elements by looking at VI characteristics.*
- ✓ *Develop a simple loop generator.*
- ✓ *Design a voltage regulator using Zener diode.*
- ✓ *Design a half wave rectifier using PN junction diode.*
- ✓ *Design a full wave rectifier using PN junction diodes.*

and currents in star and delta connected systems (Elementary treatment only).

UNIT-2 **8L+0T+8P=16 Hours**

AC MACHINES:

Electromagnetism: Concepts of Magneto motive force, Reluctance, Flux and flux density, Concept of self-inductance and mutual inductance, Coefficient of coupling.

Static & Rotating AC Machine: Principle of operation of single phase transformer, Constructional features, EMF equation (simple numerical problems).

Rotating AC Machine Principle of operation of three phase induction motor, Slip ring and squirrel cage motors, Torque equation; Constructional details of synchronous machine.

PRACTICES:

- Transformation ratio of a single phase transformer at different loads.
- Measurement of Energy in single phase resistive load circuit.
- Measurement of Power in single phase resistive load circuit
- Determination of impedance in complex AC circuits.
- Verification of line and phase quantities in a balanced three phase system.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Solve the AC (single and three phase) and DC circuits using different methods.	Apply	1,2	1,2,9,12
2	Apply the concepts of electromagnetism for its applications.	Apply	2	1,2,3,9,12
3	Analyze the resistive circuits with independent sources and find its solution.	Analyze	1,2	1,2,6,9
4	Examine the different electrical equipment.	Evaluate	2	1,2,9,12
5	Acquire the knowledge of semiconductor devices to create circuits.	Create	1	1,2,3,9,12

TEXT BOOKS:

1. V. K. Mehta, “Principles of Electrical Engineering and Electronics”, S.Chand& Co., Publications, New Delhi, 2019.
2. D.P. Kothari, “Basic Electrical and Electronics Engineering”, TMH, New Delhi, 2017.

REFERENCE BOOKS:

1. Millman and Halkias, “Electronic Devices and Circuits”, Mc Graw Hill, 2006.
2. A.K. Thereja and B.L.Thereja, “Electrical Technology”, Vol.–II, S. Chand & Co., Publications, 2020.
3. U. Bakshi and A. Bakshi, “Basic Electrical Engineering”, 1st edition, Technical Publications, Pune, Nov 2020.

22TP103 PROGRAMMING IN C

✓ Techgig.com

Hours Per Week :

L	T	P	C
2	-	4	4

PREREQUISITE KNOWLEDGE: Fundamentals of Problem Solving.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on basic concepts of C programming language and problem solving through programming. It covers basic structure of C program, data types, operators, decision making statements, loops, functions, strings, pointers, and also file manipulations. At the end of this course, students will be able to design, implement, test and debug complex problems using features of C.

MODULE- 1

UNIT-1 **8L+0T+16P=24 Hours**

INTRODUCTION TO ALGORITHMS AND PROGRAMMING LANGUAGES:

Introduction to Algorithms: Basics of algorithms; Flow charts; Generations of programming languages. Introduction to C: Structure of a C program - pre-processor statement, inline comments, variable declaration statements, executable statements; C Tokens - C character set, identifiers and keywords, type qualifiers, type modifiers, variables, constants, punctuations and operators.

Data Types and Operators: Basic data types; Storage classes; Scope of a variable; Formatted I/O; Reading and writing characters; Operators - assignment, arithmetic, relational, logical, bitwise, ternary, address, indirection, sizeof, dot, arrow, parentheses operators; Expressions - operator precedence, associative rules.

Control Statements: Introduction to category of control statements; Conditional branching statements - if, if– else, nested-if, if – else ladder, switch case; Iterative statements - for, while, do - while, nested loops; Jump statements - break, jump, goto and continue.

UNIT-2 **8L+0T+16P=24 Hours**

ARRAYS & STRINGS:

Arrays: Introduction; Types of arrays; Single dimensional array - declaration, initialization, usage, reading, writing, accessing, memory representation, operations; Multidimensional arrays.

Strings: Character array, Reading string from the standard input device, Displaying strings on the standard output device, Importance of terminating a string, Standard string library functions.

PRACTICES:

Questions on Data Handling – Level 1:

- Write a program to accept a character as input from the user and print it.
- Write a program to accept a number as input from the user and print it.
- Write a program to accept a float value from the user and print it.
- Write a program to accept a message as input from the user and print it.
- Write a program to accept a message from the user as input and print it in 3 different lines.
- Write a program to accept 2 numbers from the user as input and print their sum.
- Write a program to accept 2 numbers from the user as input and print their product.
- Write a program to accept a number as input from the user which denotes the temperature in Celsius, convert it to Fahrenheit reading and print it.

SKILLS:

- ✓ *Analysis of the problem to be solved.*
- ✓ *Select static or dynamic data structures for a given problem and manipulation of data items.*
- ✓ *Application of various file operations effectively in solving real world problems.*
- ✓ *Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.*

- Write a program to accept a number as input from the user which denotes the radius and print the area of the circle.
- Write a program to accept a character as input from the user and print it's corresponding ASCII value.

Questions on Control Statements - Looping – Level 1:

- Write a C program to print all the characters from a to z once.
- Write a C program to print all the characters from Z to A once.
- Write a C program to print all the characters from A to Z 3 times.
- Write a C program to print the first N natural numbers, where N is given as input by the user.
- Write a C program to print the first N natural numbers and their sum, where N is given as input by the user.
- Write a C program to print all the odd numbers between 1 and N where N is given as input by the user.
- Write a C program to print all the even numbers between I and N where N is given as input by the user.
- Write a C program to print the squares of the first N natural numbers between 1 and N, where N is given as input by the user.
- Write a C program to print the cubes of the first N natural numbers between 1 and N, where N is given as input by the user.
- Write a C program to print the squares of every 5th number starting from 1 to N, where N is given as input by the user.

Questions on Control Statements – Decision Making – Level 1:

- Write a program to accept two numbers as input check if they are equal.
- Write a program to accept two characters as input and check if they are equal.
- Write a program to accept two numbers as input and print the greater of the 2 numbers.
- Write a program to accept two numbers as input and print the lesser of the 2 numbers.
- Write a program to accept 3 numbers as input and print the maximum of the 3.
- Write a program to accept 3 numbers as input and print the minimum of the 3.
- Write a program to accept a number as input and print EVEN if it is an even number and ODD if it is an odd number.
- Write a program to accept a number as input and check if it is divisible by 3. If it is divisible by 3 print YES else print NO.
- Write a program to accept a number as input and check if it is divisible by both 3 & 5. If it is divisible print YES else print NO.
- Write a program to accept a number as input and check if it is positive, negative or zero.

Questions on Patterns – Level 1:

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
*****
*****
*****
*****
*****
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
*****
*   *
*   *
*   *
*****
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
*
**
***
****
*****
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
    *
   **
  ***
 ****
*****
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
1
12
123
1234
12345
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
1
22
333
4444
55555
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
54321
4321
321
21
1
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
12345
2345
345
45
5
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

```
A
AB
ABC
ABCD
ABCDE
```

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

  A

  BC

  DEF

  GHIJ

  KLMNO

Questions on Number Crunching – Level 1:

- Write a program to accept a number as input and print the number of digits in the number.
- Write a program to accept a number as input print the sum of its digits.
- Write a program to accept a number as input, reverse the number and print it.
- Write a program to accept a number and digit as input and find the number of occurrences of the digit in the number.
- Write a program to accept a number as input and check if it is an Armstrong number.
- Write a program to accept a number as input and check if it is an Adam number.
- Write a program to accept a number as input and check if is a prime number.
- Write a program to accept 2 numbers as input and check if they are amicable or not.
- Write a program to accept a number as input and check if it is a power of 2.
- Write a program to accept 2 numbers as input and find their LCM.

Questions on Arrays – Level 1:

- Print the contents of an array from the left to the right.
- Print the contents of an array from the right to the left.
- Find the sum of the elements of an array.
- Find the maximum element in an unsorted array.
- Find the minimum element in an unsorted array.
- Find the average of the elements in an unsorted array.
- Count the number of 0s and 1s in an array having 0s and 1s in random order.
- Count the number of elements in an array whose elements are lesser than a key element in an unsorted array.
- Print all the elements in an array whose values are lesser than a key element in an unsorted array.
- Find the repeated elements in a sorted array.

Questions Number crunching – Level 2:

- Write a program to accept a number as input and print the product of its digits.
- Write a program to accept a number as input and check if it is a palindrome.
- Write a program to accept a number as input and print the frequency of occurrence of each digit.
- Write a program to accept a number as input and print its factors.
- Write a program to accept a number as input and print its prime factors.
- Write a program to accept a number as input and check if it is a perfect square of not.
- Write a program to accept 2 numbers as input and check if they are betrothed numbers or not.
- Write a program to accept 2 numbers as input and print their HCF.
- Write a program to accept a number as input and check if is a strong number.
- Write a program to generate prime numbers between two intervals given as input.

Questions on Arrays – Level 2:

- Find the sum of the maximum and minimum numbers of an unsorted array.
- Replace every element in an array with the sum of its every other element.
- Replace every element in an array with the sum of its right side elements.
- Replace every element in an array with the sum of its left side elements.
- Reverse the elements of an array (in place replacement).
- Reverse the first half of an array.

- Reverse the second half of an array.
- Write a program to find the second largest element in an unsorted array.
- Write a program to find the second smallest element in an unsorted array.
- Write a program to print the number of odd and even numbers in an unsorted array.

Questions on Strings – Level 1:

- Write a program to accept a string as input and print it.
- Write a program to accept a string as input and count the number of vowels in it.
- Write a program to accept a string as input and count the number of consonants in it.
- Write a program to accept a string as input and print its length.
- Write a program to accept a string as input and print the reversed string.
- Write a program to accept 2 strings as input and check if they are the same.
- Write a program to accept a string as input and copy the contents into a second string and print the second string.
- Write a program to accept 2 strings as input and concatenate them into a third string and print the third string.
- Write a program to accept a string as input and check if it is a palindrome.
- Write a program to accept two strings as input and check if the second string is a substring of the first.

Questions on Strings – Level 2:

- Implement the string length function.
- Implement the string copy function.
- Implement the string concatenate function.
- Implement the string compare function.
- Implement the vowel count function.
- Implement the consonant count function.
- Implement the count words function.
- Implement the string reverse function.
- Implement the strstr function.
- Complete the code snippet to implement the is Palindrome function that checks if a given string is a palindrome. You will need to use the 3 functions string Copy, str Reverse and string Compare functions provided to accomplish this.

MODULE-2

UNIT-1 **8L+0T+16P=24 Hours**

FUNCTIONS & POINTERS:

User-defined functions: Function declaration - definition, header of a function, body of a function, function invocation; Call by value; Call by address; Passing arrays to functions; Command line arguments; Recursion; Library Functions.

Pointers: Declaration, Initialization, Multiple indirection, Pointer arithmetic, Relationship between arrays and pointers, Scaling up - array of arrays, array of pointers, pointer to a pointer and pointer to an array; Dynamic memory allocation functions.

UNIT- 2 **8L+0T+16P=24 Hours**

STRUCTURES, UNIONS & FILES:

Structures: Defining a structure, Declaring structure variable, Operations on structures, Pointers to structure - declaring pointer to a structure, accessing structure members using pointer; Array of structures, Nested structures, Passing structures to functions - passing each member of a structure as a separate argument, passing structure variable by value, passing structure variable by reference/ address; Typedef and structures.

Unions: Defining a union - declaring union variable, operations on union; Pointers to union - declaring pointer to a union, accessing union members using pointer; Array of union, Nested union, Typedef and union, Enumerations, Bit-fields.

Files: Introduction to files, Streams, I/O using streams – opening a stream, closing stream; Character input, Character output, File position indicator, End of file and errors, Line input and line output, Formatted I/O, Block input and output, File type, Files and command line arguments.

PRACTICES:

Questions on Strings – Level 3:

- Write a program to swap two given strings and print the swapped strings.
- Write a program to swap two given words of the given sentence and print the altered string.
- Return the maximum occurring character in the string.
- Write a program to print the character in the string with the count where count is the occurrence of the character.
- Write a program to print the duplicate characters in the given string.
- Write a program to remove the duplicate characters in the given string.
- Write a program to remove the vowels from a given string.
- Write a program to rotate a given string N number of times.
- Write a program to check if 2 strings are rotations of each other.
- Write a program to remove the characters from the first string that are present in the second string.

Questions on 2D Arrays – Level 1:

- Print the contents of a 2D array row-wise.
- Print the contents of a 2D array column-wise.
- Print the contents of a 2D array in a zig-zag order.
- Print the contents of a 2D array diagonal-wise.
- Print the contents of a 2D array right-diagonal order.
- Print the contents of a 2D array left-diagonal order.
- Print the contents of a 2D array in the upper triangular order – left top to right bottom.
- Print the contents of a 2D array in the lower triangular order.
- Find and print the maximum element along with its position in a matrix.
- Find and print the minimum element along with its position in a matrix.

Questions on 2D Arrays – Level 2:

- Find and print the maximum element of each row of a matrix.
- Find and print the minimum elements of each row of a matrix.
- Find and print the maximum element of each column of a matrix.
- Find and print the minimum element of each column of a matrix.
- Find the lowest value in the upper triangle area and the largest value in the lower triangular area of a matrix and print their product.
- Find the sum of the elements of each row and each column of a matrix and print the minimum row sum and maximum sum column.
- Write a program to find the row with the maximum number of 1’s in a matrix consisting of only 0’s and 1’s.
- Write a program to print the quotient and remainder on dividing sum of left-top to right-bottom diagonal by sum of right-top to left-bottom diagonal.
- Write a program to print the absolute difference of the sum of major diagonal elements and the sum of minor diagonals of the given matrix.
- Write a program to search a given element in a row-wise and column-wise sorted 2D array.

Questions on 2D Arrays – Level 3:

- Write a program to find the Kth smallest element in the given matrix.
- Write a program to find the Kth largest element in the given matrix.

- Write a program to check whether the given two two-dimensional array of same dimensions are equal or not.
- Write a program to add the given two two-dimensional array of same dimensions.
- Write a program to subtract the given two two-dimensional array of same dimensions.
- Write a program to multiply the given two two-dimensional array of same dimensions.
- Write a program to sort each row of a matrix.
- Write a program to find the sum of the elements in 'Z' sequence of the given 2D array.
- Write a program to print the unique rows of the given two-dimensional array consisting of only 0's and 1's.
- Write a program to print the unique columns of the given two-dimensional array consisting of only 0's and 1's.

Questions on Files, Structures & Unions:

- Write a C program to create a struct, named Student, representing the student's details as follows: first_name, last_name, Age and standard.

  Example

  Read student data

  john

  carmack

  15

  10

  Display the data in the following format

  First Name: john

  Last Name: carmack

  Age: 15

  Standard: 10

- Declare a structure POINT. Input the coordinates of point variable and write a C program to determine the quadrant in which it lies. The following table can be used to determine the quadrant.

Quadrant	X	Y
1	Positive	Positive
2	Negative	Positive
3	Negative	Negative
4	Positive	Negative

  Example

  Input the values for X and Y coordinate: 7 9

  The coordinate point (7,9) lies in the First quadrant.

- Bob and Alice both are friends. Bob asked Alice how to store the information of the books using Structures. Then Alice written a c program to store the information of books using book structure by taking different attributes like book_name, author, book_id, price. Write a C program to read and display the attributes of the books using structures.

  Sample Input:

  Enter number of books: 1

  Enter the book name: c Programming

  Enter the author name: balaguruswamy

  Enter the book ID: 23413

  Enter the book price: 500

  Sample Output:

  The details of the book are:

  The book name is: c Programming

The author name is: balaguruswamy

The book ID is: 23413

The book price is: 500.00

- Ramesh wants to do addition on complex numbers. He did it with regular practice but Charan asked him to do with the help of structures by following below Criteria.

  Write a C program that defines a structure named 'Complex' consisting of two floating point members called "real and imaginary". Let c1 and c2 are two Complex variables; compute the sum of two variables.

  Example:

  c1= 2 8
  c2= 6 4
  Sum= 8.000000+12.000000i

- Customer Payment Details is a structure with members as customers_name, address, account_number, payment_status(paid(1)/ not_paid(0)), due_date, and amount. In this example, payment_date is another structure with month, day and year as integer members. So, every customer record can be considered as an array of structures.

  Write a C program that displays the amount to be paid by each customer along with their names. If payment_status is 1, display NIL for such customers.

  Input Format:

  First line of input contains 'n' number of customers, followed by 8 lines of input for each customer. Each line represents (customers_name, address, account_number, amount payment_status(paid(1)/ not_paid(0)), and due_date).

  Output Format:

  First line of output is Amount to be paid by each customer as on date: followed by n lines of output. Each line contains name of the customer followed by tab space, and amount to be paid.

  Hint: Use nested structure to represent date.

  Write a 'C' program to accept customer details such as: Account_no, Name, Balance using structure. Assume 3 customers in the bank. Write a function to print the account no. and name of each customer whose balance < 100 Rs.

- Write a C program to accept details of 'n' employee(eno, ename, salary) and display the details of employee having highest salary. Use array of structure.

- Write a C program to print the bill details of 'N' number of customers with the following data: meter number, customer name, no of units consumed, bill date, last date to deposit and city. The bill is to be calculated according to the following conditions:

No. of units	**Charges**
For first 100 units	Rs.0.75 per unit
For the next 200 units	Rs.1.80 per unit
For the next 200 units	Rs.2.75 per unit

  Sample Input

  Enter no. of customers

  1

  Enter Meter Number AP01213

  Enter Customer Name: Karthik

  Enter No. of units consumed: 200

  Enter Bill date:22/01/2021

  Enter Last date: 12/2/2021

  Enter City: Guntur

  Sample Output

  Meter Number AP01213

  Customer Name: Karthik

No. of units consumed: 200

Bill date:22/01/2021

Last date: 12/2/2021

City: Guntur

Total Amount: 255.000000

- Write a C program that creates a student file containing {Roll No, Student Name, Address, Stream}, where the data will be inserted and display the list of students who are in CSE (Stream=CSE).

  Input: A file name

  Output: The attributes such as Roll_No, Student_Name, Stream, Address.

  Sample Input

201fa4200	Raja	CSE	Guntur
201fa4201	Bala	IT	Tenali

  Sample Output

201fa4200	Raja	CSE	Guntur

- Write a C program that reads content from an existing text file and write the same in a new file by changing all lowercase alphabetic character to upper case. (Existing file may contain digit and special characters).

  Example:

  Input: Enter the file name.

  Output: New file with updated content.

- Write a C program to count the occurrences of the given string in a file.

  Example:

  Input: Enter the File name to read the string to be counted.

  Output: Display the count of occurrences of the string.

- Write a C Program to transfer the data from one location to another location without changing the order of the content.

  Example:

  Read the file name from the user. If the source file exists, Transfer the data and display the message as “Data is transferred successfully” otherwise display the message “No such file is existing in the directory.”

- Write a C program that reads numbers and write them into a text-file. Also find odd and even numbers in that file and store it in 2 separate files named odd.txt and even.txt. All the values should be in ascending order.

  Input: Enter the values.

  Output: Creates a separate file for Even and Odd numbers.

  Sample Input:

  4 43 2 53 45

  Sample Output:

  Even.txt: 2 4

  Odd.txt: 43 45 53

- Write a C program to replace the content in the given text file.

  Input: Enter the file name, line number to be replaced and the new content

  Output: New file with replaced lines.

  Example:

  Sample Input: Enter the file name: abc.txt

  Enter the line no to replace: 3

  Enter the content: Files stores data presently.

Sample Output:

Line no 3 is replaced with the given content.

The content of the file abc.txt contains:

test line 1

test line 2

Files stores data presently

test line 4

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify suitable data type for operands and design of expressions having right precedence.	Apply	1,2	1
2	Apply decision making and iterative features of C Programming language effectively.	Apply	1,2	1
3	Select problem specific data structures and suitable accessing methods.	Analyze	1,2	1,2
4	Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.	Evaluate	1,2	3,4
5	Design and develop non- recursive and recursive functions and their usage to build large modular programs and also able to design string manipulation functions.	Create	1,2	3

TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, “Programming for Problem Solving”, 1st edition, Cengage publications, 2019.
2. Ajay Mittal, “Programming in C - A Practical Approach”, 1st edition, Pearson Education, India, 2010.

REFERENCE BOOKS:

1. Reema Thareja, “Computer Fundamentals and Programming in C”, 1st edition, Oxford University Press, India, 2013.
2. Herbert Schildt, “C: The Complete Reference”, 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, “Programming with C”, 4th edition, Tata McGraw-Hill, 2018.

22CT101 APPLIED CHEMISTRY

https://www.dreamstime.com/photos-images/applied-chemistry.html

Hours Per Week :

L	T	P	C
2	-	2	3

PREREQUISITE KNOWLEDGE: Concept of bonding, chemical reactions and organic dyes.

COURSE DESCRIPTION AND OBJECTIVES:

This course aims to emphasize the importance of chemistry and its applications in engineering disciplines (particularly Chemical and Textile Engineering). In addition to gaining knowledge on some of the basic concepts of chemistry such as chemical bonding etc., the students are expected to learn contemporary advanced topics, such as instrumental techniques, nanomaterials, polymers, dyes and pigments, particularly relevant for their respective engineering branches.

MODULE-1

UNIT-1 **8L + 0T + 8P = 16 Hours**

CHEMICAL BONDING & NANOMATERIALS:

Chemical bonding: Types of Bonds: ionic, covalent, metallic and mechanical bonds; Crystal field theory of octahedral and tetrahedral complexes, Molecular orbital theory of diatomic molecules (O_2 and CO).

Nanomaterials: Introduction, Classification, Properties, Top-down and Bottom-up synthetic methods, Synthesis, Properties and Potential applications of Carbon Nanotubes, Graphene.

UNIT-2 **8L + 0T + 8P = 16 Hours**

INSTRUMENTAL TECHNIQUES:

Electronic spectroscopy: Principle, Electronic transitions, Chromophore and Auxochrome, Beer-Lambert's law derivation and limitations, Instrumentation of UV-Visible spectrophotometer, Quantitative & qualitative applications.

IR spectroscopy: Types of vibrations; Vibrational degrees of freedom, Instrumentation of IR spectrophotometer and Applications.

X-ray Diffraction: Introduction; Principle, Bragg's equation, and Potential applications.

PRACTICES:

- Synthesis of Iron oxide nanoparticles.
- Synthesis of Au/Ag nanoparticles using plant extract (Azadirachta indica or Neem) leaves and characterization by UV-Visible Spectroscopic technique.
- Characterization of prepared nanomaterials using XRD.
- Synthesis of Tetraamminecopper (II) sulfate
- Determination of Mn^{7+} by colorimetry.
- Simultaneous determination of Cr (VI) & Mn (VII) by UV-Visible spectrophotometry.

MODULE-2

UNIT-1 **8L + 0T + 8P = 16 Hours**

POLYMERS:

Introduction, Classification, Molecular weight determination, (Mw & Mn) Types of polymerization, Preparation, properties and applications of PE, PMA, Nylon-6,6; Rubber-vulcanization, Synthetic rubbers – Buna-S, Neoprene.

SKILLS:

- ✓ *Synthesize nanomaterials like carbon nanotubes, fullerenes.*
- ✓ *Identify the properties of different industrially relevant nanomaterials.*
- ✓ *Characterize chemical compound by using UV and IR spectroscopic techniques.*
- ✓ *Synthesize various polymers.*
- ✓ *Design dyes and pigments for their specific applications.*

UNIT-2 **8L + 0T + 8P = 16 Hours**

DYES & PIGMENTS:

Dyes: Introduction to color science, Adsorption and scattering of light, Dyes-Nomenclature, Classification of Dyes – based on chemical composition and applications.

Pigments: History of pigments, Classification of pigments, Influence of physical structure on color; Color index, Properties and applications of pigments, Toxicity of pigments, Green pigments.

PRACTICES:

- Synthesis of Bakelite.
- Dye adsorption/degradation using nanomaterials
- Chemistry of Blue printing.
- Synthesis of ancient paints/ traditional & indigenous paints.
- Synthesis of Indigo.
- Impacts of dyes in Environment.
- Preparation of Urea-Formaldehyde resin and characterization by IR.
- Preparation polyurethane and characterization by IR.
- Preparation of Nylon-6,6 and characterization by IR.
- Synthesis of Magneson II and characterization by UV & IR.
- Synthesis of Solochrome Orange M and characterization by UV & IR.
- Pigment Extraction and Separation by Paper Chromatography.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply different bonding theories to predict the properties of small molecules.	Apply	1	1, 2, 9, 10, 11, 12
2	Identify various synthetic approaches of nanomaterials for specific applications.	Apply	1	1, 2, 3, 6, 9, 10, 11, 12
3	Analyze properties of various nanomaterials using spectroscopic techniques for the engineering.	Analyze	1	1, 2, 3, 4, 5, 9, 10, 11, 12
4	Distinguish various types of synthetic approaches of polymers for their specific engineering applications.	Analyze	2	1, 2, 9, 10, 11, 12
5	Recommend the use of dyes and pigments in the industrial applications.	Evaluate	2	1, 2, 6, 7, 8, 9, 10, 11, 12

TEXT BOOKS:

1. S. Chawala, “A Textbook of Engineering Chemistry Engineering Materials and Applications”, Dhanpat Rai Publications, 3rd Edition, 2015.
2. P.C. Jain and M. Jain, “Engineering Chemistry”, Dhanpat Rai Publications, 17th Edition, 2015.

REFERENCE BOOKS:

1. K. S. Maheswaramma and M. Chugh, “Engineering Chemistry”, Pearson, 1st Edition, 2015.
2. B. S. Bahl, Arun Bahl and B. D. Tuli, “Essentials of Physical Chemistry”, S. Chand and Co. Ltd., 2007.
3. G. Raj and C. Anand, “Instrumental Methods of Analysis”, Himalaya Publications, 5th edition, 2007.
4. T. Pradeep, “Nano: The Essentials; Understanding of Nano Science and Technology” Tata McGraw-Hill, New Delhi, 2012.
5. J. Mendham, R. C. Denney, J. D. Bares, M. Thomas and B. Siva Sankar, “Vogel’s Textbook of Qualitative Chemical Analysis” (vol. 1), Pearson Publications, 2009.

22MT103 LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS

Source: https://www.amazon.com/Differential-Equations/dp/B01H30X2JA

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Basics of matrices, Differentiation and Integration.

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to build a grasp of the principles of mathematics through matrices, differential equations and applications that serves as an essential tool in several engineering applications.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

MATRICES:

Definition of matrix; Types of matrices; Algebra of matrices, adjoint of a matrix, inverse of a matrix through adjoint and elementary row operations, Rank of a matrix, Echelon form, Normal form.

Eigen values and Eigen vectors (up to 3 x 3 matrices only) and properties (without proofs).

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF MATRICES:

Consistency of system of linear equations, Solution of system of linear equations having unique solution and involving not more than three variables by Gauss elimination method and Gauss Jordan method.

Cayley-Hamilton theorem (without proof), Power of a matrix, Inverse of a matrix.

Strength of materials and strength of beams using Eigen value and Eigen vectors.

PRACTICES:

- Compute inverse of a matrix if exists.
- Explain with suitable examples how rank of matrix is independent of the elementary operations.
- Explain with suitable examples how rank of matrix is unique.
- Discuss with suitable examples when eigen values and eigen vectors are possible for a matrix.
- Discuss the possibility of solution of a system of equations.
- Discuss when inverse and power of a matrix exist using Cayley-Hamilton theorem.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

ORDINARY DIFFERENTIAL EQUATIONS (ODE):

First Order Differential Equations: Introduction to ODE, variable separable method, homogenous and non-homogenous differential equations, linear differential equations, Bernoulli's equations.

Second Order Differential Equations: Linear differential equations with constant coefficients with RHS of the form eax, xn, sin(ax) or cos(ax).

SKILLS:

- ✓ *Find rank of a matrix using different methods.*
- ✓ *Compute the eigen values and eigen vectors of a matrix.*
- ✓ *Find analytical solution of a differential equation using appropriate method.*
- ✓ *Demonstrate any one numerical method to solve differential equation.*

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF ODE:

Applications of ODE: Newton's law of cooling, Law of natural growth and decay, LR Circuit.

PRACTICES:

- Check the order and degree of an ODE.
- Find solution for any four ordinary differential equations by applying suitable method.
- Find numerical solution for any four ordinary differential equations by applying suitable method.
- Discuss some applications of ODE.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concepts of rank, eigen values and eigenvectors of a matrix and finding inverse of a matrix and powers of a matrix.	Apply	1	1, 2, 9, 10, 12
2	Apply differential equations in real life problems.	Apply	2	1, 2, 9, 10, 12
3	Analyse the solution of a system of linear equations and find it.	Analyze	1	1, 2, 9, 10, 12
4	Inspect the analytical method for solving differential equations and applications.	Analyze	2	1, 2, 9, 10, 12

TEXTBOOK:

1. 1. N. P. Bali, K. L. Sai Prasad, "A Textbook of Engineering Mathematics I, II, III", 2nd Edition Universal Science Press, New Delhi, 2018.
2. B. S. Grewal, "Higher Engineering Mathematics", 44 Edition, Khanna Publishers, 2018.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, Inc, 2010.
2. H. K. Dass and Er. RajanishVerma, "Higher Engineering Mathematics", 3rd revised edition, S. Chand & Co., 2015.
3. B. V. Ramana, "Advanced Engineering Mathematics", TMH Publishers.
4. T. K.V. Iyengar et al, "Engineering Mathematics, I, II, III", S. Chand & Co., New Delhi,2018.

22EN102 ENGLISH PROFICIENCY AND COMMUNICATION SKILLS

Hours Per Week :

L	T	P	C
-	-	2	1

PREREQUISITE KNOWLEDGE: Basics of grammar, Read and understand for global context, Cultural sensitivity and Basic writing skills.

COURSE DESCRIPTION AND OBJECTIVES:

English Proficiency and Communication Skills seeks to develop the students' abilities in grammar, speaking, reading, writing and overall comprehension skills. The course will provide students an exposure on a wide range of language use in everyday situations. It will make the students to equip with functional English and make them use it confidently in their professional and social contexts. Finally, students will strengthen their reading, writing, listening and speaking skills in English

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

MY LIFE AND HOME – MAKING CHOICES – HAVING FUN:

Reading: Understanding main message, factual information global meaning, specific information and paraphrasing.
Writing: Developing hints based mail, Writing short messages/paragraphs.
Listening: Understanding short monologues or dialogues and choose the correct visual.
Speaking: Express simple opinions /cultural matters in a limited way.
Vocabulary: Discerning use of right word suiting the context, B1 Preliminary word list.
Grammar: Frequency Adverbs, State Verbs, AFV and Prepositions.

UNIT-2 **0L+0T+8P=8 Hours**

ON HOLIDAY - DIFFERENT FEELINGS – THAT'S ENTERTAINMENT!:

Reading: Longer text for detailed comprehension, gist and inference.
Writing: Developing notes and responding to penfriends or 'e-pals'.
Listening: Understand straightforward instructions or public announcements.
Speaking: Describing people, things and places in a photograph.
Vocabulary/Grammar:
Comparatives and Superlatives, Gradable and non-gradable adjectives, Cloze tests.

PRACTICES:

- Developing hints based mail.
- Writing short message.
- Writing paragraphs.
- Expressing opinions and cultural matters.
- Understanding short monologues.
- Understanding straightforward instructions and public announcements.
- Describing people, things and places in a photograph.

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

GETTING AROUND – INFLUENCES - STAY FIT AND HEALTHY:

Reading: Reading for understanding coherence of the text and drawing inferences.
Writing: Reading an announcement from a magazine or website for preparing an article.
Listening: Discussion activities and listening to understand the gist of each short dialogue.

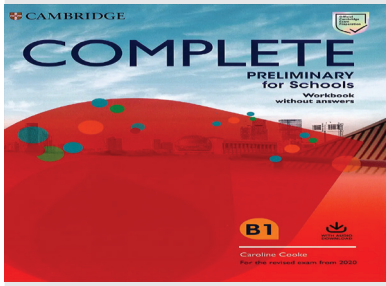


Image source: https://www.scribd.com/document/502301821/Cambridge-Complete-B1-Preliminary-for-Schools-Workbook-2020-Edition

SKILLS:

- ✓ *Use of appropriate grammar and vocabulary with syntactic patterns in short texts.*
- ✓ *Read and extract the main message, global meaning, specific information, detailed comprehension, understanding of attitude, opinion and writer purpose and inference.*
- ✓ *Listen to understand key information, specific information, gist and detailed meaning and to interpret meaning.*
- ✓ *Understand questions and make appropriate responses and talk freely on everyday topics.*

Speaking: Snap Talks, Make and respond to suggestions, discuss alternatives and negotiate agreement.

Vocabulary / Grammar: Punctuation, Prepositions, Phrasal Verbs, B1 Preliminary word list.

UNIT-2 **0L+0T+8P=8 Hours**

LOOKS AMAZING! – THE NATURAL WORLD – EXPRESS YOURSELF!:

Reading: Content, Communicative Achievement, Organisation and Language.

Writing: Developing a story with clear links to the given opening sentence.

Listening: An interview for a detailed understanding of meaning and to identify attitudes and opinions.

Speaking: Discuss likes, dislikes, experiences, opinions, habits, etc.

Vocabulary/Grammar: Modals, Conditionals, Verb forms (Time and Tense).

PRACTICES:

- Listening to understand the gist of each short dialogue.
- Listening to an interview for a detailed understanding of meaning and to identify attitudes and opinions.
- Preparing an article.
- Discuss for alternatives and negotiate agreement.
- Discussion on likes, dislikes, experiences, opinions, habits, etc.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply to read and grasp content on a range of topics/ texts related to their everyday life like notifications, advertisements, travel brochures, news reports, articles.	Apply	1	7, 8, 9, 10, 12
2	Apply suitable strategies to achieve comprehension, like listening for main points and checking comprehension using contextual clues etc.	Apply	1	7, 8, 9, 10, 12
3	Demonstrate vocabulary beyond that of the familiar subjects.	Analyze	1, 2	7, 8, 9, 10, 12
4	Show sufficient control of English grammar and sentence variety to coherently organise information at sentence and discourse levels.	Evaluate	2	7, 8, 9, 10, 12
5	Use functional English to communicate and interact effectively in everyday situations.	Create	2	7, 8, 9, 10, 12

TEXT BOOKS:

1. Emma Heyderman and Peter May, “Complete Preliminary”, Student’s Book with Answers, 2nd edition, Cambridge University Press, 2019.

REFERENCE BOOKS:

1. Annette Capel and Rosemary Nixon, “Introduction to PET”, Oxford University Press, 2009.
2. Adrian Doff and Craig Thaine, “Empower Pre intermediate”, Cambridge University Press, 2015.
3. Louise Hashemi and Barbara Thomas, “Objective PET”, Cambridge University Press, 2010.

22TP101 CONSTITUTION OF INDIA

Image: https://commons.wikimedia.org/wiki/File:Constitution_india.jpg

Hours Per Week :

L	T	P	C
-	2	-	1

PREREQUISITE KNOWLEDGE: High School-level Civics and Social Studies.

COURSE DESCRIPTION AND OBJECTIVES:

To provide students with a basic understanding of Indian Polity and Constitution and make students understand the functioning of government at the center and state level besides local self-government. This course also equips students with knowledge pertaining to fundamental rights and fundamental duties of a citizen in a democracy such as India.

MODULE-1

UNIT-1 **0L+8T+0P=8 Hours**

HISTORICAL BACKGROUND TO THE INDIAN CONSTITUTION:

Meaning of the constitution law and constitutionalism; Historical perspective of the Constitution of India; Salient features and characteristics of the Constitution of India.

UNIT-2 **0L+8T+0P=8 Hours**

FUNDAMENTAL RIGHTS, DUTIES, DIRECTIVE PRINCIPLES, AND AMENDMENT:

Scheme of the fundamental rights - scheme of the Fundamental Right to Equality; scheme of the Fundamental Right to certain Freedom under Article 19; scope of the Right to Life and Personal Liberty under Article 21; Scheme of the Fundamental Duties and its legal status; Directive Principles of State Policy – its importance and implementation; Amendment of the Constitution - Powers and Procedure.

PRACTICES:

- Enactment of Constituent Assembly debates to further understand the rationale for the provisions of the constitution.
- Fundamental Rights in our popular culture - discussion in the movie Jai Bhim.

MODULE-2

UNIT-1 **0L+8T+0P=8 Hours**

STRUCTURE AND FORM OF GOVERNMENT:

Federal structure and distribution of legislative and financial powers between the Union and the States; Parliamentary Form of Government in India – The constitution powers and status of the President of India; Emergency Provisions: National Emergency, President Rule, Financial Emergency.

UNIT-2 **0L+8T+0P=8 Hours**

LOCAL SELF GOVERNMENT:

Local Self Government – Constitutional Scheme in India – 73rd and 74th Amendments.

PRACTICES:

- Debate on federalism in India.
- Collect news published in the local papers about panchayats in the nearby areas.

SKILLS:

- ✓ *Understanding the basics of the Indian constitution.*
- ✓ *Know the fundamental rights, fundamental duties, and Directive Principles of State Policy.*
- ✓ *Fair knowledge about the functioning of various institutions in a democracy.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyse major articles and provisions of the Indian constitution.	Analyze	1	6
2	Appreciation for the constitution and safeguarding individual rights.	Apply	1	6
3	Evaluating functions of various organs of the State in a democracy.	Evaluate	2	6

TEXTBOOK:

1. PM Bhakshi, “Constitution of India”, 15th edition, Universal Law Publishing, 2018.

REFERENCE BOOKS:

1. B. R. Ambedkar, “The Constitution of India” Educreation Publishing, India, 2020.
2. Subhash Kashyap, “Our Constitution” 2nd edition, National Book Trust, India, 2011.
3. Arun K. Thiruvengadam, “The Constitution of India: A Contextual Analysis”, Hart Publishing India, 2017.

22ME101 ENGINEERING GRAPHICS

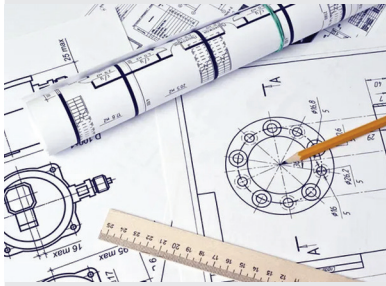


Image source: https://depositphotos.com/5087383/stock-photo-the-engineering-drawing.html

Hours Per Week :

L	T	P	C
2	-	2	3

PREREQUISITE KNOWLEDGE: Basics of Geometry

COURSE DESCRIPTION AND OBJECTIVES:

Engineering graphics is the language of engineers and is the most effective way of communicating and sharing technical ideas in the form of pictures/drawings. The objective of this course is to familiarize the students with the conventional concepts of engineering drawing and computer aided drawing.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

ENGINEERING CURVES:

Types of lines; Lettering, Dimensioning, Geometric constructions - lines, polygons (Angle, ARC, General and Inscribe in circle method), Conical curves (General method), Ellipse by Oblong method.

UNIT-2 **10L+0T+10P=20 Hours**

ORTHOGRAPHIC PROJECTIONS OF POINTS, LINES & PLANES:

Principles of projection; Projections of points; Projection of straight lines - Inclined to one plane, inclined to both planes; Projection of planes - Inclined to one plane.

PRACTICES:

- Construction of polygons using different methods (i.e. ARC, Angle, General).
- Inscribe a regular hexagon & pentagon in a circle of the given diameter.
- Tracing of conical curves (Ellipse, Parabola, Hyperbola) by using General Method.
- Draw the projections of the points situated in all the 4 quadrants.
- Draw the projections of a line when it is inclined to one plane (HP or VP).
- Draw the projections of a line when it is inclined to both the planes (HP &VP).
- Draw the projections of a plane when it is inclined to one plane (HP or VP).

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

PROJECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES:

Projections of Solids: Projection of solids axis inclined to one reference plane - Prisms, pyramids, Cylinder and cone.

Development of Surfaces: Development of lateral surfaces of simple solids - Prisms, Pyramids, Cylinder and cone.

UNIT-2 **10L+0T+10P=20 Hours**

ORTHOGRAPHIC VIEWS AND DRAFTING USING COMPUTER PACKAGE:

Orthographic Views: Conversion of pictorial views into orthographic views.

Drafting Using Computer Package: Introduction to 2D modelling software - AutoCAD; Conversion of Isometric view into Orthographic views of simple castings; Conversion of Orthographic views into

SKILLS:

- ✓ *Convert iso-metric views of objects into orthographic views and vice versa.*
- ✓ *Visualize the shape of the 3D components.*
- ✓ *Create pictorial views by using AutoCAD.*
- ✓ *Understand projections by visualization.*

Isometric view of simple solids - Prisms, Pyramids, Cylinders and cones.

PRACTICES:

- Draw the projections of Prisms, when they are inclined to one reference plane (HP or VP).
- Draw the projections of Pyramids, when they are inclined to one reference plane (HP or VP).
- Draw the projections of cylinder & cone, when they are inclined to one reference plane (HP or VP).
- Draw the complete surface development of prisms & pyramids with the given dimensions.
- Draw the complete surface development of cylinder & cone with the given dimensions.
- Draw the orthographic view's (i. e. front view, top view, and side view) of the given pictorial view of the sketches by using AutoCAD.
- Draw the Isometric view of simple solids (Prisms & Pyramids) by using AutoCAD.
- Draw the Isometric view of simple solids (Cylinder & Cone) by using AutoCAD.

COURSEOUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Communicate the technical ideas in the form of drawings.	Apply	1	1,2,3,5
2	Apply the drawing skills in representing various geometrical features.	Apply	1	1,2,3,5
3	Develop orthographic projections and isometric views of various objects.	Apply	1	1,2,3,5
4	Estimate the lateral surface area of regular geometrical solids.	Analyze	2	1,2,3,5
5	Sketch simple objects and their pictorial views using AutoCAD.	Analyze	2	1,2,3,5

TEXT BOOKS:

1. J Hole, "Engineering Drawing", 2nd edition, Tata McGraw-Hill, 2019.
2. N D Bhatt, "Engineering Drawing", 53rd edition, Charotar Publication, 2014.

REFERENCE BOOKS:

1. Basant Agrawal and C.M. Agrawal "Engineering Drawing", 2nd edition, Tata Mc Graw- Hill, 2018.
2. K L Narayana, "Engineering drawing", 3rd edition, SciTech Publications, 2011.
3. Colin H. Simmons, Dennis E. Maguire, Manual of Engineering Drawing, 2nd edition, 2003.

22TP104 BASIC CODING COMPETENCY

Source: https://www.geeksforgeeks.org/best-way-to-start-with-competitive-programming-geeksforgeeks-cp-live-course/

Hours Per Week :

L	T	P	C
-	1	3	2

PREREQUISITE KNOWLEDGE: Programming in C.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on advanced concepts of C programming language and problem solving. At the end of this course, students will be able to design, implement, test and debug complex problems using features of C.

MODULE-1

UNIT-1 **0L+4T+12P=16 Hours**

NUMBER CRUNCHING :

PRACTICES:

Problems On Number Crunching

- Write a program to check if a given number is perfect or not.
- Write a program to check if a given number is deficient or not.
- Write a program to check if 2 given numbers are amicable or not.
- Write a program to check if 2 given numbers are betrothed or not.
- Write a program to check whether a given number is an Armstrong number or not.
- Write a program to print the series of prime numbers in the given range.
- Write a program to print all the perfect numbers in a given range.
- Write a program to generate all deficient numbers in a given range.
- Write a program to generate all the amicable numbers in a given range.
- Write a program to generate all the betrothed numbers in a given range.
- Write a program to find the largest prime factor of a given number.
- Write a program to check whether the given number is a palindrome or not.
- Write a program to calculate sum of the individual digits for the given number.
- Write a program to find the first number that has more than ‘n’ factors, excluding 1 and that number.
- Write a program to accept a number as input and print its factorial.
- Write a program to accept a number n, print first N Fibonacci numbers.
- Write a program to check if an input number is Armstrong number or not.
- Write a program that takes input a,b. Print a power b.
- Write a program that takes input a number n, check if it a perfect square or not.
- Print array in spiral format.
- Print sum of each row in a matrix.
- Print sum of each column in matrix.
- Print left->right and right->left diagonals in a matrix.
- Initially you are at (0,0) find the shortest path count to reach the (n, n) block in matrix.
- Remove all the elements present in row and column of unsafe elements. An element is called unsafe if it is equal to smallest or largest value. Count number of remaining elements.
- Write a program to check if the string contains all the letters of alphabet.

SKILLS:

- ✓ *Analysis of the problem to be solved.*
- ✓ *Application of various file operations effectively in solving real world problems.*
- ✓ *Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.*

- Check if a string is matching password requirements.
- Check if String A contains String B (String searching).
- Check if a number is harshad number or not.
- Write a program to get 3 numbers as input. The first is the number num1 and second is the digit that needs to be replaced. The third is the digit that is to replace the 2nd digit. Print the number after performing this operation.
- Write a program to accept a number and swap its alternate digits. Print the number generated.
- Write a program to accept a number and choice as input. If the choice is 0 rearrange the number such that the odd digits are ordered first followed by the even digits. If the choice is 1 rearrange the number such that the even digits are ordered first followed by the odd digits. Print the rearranged number. The order of occurrence of the digits is to be preserved.
- Write a program to determine that whether the given quadrilateral is cyclic or not. You are given the sizes of angles of a simple quadrilateral (in degrees) A, B, C and D, in some order along its perimeter.

  Note: A quadrilateral is cyclic if and only if the sum of opposite angles is 180^0.
- Chef is a very lazy person. Whatever work is supposed to be finished in x units of time, he finishes it in m*x units of time. But there is always a limit to laziness, so he delays the work by at max d units of time. Given x,m,d, find the maximum time taken by Chef to complete the work.
- Suppose Chef is stuck on an island and currently he has x units of food supply and y units of water supply in total that he could collect from the island. He needs xr units of food supply and yr units of water supply per day at the minimal to have sufficient energy to build a boat from the woods and also to live for another day. Assuming it takes exactly D days to build the boat and reach the shore, tell whether Chef has the sufficient amount of supplies to be able to reach the shore by building the boat? Read five integers x,y,xr,yr,D from the user and display “YES” if Chef can reach the shore by building the boat and “NO” if not (without quotes).
- There are 3 problems in a contest namely A,B,C respectively. Alice bets Bob that problem C is the hardest while Bob says that problem B will be the hardest.

  You are given three integers SA,SB,SC which denotes the number of successful submissions of the problems A,B,C respectively. It is guaranteed that each problem has a different number of submissions. Determine who wins the bet.

  1) If Alice wins the bet (i.e. problem C is the hardest), then output Alice.

  2) If Bob wins the bet (i.e. problem B is the hardest), then output Bob.

  3) If no one wins the bet (i.e. problem A is the hardest), then output Draw.

  Note: The hardest problem is the problem with the least number of successful submissions.

  Input Format

  - The first line of input contains a single integer T denoting the number of test cases. The description of T test cases follows.
  - The first and only line of each test case contains three space-separated integers SA,SB,SC, denoting the number of successful submissions of problems A,B,C respectively.

  Output Format

  For each test case, output the winner of the bet or print Draw in case no one wins the bet.

  Sample Input 1

  3

  1 4 2

  16 8 10

  14 15 9

  Sample Output 1

  Draw

  Bob

  Alice

- In a season, each player has three statistics: runs, wickets, and catches. Given the season stats of two players A and B, denoted by R, W, and C respectively, the person who is better than the other in the most statistics is regarded as the better overall player. Tell who is better amongst A and B. It is known that in each statistic, the players have different values.

  Input

  The first line contains an integer T, the number of test cases. Then the test cases follow.

  Each test case contains two lines of input.

  The first line contains three integers R1, W1, C1, the stats for player A.

  The second line contains three integers R2, W2, C2, the stats for player B.

  Output

  For each test case, output in a single line "A" (without quotes) if player A is better than player B and "B" (without quotes) otherwise.

- Write a program to find the direction.

  Chef is currently facing the north direction. Each second he rotates exactly 90 degrees in clockwise direction. Find the direction in which Chef is facing after exactly X seconds.

  Note: There are only 4 directions: North, East, South, West (in clockwise order). Initially chef is at 0th second i.e., facing North direction.

  Input Format

  - First line will contain T, number of testcases. Then the testcases follow.
  - Each testcase contains of a single integer X.

  Output Format

  For each testcase, output the direction in which Chef is facing after exactly X seconds.

  Sample Input 1

  3

  1

  3

  6

  Sample Output 1

  East

  West

  South

- Chef is playing in a T20 cricket match. In a match, Team A plays for 20 overs. In a single over, the team gets to play 6 times, and in each of these 6 tries, they can score a maximum of 6 runs. After Team A's 20 overs are finished, Team B similarly plays for 20 overs and tries to get a higher total score than the first team. The team with the higher total score at the end wins the match.

  Chef is in Team B. Team A has already played their 20 overs, and have gotten a score of R. Chef's Team B has started playing, and have already scored C runs in the first O overs. In the remaining 20−O overs, find whether it is possible for Chef's Team B to get a score high enough to win the game. That is, can their final score be strictly larger than R?

  Input: There is a single line of input, with three integers, R, O, C.

  Output: Output in a single line, the answer, which should be "YES" if it's possible for Chef's Team B to win the match and "NO" if not.

- Make Array Zeros using pointers

  You are given an array A of length N (size should be created using Dynamic memory allocation) and can perform the following operation on the array:

  Select a subarray from array A having the same value of elements and decrease the value of all the elements in that subarray by any positive integer x.

  Find the least possible number of operations required to make all the elements of array A equal to zero.

The first line contains an integer N denoting the number of elements in the array.

The next line contains space-separated integers denoting the elements of array A.

Print the least possible number of operations required to make all the elements of array A equal to zero.

Sample Test case

Input:

5

2 2 1 3 1

Output:

4

UNIT-2 **0L+4T+12P=16 Hours**

PATTERNS:

PRACTICES:

Problems on Number Patterns

- Write a program to generate Floyd triangle. Sample input N= 4.
  1
  2 3
  4 5 6
  7 8 9 10
- Write a program to generate the following pattern. Sample input N=5.
  13579
  3579
  579
  79
  9
- Write a program to generate the following pattern. Sample input N=4.
  1111111
  222222
  33333
  4444
  333
  22
  1
- Write a program to generate the following pattern. Sample input N=5.
  5432*
  543*1
  54*21
  5*321
  *4321
- Write a program to generate the following pattern. Sample input N=5.
  12 21
  123 321
  1234 4321
  123454321

- Write a program to generate the following pattern. Sample input N=5.

  1
  2*2
  3*3*3
  4*4*4*4
  4*4*4*4
  3*3*3
  2*2
  1

- Write a program to generate the following pattern. Sample input N=4.

  1
  212
  32123
  4321234

- Write a program to generate the following pattern. Sample input N=5.

  *
  * *
  * * * *
  * *
  *

- Write a program to print Pascal triangle for the given number of rows. Sample input N=5.

```
                1
            1       1
        1       2       1
    1       3       3       1
1       4       6       4       1
```

- Write a program to generate the following pattern. Sample input N=4.

  1234
  2341
  3421
  4321

- Print Hollow Diamond pattern.
- Print pascals triangle.
- Print Floyds triangle.
- Print Butterfly Pattern.
- Print palindromic pattern.
- Print full inverted number triangle.
- Check if a number is prime or not (Efficient Approach).
- Find sum of all the digits of the number.
- Print transpose of given matrix.
- Rotate a two dimensional matrix by 90, 180, 270 degrees.

MODULE-2

UNIT-1 **0L+4T+12P=16 Hours**

ARRAYS:

PRACTICES:

Problems On Arrays

- Given an unsorted array of size N, and the array elements are in the range of 1 to N. There are no duplicates, and the array is not sorted. One of the integers is missing. Write a program to find the missing number.
- Given an array consisting of only 0s and 1s in random order rearrange the array such that all the 0s are to the left of the array and 1s to the right.
- Give an array consisting of odd and even numbers in random order, rearrange the array such that all the odd numbers are to the left of the array and even numbers are to the right of the array.
- Write a program to find all the unique elements in an array.
- Write a program to merge two arrays of the same size sorted in descending order.
- Write a program to count the frequency of each element in an array of integers.
- Write a program to find the second largest element in an array.
- Write a program to find the second smallest element in an array.
- Write a program to find that one element in array that occurs odd number of times, where every other element appears even number of times.
- Create a jagged array (adjacency list representation of a graph) with no of rows and no of columns in each row as specified by the user.
  Hint: Use Dynamic memory allocation (malloc() or calloc())

  Input:

  Enter no of rows: 3

  Enter no of columns Row in 1: 3

  Enter no of columns Row in 2: 5

  Enter no of columns Row in 3: 2

  Enter the elements row wise:

  8 6 5

  8 4 6 9 7

  9 2

  Output:

  8 6 5

  8 4 6 9 7

  9 2
- Write a program to find second largest number in the array.
- Write a program to find first repeating element in the array.
- Write a program to left rotate the array.
- Write a program to right rotate the array.
- Write a program to find the largest continuous sum.
- Write a program to print the sum of 2nd largest and 2nd smallest elements.
- Write a program to find the maximum product of two numbers multiplies in array (same index should not be used twice).
- Rearrange an array consisting of 1s and 0s such that they are alternatively arranged. Print minimum number of moves required.
- In a given array, find two numbers whose sum equal k.
- Find the difference between positive and negative elements in the array.
- Implement sorting algorithms (Insertion, selection, bubble).

UNIT-2 **0L+4T+12P=16 Hours**

STRINGS:

PRACTICES:

Problems on Strings:

- Write a program to reverse a given string word by word.
- Write a program to find the first occurrence of non-repeating character in the given string.
- Write a program to compress the string as provided in the example.
- Write a program to expand a string as provided in the example.
- Write a program to reverse those words of a string whose length is odd.
- Write a program to check if a given matrix is symmetric or not.
- Write a program to convert all the cases of letter (Lower case -> Upper Case, Upper Case-> Lower Case).
- Write a program to reverse all the words (Not the entire sentence but individual words).
- Find the longest palindrome in a given string.
- Check if two strings are anagrams or not.
- Find minimum number of changes to be done to make a string palindrome.
- Convert Excel sheet name to number (A-1, B-2, Z-26, AA-27).
- Find number of possible palindromes present in a string.
- Write a C program to read a string s, and determine the number of words in s.
  Example : s=oneTwoThree
  There are 3 words in the string: ‘one’, ‘Two’, ‘Three’.
- Write a C program that reads a string S and remove all duplicates characters from the given string S.
  NOTE: 1) Order of characters in output string should be same as given in input string.
  2) String S contains only lowercase characters [‘a’-’z’].
  Example: S = Vignanuniversity
  The program should generate the output as: Vignauersty
- Today Ron is reading the book. Due to some reason, he started hating the word ‘are’ (without quotes). So he decided to replace the substring ‘are’ with ‘R’. Write a C program that reads a line of message ‘s’ and replace the substring ‘are’ with ‘R’. Example: s= Howareyou.
  The program should generate the output as: HowRyou
- Write a program to concatenate the characters of the two given strings alternatively.
- Given a string S consisting of uppercase and lowercase letters, change the case of each alphabet in this string. That is, all the uppercase letters should be converted to lowercase and all the lowercase letters should be converted to uppercase.
  Input: Vignan University
  Output: vIGNAN uNIVERSITY
- Write a program to insert a given character at the beginning and end of the given string.
- Given two Strings A and B. They are said to be friends if ASCII sum of the each individual string is divisible by 4 else they are not friends. You need to find whether given two strings are friends or not.
  Sample Test case:
  Input:
  man nam
  vignan university
  Output:
  YES
  NO

- Write a program to find the frequency of each digit in the given string.

  Input Format

  The first line contains a string, which is the given number.

  Output Format

  Print ten space-separated integers in a single line denoting the frequency of each digit, indicate that the integers are from 0 to 9.

  Sample Input 0

  a11472o5t6

  Sample Output 0

  0 2 1 0 1 1 1 1 0 0

  Explanation 0

  In the given string:

  · 1 occurs two times.
  · 2,4,5,6 and 7 occur one time each.
  · The remaining digits and don't occur at all.

- Sherlock considers a string to be valid if all characters in the given string appear the same number of times. It is also valid if he can remove just 1 character at 1 index in the string, and the remaining characters will occur the same number of times.

  Write a C program that reads a string s and determine whether it is valid or not. If valid, return YES, otherwise return NO.

  Example: S=abc
  This is a valid string because frequencies are {a:1,b:1,c:1}
  S=abcc
  This is a valid string because we can remove one c and have 1 of each character in the remaining string.
  S=abccc
  This string is not valid as we can only remove 1 occurrence of c. That leaves character frequencies of {a:1,b:1,c:2}

- Read a string containing characters A and B only. Your task is to change it into a string such that there are no matching adjacent characters. To do this, you are allowed to delete zero or more characters in the string.

  Write a C program that finds the minimum number of deletions required.

  Example: S=AABAAB

  Remove A at positions 0 and 3 to make S=ABABA in 2 deletions.

  Input Format

  The first line contains an integer (the number of queries).

  The next q lines each contain a string s to analyze.

  Sample Input:

  5

  AAAA

  BBBBB

  ABABABAB

  BABABA

  AAABBB

  Sample Output:

  3
  4
  0
  0
  4

- Write a C program that reads a string 's' and it is said to be complete if it contains all the characters from a to z.
  Input Format
  First line of the input contains the number of strings N. It is followed by N lines each contains a single string.
  Output Format
  For each test case print "YES" if the string is complete, else print "NO"
  Constraints 1 <= N <= 10
  The length of the string is at max 100 & the string contains only the characters a to z.
- Write a C program that reads two strings and determine whether they share a common substring or not. A substring may be as small as one character.
  Example;
  S1=and
  S2=art
  The common substring in these two strings: a.
  Sample Input
  2
  hello
  world
  hi
  world
  Sample Output
  YES
  NO

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Write simple, but complete, C programs.	Apply	1,2	1
2	Identify suitable data type for operands and design of expressions having right precedence.	Apply	1,2	1
3	Apply decision making and iterative features of C Programming language effectively.	Apply	1,2	1
4	Select problem specific data structures and suitable accessing methods.	Analyze	1,2	1,2
5	Design and develop non- recursive and recursive functions and their usage to build large modular programs and also able to design string manipulation functions.	Create	1,2	3
6	Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.	Create	1,2	3,4

TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, "Programming for Problem Solving", 1st edition, Cengage publications, 2019.
2. Ajay Mittal, "Programming in C - A Practical Approach", 1st edition, Pearson Education, India, 2010.

REFERENCE BOOKS:

1. Reema Thareja, "Computer Fundamentals and Programming in C", 1st edition, Oxford University Press, India, 2013.
2. Herbert Schildt, "C: The Complete Reference", 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, "Programming with C", 4th edition, Tata McGraw-Hill, 2018.

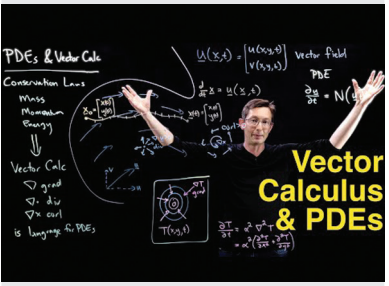


Image Source: https://i.ytimg.com/vi/Jt5R-Tm8cV8/hqdefault.jpg

22MT112 PARTIAL DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Differentiation, Integration, Vectors.

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to build an ability of understand how partial differential equations arise in the mathematical description of heat flow and vibration. The methods to explain the physical interpretations of common forms of PDEs and solution for initial and boundary value problems will be the primary focus. Students will gain deeper knowledge of multiple differentiation operations such as Gradient, Divergent and Curl.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

PARTIAL DIFFERENTIAL EQUATIONS:

Partial differential equations: Order and degree, Formation of partial differential equations, Lagrange linear equations, Method of multipliers.

Classification of Second Order PDE, Method Separation of variables.

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS AND NUMERICAL METHODS:

Solution to one dimensional wave equation, heat equation and Laplace's equation.

Numerical Methods: Numerical methods to solve Laplace's equation: Standard five-point formula, Diagonal five-point formula (Liebmenn's iteration process).

PRACTICES:

- Learn method of forming partial differential equations.
- Identify and apply different methods to solve differential equations.
- Determine the displacement of a vibrational string is initially at rest in equilibrium position.
- Evaluate the temperature distribution in insulated rods.
- Determine solutions of Laplace equation.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

VECTOR CALCULUS:

Vector Differentiation: Scalar and vector point functions, Differentiation of vector functions, Gradient, Divergence, Curl.

Vector Integration: Introduction to multiple integrals (Review), Line integral, Surface integral, Volume integral.

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF VECTOR CALCULUS

Normal vector, Directional Derivate, Solenoidal and Irrotational flow. Green's theorem for plane, Gauss divergence theorem, Stokes' theorem (without proofs).

PRACTICES:

- Compute the work done when an object moves along the path subject to a force.
- Use divergence and curl to measure the tendency of the fluid to collect or disperse at a point and the tendency of the fluid to swirl around the point.
- Compute the flux of a vector per unit time flowing across in the direction of a vector.
- Verify Green's theorem, stokes theorem and Divergence theorem for the functions over a region.
- Compute the tangent vector to a curve in space.
- Compute the directional derivative of a scalar point function at a point.
- Compute any integral which is to be evaluated over a curve, over a surface or over a volume.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the numerical methods to solve Laplace's equation.	Apply	1	1, 2, 9, 10,12
2	Apply Green's theorem for plane, Gauss divergence theorem, Stokes' theorem.	Apply	2	1, 2, 9, 10,12
3	Evaluate differential operators and the solutions of first order and some second order partial differential equations.	Evaluate	1	1, 2, 9, 10,12
4	Evaluate the line integrals, surface integrals and volume integrals.	Evaluate	2	1, 2, 9, 10,12

TEXT BOOK:

1. N. P. Bali, K. L. Sai Prasad, A Textbook of Engineering Mathematics I, II, III, 2nd Edition, Universal Science Press, New Delhi, 2018.
2. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers,
3. 2018.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley and Sons, Inc,
2. H. K. Dass and Er. Rajanish Verma, Higher Engineering Mathematics, S. Chand and Co., Third revised edition, 2015.
3. B. V. Ramana, Advanced Engineering Mathematics, TMH Publishers.
4. T. K.V. Iyengar et al: Engineering Mathematics, I, II, III, S. Chand and Co., New Delhi, 2018.

SKILLS:

- ✓ *Apply the transformation between line integral, surface integral and volume integral.*
- ✓ *Gain deeper knowledge of differential operators.*
- ✓ *Be able to use the separation of variables technique to solve partial differential equations.*

22PY102 ENGINEERING PHYSICS

Hours Per Week :

L	T	P	C
2	-	2	3

PREREQUISITE KNOWLEDGE: Atomic structure, electronic transitions, Bonding in solids and wave optics.

COURSE DESCRIPTION AND OBJECTIVES:

The course is aimed at realizing the concept of waves in understanding the applications of ultrasonics and quantum optics in lasers. It imparts knowledge on distinguishing crystal structures and synthesis of nanomaterials and their characterization.

MODULE – 1

UNIT-1 **8L+0P+8P=16 Hours**

WAVES, OSCILLATIONS AND ULTRASONICS:

Waves & Oscillations: Simple harmonic motion & Free oscillations- Equation of motion-Energy expressions; Damped oscillations-Differential equation-different cases of damping-logarithmic decrement-relaxation time-quality factor; Forced oscillations-Difference between free and forced oscillations-equation of motion- expression for amplitude and phase; Resonance and its examples.

Ultrasonics: Introduction – properties of ultrasonic waves- Production of ultrasonic waves by Piezoelectric method-Determination of velocity of ultrasonic waves in liquids-Interferometer method-NDT- Ultrasonic testing & X-ray radiography.

UNIT-2 **8L+0P+8P=16 Hours**

LASER AND FIBER OPTICS:

Laser: Introduction to Laser-population inversion and pumping methods-CO_2 laser. Laser applications in industry and scientific research. Holography-construction of hologram-reconstruction of image and applications.

Fiber Optics: Introduction-Classification-Step and Graded index fibers- Acceptance angle-Numerical aperture- Fibre optic sensors and types of sensors.

PRACTICES:

- Melde's experiment- Determination of frequency of a given tuning fork.
- Ultrasonic Interferometer-Determination of the velocity of ultrasonic waves in liquids.
- Semiconductor laser- Determination of wavelength.
- Optical fibre- Determination of Numerical Aperture and Acceptance angle.

MODULE-2

UNIT-1 **8L+0P+8P=16 Hours**

CRYSTAL PHYSICS:

Fundamental terms of crystal Physics-Lattice parameters- Crystal Systems-Packing factor for SC, BCC and FCC - Miller indices-Important planes of cubic crystal system-Distance of separation between successive (h k l) planes- X-ray diffraction –Bragg's law - Defects in solids- Point defects- Line defects-Edge & Screw dislocations.

UNIT-2 **8L+0P+8P=16 Hours**

NANOMATERIALS AND THEIR CHARACTERIZATION:

Introduction to nanoscience and technology-surface area to volume ratio & quantum confinement; Synthesis of nanomaterials Top-down & Bottom-up approach, Ball milling- Sol-Gel method; Applications of nanotechnology in various fields; X-Ray Diffraction-Bragg's law -Powder method- Electron microscopy-(SEM &TEM); Atomic force microscopy (AFM).

PRACTICES:

- Semiconductor- Determination of Bandgap.
- Diffraction grating- Determination of wavelength of a given light source.
- Photoelectric effect- Determination of Planks constant.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge of mechanical and sound waves from the perspective of engineering applications.	Apply	1	1, 2, 3, 4 , 9, 10
2	Apply the knowledge of crystal geometry to distinguish solids.	Apply	2	1, 2, 3, 4, 5, 9, 10
3	Analyze the wavelengths of lasers for relevant diverse applications and foster the knowledge to realize fiber optic sensors.	Analyze	1	1, 2, 5, 9, 10
4	Compute the dimensions of nano particles to the physical and chemical aspects of nanomaterials.	Evaluate	2	1, 2, 3, 4, 9, 10

TEXT BOOK:

1. S.O.Pillai, "Solid State Physics", New age International publishers, 8th edition, 2018.
2. H. P. Myers, "Introduction to Solid State Physics", Taylor & Francis, 2009.
3. V.Rajendran, "Engineering Physics", Tata Mc –Graw Hill Publications, 2016.

REFERENCE BOOKS:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", 6th edition, John Wiley and Sons, New York, 2001.
2. Charles Kittel, "Introduction to Solid State Physics", 7th edition, Wiley, Delhi, 2007.
3. Donald A. Neamen, "Semiconductor Physics and Devices: Basic Principle", 4th edition, McGraw-Hill, New York, 2012.
4. N.W. Ashcroft and N.D. Mermin, "Solid State Physics", International student edition, Brooks Cole, 2008.

SKILLS:

- ✓ *To apply Ultrasonic waves in non-destructive testing.*
- ✓ *To compute the power of the laser and the signal carrying capacity of optical fiber.*
- ✓ *To distinguish various crystals and the orientation of crystal planes.*
- ✓ *To demonstrate the synthesis and characterization of nanoparticles in view of their application.*

Image source: https://www.abebooks.com/9781316640081/English-Technical-Communication-Students-Book-1316640086/plp

22EN104 TECHNICAL ENGLISH COMMUNICATION

Hours Per Week :

L	T	P	C
2	-	2	3

PREREQUISITE KNOWLEDGE: Basic sentence formation, understanding contextual meanings, basic writing skills and moderate fluency in English.

COURSE DESCRIPTION AND OBJECTIVES:

In this course students will read, analyze, and interpret material from technical and general fields, and practice reading, writing, listening and speaking skills to gain exposure and functional English on a variety of contemporary topics. The overall course objective is to provide English for Specific Purposes(ESP) instruction to enhance students' reading, writing, listening and speaking skills through a practice in the language. It will aim to build students' confidence and motivation through exposure to academic skills like Note making/taking, Paraphrasing, Summarizing, Report Writing, Making Presentations etc., so as to generate interest in the language from an ESP perspective. Finally, students are expected through the course to gain key strategies and expression for communicating with professionals and non-specialists.

MODULE-1

UNIT-1 **8L+0T+8P=16 Hours**

GENETICS:

Reading: Reading for Note Making Sub skills: Reading for global understanding (skimming), specific information (scanning), understanding main ideas and supporting ideas, guessing contextual meanings from the text. -Vocabulary building: commonly used roots, prefixes, and suffixes.

Writing: Note making, organising main points and sub points, numbering and sequencing, suggesting titles, paraphrasing and summarising.

Functional grammar: Common Errors in Articles and Prepositions (Handout).

Listening: Listening for Note Taking: top down and bottom up approach, listening for main ideas and supporting points.

Speaking: Presentation in teams - ideas on the topic summarised, making a PPT, effective introductions and conclusions, logical organisation of content, using appropriate structure and cohesive devices.

UNIT-2 **8L+0T+8P=16 Hours**

ALIENS:

Reading : Predicting, skimming, scanning, reading for inference, extrapolative reading

Vocabulary building: Academic vocabulary from the text: synonyms, antonyms, Words often confused.

Writing : Paragraph writing; writing a topic sentence, supporting sentences, effective introductions and conclusions, use of cohesive devices. Types of Paragraphs: Descriptive, narrative, argumentative and expository.

Functional grammar: Common Errors in Verb forms and Conditional sentences (Handout).

Listening : Listening for identifying parts from a description, listening to and sorting information, listening for specific information.

Speaking : Narrating/Retelling an incident, using suitable cohesive devices/discourse markers Speaking of past and present habits/ activities/events - Speaking of future plans.

PRACTICES:

- Note making.
- Summarizing.
- Paragraph Writing.
- Error correction and Restructuring.
- Vocabulary building.
- Listening comprehension.
- Note taking.

SKILLS:

- ✓ *Apply different sub skills like skimming, scanning, reading for information, reading for inference etc. to understand different kinds of text.*
- ✓ *Apply different sub skills like top down, bottom up approaches to listening.*
- ✓ *Use functional vocabulary relevant to engineering and technology to express ideas lucidly.*
- ✓ *Use appropriate sentence structure, cohesive devices to construct simple text in regular correspondence like e-mails and letters.*

MODULE-2

UNIT - 1 **8L+0T+8P=16 Hours**

SOCIAL MEDIA – HEALTH AND NUTRITION:

Reading : Reading for factual information researching for supporting evidence - skimming, scanning, Vocabulary building: One-word substitutes.

Writing : Letter Writing- E-mail writing – New age communication – Format, protocol, and style- WhatsApp, Facebook and Twitter Functional grammar: Common Errors in Sub-Verb Agreement and Modals.

Listening : Listening to a Business Presentation: Listening for deducing information, for abstract details and specific details, listening for taking a message.

Speaking : Making a presentation with a PPT on a topic assigned- organising the presentation using appropriate discourse markers - presenting a point of view - Extempore.

UNIT-2 **8L+0T+8P=16 Hours**

FASHION:

Reading : Reading for data interpretation and information transfer from graphical aids to text reports (pictograms. tables, graphs, pie charts, flow charts), deducing specific information and general information

Vocabulary building: Business vocabulary, collocations, idioms and phrasal verbs.

Writing: Writing a Report: Drafting general and factual reports - writing an overview - an effective introduction - organising information into paragraphs (Stages of writing: planning /organising /writing / editing /rewriting)

Functional grammar: Transformations and miscellaneous common errors.

Listening : Listening to a Ted talk and sorting information – taking notes from a discussion.

Speaking : Group Discussion – prerequisites -generating content - initiating a discussion - expressing one's opinion ~ leading a discussion - agreeing/ disagreeing to someone's view - cutting into a speech - body language and voice modulation.

PRACTICES:

- E-mail writing.
- Letter writing.
- Report writing.
- Messaging in Social media.
- Extempore.
- Making PPTs.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply a variety of strategies to interpret and comprehend spoken texts/ discourse using contextual clues.	Apply	1	6, 7, 8, 9, 10, 12
2	Apply appropriatereading strategies to interpret content / material related to engineering and technology domain.	Apply	1	6, 7, 8, 9, 10, 12
3	Possess an ability to write clearly on topics related to technology and workplace communication.	Analyze	2	6, 7, 8, 9, 10, 12
4	Choose functional language, grammar structures, cohesive devices and skills of organisation to express clearly in speaking.	Evaluate	2	6, 7, 8, 9, 10, 12
5	Participate in discussions and make short presentations on general and technical topics.	Create	2	6, 7, 8, 9, 10, 12

LANGUAGE LAB ACTIVITIES

Session - 1: Dictionary Skills

Session - 2: Introduction to Phonetics and Identifying Phonemes

Session - 3: Pronunciation Practice (Commonly mispronounced words)

Session - 4: Rosetta Stone (Exercises on LSRW)

Session - 5: Listening Comprehension (Summarising exercise on a Ted Talk)

Session - 6: Technical Presentations (Individual)

Session - 7: Technical Presentations (Team)

Session - 8: TOEFL Mastery

TEXT BOOK:

1. N P Sudharshana & C Savitha, “English For Technical Communication”, Cambridge University Press, 2016.

REFERENCE BOOKS:

1. Balasubramanian T,“A Text book of Phonetics for Indian Students”, Orient Longman, New Delhi, 1989.
2. Krishnaswamy, N and Sriraman, T, “Current English for Colleges”, Trinity publications, 2016.
3. Mohan Krishna and Meera Banerjee, “Developing Communication Skills”, Macmillan India Ltd. New Delhi, 1990.
4. Ashraf Rizvi M, “Effective Technical Communication”, 2nd Edition, McGraw Hill Education, 2017.
5. Narayana Swamy V R, “Strengthen your Writing”, Third Edition Orient Black Swan, New Delhi, 2005.

22CT105 ORGANIC CHEMISTRY FOR CHEMICAL ENGINEERS

Image source: https://www.thecoldwire.com/why-is-organic-chemistry-so-hard/

Hours Per Week :

L	T	P	C
3	-	2	4

PREREQUISITE KNOWLEDGE: Intermediate level knowledge of chemistry.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamental concepts of organic chemistry which will help to design and synthesize organic compounds and understand their properties. This course will make the student familiar with basic concepts of bonding, reaction intermediates and stereochemical aspects applicable in synthetic organic chemistry and organic materials. As a first-level course for B. Tech. students with chemical engineering background, it will be a strong basis to understand advanced level mechanistic aspects of biochemical reactions and also synthesis of organic molecules with medicinal value.

MODULE-1

UNIT–1 **12L+0T+8P=20 Hours**

CHEMICAL BONDING AND REACTION INTERMEDIATES:

Chemical Bonding: Introduction to VBT and VSEPR theory, Molecular orbital (MO) energy diagram of Ethylene, 1,3-Butadiene.

Reaction Intermediates: Bond fissions and arrow-pushing, formation, and reactivity of carbanions, carbenium ions, free radicals, carbenes.

UNIT–2 **12L+0T+8P=20 Hours**

STEREOCHEMISTRY:

Representations of 3 Dimensional structures, Structural isomers and Stereoisomers, Chirality, Optical isomerism-Enantiomers Diastereomers (Lactic acid and Tartaric acid); Absolute configurations (R/S); Conformational analysis – Ethane.

PRACTICES:

- Comparison MO diagrams of 1,3,5 hexatriene and benzene.
- Determination of melting point and boiling point of organic compounds.
- Separation of organic compounds by thin layer chromatography (TLC).
- Drawing of chemical structures (Vitamin A, B1, C, D / Amino acids / Sugars / Carbohydrates / Flavonoids / Terpenoids).
- Analysis of functional groups.
  - o Carboxylic acids.
  - o Carbonyl compounds.
  - o Amines.
- Construction of organic molecules (Tartaric acid (meso, RR and SS) using ball stick models.
- Relevance of stereochemistry in biology. e.g. Thalidomide.
- Stability of carbocation by rearrangement.

SKILLS:

- ✓ *Design a scheme for an organic reaction.*
- ✓ *Choose an appropriate Oxidising/reducing reagent for a synthetic transformation.*
- ✓ *Choose the desired green solvent required for a reaction.*
- ✓ *Analyse the desired product, side product and impurities formed during the course of the reaction pathway*

MODULE-2

UNIT–1 **12L+0T+8P=20 Hours**

ORGANIC REACTIONS AND GREEN CHEMISTRY:

Organic reactions: Introduction to reactions involving Substitution (SN_1 vs SN_2), Addition-Electrophilic and Nucleophilic, Elimination (E_1 and E_2); Oxidation (Jones reagent) and Reduction ($LiAlH_4$).

Green Chemistry: 12 Principles of Green chemistry and introduction to catalysis with example.

UNIT – 2 **12L+0T+8P=20 Hours**

STRUCTURAL ELUCIDATION OF ORGANIC COMPOUNDS:

IR Spectroscopy: Introduction, principle, identification of functional groups.

NMR spectroscopy: Introduction, principle, chemical shift, ^{1}H-NMR (Ethyl alcohol and other simple molecules), cis-trans isomers (J values).

Mass spectroscopy: Introduction, principle, fragmentation (nitrogen rule); Radioisotopes in biology.

PRACTICES:

- Preparation and characterization of Aspirin.
- Paper Chromatography for Identification of Amino acids from the mixture.
- Reduction of Nitro group to amino group using metal catalysis and characterization by IR and NMR.
- Characterisation (IR) of functional groups.
  - o Carboxylic acids.
  - o Carbonyl compounds.
  - o Amines.
- Oxidation of an Organic compound using Potassium Permanganate (KMnO4).
- Reduction of Aldehydes using Sodium Borohydride (NaBH4).
- Preparation of Paracetamol and its characterization using IR.
- Synthesis of BINOL using solvent free methods.
- Qualitative analysis of Phytochemicals.
  - o Alkaloid.
  - o Flavonoids.
- Synthesis and characterisation of Friedel-Craft acylation and alkylation product using β-naphthol.
- Demonstration of C-C bond formation reaction using L-Proline catalyst.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the theories of bonding to predict the formation and reactivity of different reaction intermediates in organic reactions.	Apply	1	1, 2, 9, 10, 11, 12
2	Identify the stereochemical features of organic molecules and their the importance of chirality with relevance to biological activity.	Analyse	1,	1, 2, 6, 9, 10, 11, 12
3	Analyse various synthetic reactions for preparation of drug molecules by implementing the concept of Green Chemistry.	Analyse	1, 2	1, 2, 6, 7, 9, 10, 11, 12
4	Verify the structure of organic compound using the principles of instrumental techniques for structure determination.	Evaluate	2	1, 2, 4, 5, 9, 10, 11,12

TEXT BOOK:

1. A. Bahl and B.S. Bahl, “Text Book to Organic Chemistry”, S. Chand & Co, 8th Edition, 2009.
2. R. T. Morrison, R. M. Boyd and S. K. Bhattacharjee, “Organic Chemistry”, Pearson Publications, 7th Edition, 2018.

REFERENCE BOOKS:

1. I. L. Finar, “Organic Chemistry”, Vol. 1, Longman Scientific Publications, 6th Edition, 2006.
2. P. Bruice, “Organic Chemistry”, Pearson Scientific Publications, 8th Edition, 2020.
3. R. M. Silverstein, G. Bassler, M. Clayton, C. Terence, “Spectroscopic Identification of Organic Compounds”, Wiley-VCH, 8th Edition, 2014.
4. J. Mendham, R. C. Denney, J.D. Bares, M. Thomas, B. Siva Sankar, “Vogel’s Text Book of Qualitative Chemical Analysis”, Pearson Publications - Volume I, 2009.
5. D. L. Pavia, G. M. Lampman, G.S. Kriz, R.G. Engel, “A microscale approach to Organic Laboratory Techniques”, Cengage Learning Brooks/Cole Cengage, 5th Edition, 2012.

II YEAR

B.Tech.

CHEMICAL ENGINEERING

COURSE CONTENTS

I SEM & II SEM

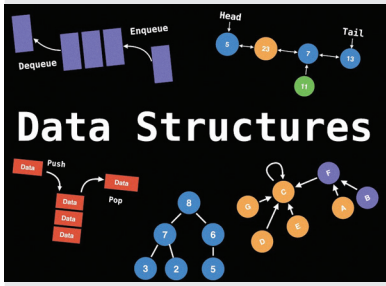
I SEMESTER

22TP201	-	Data Structures
22ST202	-	Probability and Statistics
22CH201	-	Chemical Engineering Thermodynamics - I
22CH202	-	Chemical Process Calculations
22CH203	-	Momentum Transfer
22CH204	-	Mechanical Unit Operations
22SA201	-	Life Skills-I

II SEMESTER

22TP203	-	Advanced Coding Competency
22CT201	-	Environmental Studies
22MS201	-	Management Science
22TP204	-	Professional Communication Laboratory
22CH205	-	Chemical Engineering Thermodynamics - II
22CH206	-	Process Heat Transfer
	-	Department Elective – 1
	-	Open Elective – 1
22SA202	-	Life Skills-II

22TP201 DATA STRUCTURES



Source: https://www.youtube.com/watch?v=Qmt0QwzEmh0

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Programming in C.

COURSE DESCRIPTION & OBJECTIVES:

This course is aimed at offering fundamental concepts of data structures and explains how to implement them. It begins with the basic concepts of data, data structures and then introduces the primitive and non-primitive data structures in detail. It forms the basis for understanding various ways of representing data and its usage in different computing applications.

MODULE-1

UNIT-1 **5L+6T+6P = 17 Hours**

DATA STRUCTURES BASICS:

Basic Terminology – data, information, datatype; Data Structures – Introduction, storage structures-sequential and linked storage representations; classification of data structures; Applications of data structures.

Sorting: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort and Merge Sort.

Searching: Linear Search and Binary Search.

UNIT-2 **11L+10T+10P = 31 Hours**

LINKED LISTS AND STACKS, QUEUES:

Linked List: Introduction, Types of linked list – Singly linked list, doubly linked list and circular linked list, representation of linked list, Operations of linked list: Traverse forward/ reverse order, searching, insertion and deletion; Applications of linked lists.

Stack – Introduction, array and linked representations, implementation and their applications; Queue – Introduction, array and linked representations, implementation; Types – Linear, circular and doubly ended queues – operations; Applications of Queues.

PRACTICES:

Problems on Recursion – Level 1

- Find the product of 2 numbers using recursion.
- Find the sum of natural numbers using recursion.
- Find the factorial of a number using recursion.
- Find the Nth term of Fibonacci series using recursion.
- Calculate the power using recursion.
- Write a recursive program for checking if a given number is a prime number.
- Given two integers write a function to sum the numbers without using any arithmetic operators.
- Convert a decimal to binary using recursion.
- Print all factors using recursion.
- Find the maximum product of digits among numbers less than or equal to N.

SKILLS:

- ✓ *Experienced to Store data and various types of data to handle.*
- ✓ *Ordering and sorting of data.*
- ✓ *Indexing and Searching of required data from large data sequences.*
- ✓ *Exposed to various characteristics such as Linear or non-linear, Homogeneous or heterogeneous and Static and Dynamic.*

Problems Recursion – Level 2

- Implement insertion sort recursively.
- Write a program to find the numbers less than N that are product of exactly 2 distinct prime numbers - using recursion.
- Implement selection sort recursively.
- Find the middle of a singly linked list using recursion.
- Find the sum of even numbers of an array using recursion.
- Check if a given array is in sorted order using recursion.
- Print alternate nodes of a linked list using recursion.
- Reverse a doubly linked list using recursion.
- Write a recursive function that returns all permutations of a given list.
- Implement bubble sort recursively.

Problems on Sorting and Searching – Level 1

- Implement the insertion sort function.
- Implement the bubble sort function.
- Implement the quick sort function.
- Implement the merge sort function.
- Implement the selection sort function.
- Implement linear search function.
- Implement binary search function.

Problems on SLL – Level 1

- Implement the insert function to insert nodes into a singly linked list (ascending order).
- Implement the insert function to insert nodes into a singly linked list (descending order).
- Implement the search node function.
- Implement the delete node function.
- Display forwards function.
- Display backwards function.
- Count the number of nodes in a singly linked list.
- Swap alternate nodes of a singly linked list.
- Move last node to the front of the linked list.
- Move first node to the last of the linked list.

Problems on Stacks – Level 1

- Implement two stacks using a single array.
- Given an array replace every element with nearest greater element on the right.
- Given a stack reverse the elements using only push and pop functions.
- Postfix evaluation using stack.
- Balance symbols.
- Find middle element in a stack.
- Remove middle element from a stack.
- Implement push and pop using linked list.
- Given an array of characters with the middle marked by X, check if the string is a palindrome.
- Maximum sum in sliding window.

Problems on Queues – Level 1

- Write a program to accept two numbers as input check if they are equal.
- Write a program to accept two characters as input and check if they are equal.
- Write a program to accept two numbers as input and print the greater of the 2 numbers.
- Write a program to accept two numbers as input and print the lesser of the 2 numbers.
- Write a program to accept 3 numbers as input and print the maximum of the 3.
- Write a program to accept 3 numbers as input and print the minimum of the 3.
- Write a program to accept a number as input and print EVEN if it is an even number and ODD if it is an odd number.
- Write a program to accept a number as input and check if it is divisible by 3. If it is divisible by 3 print YES else print NO.
- Write a program to accept a number as input and check if it is divisible by both 3 & 5. If it is divisible print YES else print NO.
- Write a program to accept a number as input and check if it is positive, negative or zero.

Problems on DLL – Level 1

- Implement insert function.
- Implement display forward function.
- Implement display backward function.
- Implement search function.
- Implement delete function.
- Reverse a doubly linked list from M to N.
- Find the sum of the odd and even nodes.
- Count odd keys of the linked list.
- Merge two sorted lists.
- Delete adjacent duplicate nodes.

Problems on CLL – Level 1

- Insert function (circular doubly linked list).
- Search function.
- Display forward.
- Display backward.
- Delete node (circular doubly linked list).
- Print the middle N nodes of a circular singly linked list.
- Move the last node of a circular singly linked list to the beginning.
- Delete adjacent duplicate nodes of a circular singly linked list.
- Delete nodes greater than a value from a circular doubly linked list.
- Find the sum of the nodes of a circular linked list.

Problems on Linked List – Level 2

- Given 2 sorted linked lists, print the common elements.
- Reverse a list (using Stack).
- Given a pointer to a node (not the last node), delete the node.
- Reverse a list (Recursive).
- Reverse a list (Iterative).
- Reverse a singly linked list in pairs (recursive).
- Reverse a singly linked list in pairs (iterative).
- Check if a singly linked list is a palindrome or not.
- Remove the loop if exists.
- Given 2 linked lists with data in the ascending order, merge them into a single list.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

TREES:

Trees: Basic Terminology, Types of Trees, Binary Tree – Introduction, properties, array and linked representations; Tree traversals and their implementation; Expression trees; BST – definition and operations, AVL trees – definition and construction; Applications of binary trees.

UNIT-2 **8L+8T+8P=24 Hours**

GRAPHS & HASHING:

Graphs: Basic Terminology, Types of Graphs, Graphs representations – adjacency matric, adjacency list; Traversals - breath first search and depth first search; Applications of graphs.

Hashing: Introduction, Different hash functions, collision: avoidance and handling methods.

PRACTICES:

Problems on BST – Level 1

- Insert function.
- Insert function (recursive).
- Search function.
- Pre order traversal.
- Post order traversal.
- In order traversal.
- Level order traversal.
- Delete child node.
- Delete parent node.
- Delete nodes greater than a value from a circular doubly linked list.

Problems on Priority Queues – Level 1

- Meeting rooms problem.
- Ugly number.
- Find median from data stream.
- Find the top K frequent elements.
- Find K Pairs with smallest sums.
- Find the Kth smallest element in a sorted matrix.
- Trapping Rain Water.
- Rearrange String k distance apart.
- Sort characters by frequency.
- Solve the maze problem.

Problems on Graphs – Level 1

- Implement Graph data structure.
- Implement BFS - iterative solution.
- Implement BFS - recursive solution.
- Implement DFS - iterative solution.
- Implement DFS - recursive solution.
- Check if given graph is strongly connected or not.
- Check if given graph is strongly connected or not - using DFS.
- Given a graph find the arrival and departure time of its vertices in DFS. Arrival time is the time when the vertex was explored for the first time, and departure time is the time at which all the neighbours are explored and are ready to backtrack.
- Given a directed acyclic graph and a source vertex, find the cost of the shortest path from source vertex to all other vertices present in the graph. If a vertex cannot be reached from given source vertex that distance may be printed as infinite.
- Given an undirected graph, check if the graph is 2 edge connected or not.

Problems on Hashing – Level 1

- Print a binary tree in vertical order.
- Find whether an array is subset of another array.
- Given an array A [] and a number x, check for pair in A [] with sum as x.
- Minimum operation to make all elements equal in array.
- Maximum distance between two occurrences of same element in array.
- Check if a given array contains duplicate elements within k distance from each other.
- Find duplicates in a given array when elements are not limited to a range.
- Most frequent element in an array.
- Smallest subarray with all occurrences of a most frequent element.
- First element occurring k times in an array.

Problems on Graphs – Level 2

- Find the shortest graph distances between every pair vertex in a given path. Assume that the graph does not have any negative edges.
- Find the shortest graph distances between every pair of vertices in a given path. The graph can have negative edges.
- Detect cycle in DFS.
- Count the number of connected components of a graph represented in the adjacent matrix.
- Count the number of connected components of a graph represented in the adjacent matrix - using DFS.
- Find a spanning tree - not necessarily a minimum spanning tree.
- Detect cycle in an undirected graph.
- Given an undirected graph, find its depth.
- Determine if a directed graph has a unique topological ordering.
- Given a directed acyclic graph and two vertices v and w, find the lowest common ancestor.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Explore the organization of several ADTs and the manipulation (searching, insertion, deletion, traversing) of data stored in various data structures.	Apply	1,2	1
2	Apply different data structures to solve a given problem.	Apply	1,2	1
3	Analyze the efficiency of using different data structures and choose the efficient data structure for solving a given problem.	Analyze	1,2	2
4	Develop new algorithms to solve various problems.	Create	1,2	3,4

TEXT BOOKS:

1. Reema Thareja, “Data Structures Using C”, 2nd Edition, Oxford University Press, 2014.
2. Seymour Lipschutz, “Data Structures with C”, 1st Edition, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, illustrated edition, Computer Science Press, 2006.
2. Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd Edition, CENAGE Learning, 2005.
3. R G Dromey and Pearson, “How to solve it by Computer”, 2nd edition, Impression edition, 1998.

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22ST202 PROBABILITY AND STATISTICS

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Basic knowledge in statistics and mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

To provide students with foundation in elementary topics of statistics and probability such as descriptive statistics, correlation, probability, random variables, correlation, regression, and testing of hypothesis. The course emphasizes statistics to solve engineering and management problems.

MODULE-1

UNIT-1 **12L+8T+0P = 20 Hours**

DESCRIPTIVE STATISTICS:

Basic Definitions, Frequencies, Graphical Representation, Histogram, Ogive curves; Measures of Central tendency, Arithmetic mean, Median, Mode, Mean deviation, Standard deviation; Symmetry and Skewness, Karl Pearson's Coefficient of skewness.

UNIT-2 **12L+8T+0P = 20 Hours**

PROBABILITY AND RANDOM VARIABLES:

Probability: Introduction, Definition (Classical and Axiomatic approach), Addition theorem, Conditional probability, Multiplication theorem and Bayes theorem.

Random Variables: Random variables, Discrete and Continuous variables and distribution function. Expectation, Variance of random Variables, Tchebysher's inequality.

PRACTICES:

- Various graphical presentation techniques.
- Measures of central tendency.
- Skewness.
- Karl Pearson's coefficient of skewness.
- Definitions of probability.
- Applications of addition theorem.
- Applications of multiplication theorem.

MODULE-2

UNIT-1 **12L+8T+0P = 20 Hours**

REGRESSION ANALYSIS AND DISTRIBUTIIONS:

Correlation and regression: Correlation, Types, Pearson's and Spearman's Coefficient of correlation, Regression, Regression lines.

Distributions: Introduction to Distributions: Binomial, Poisson and Normal distributions with properties and applications.

UNIT-2 **12L+8T+0P = 20 Hours**

SKILLS:

- ✓ *Collect the data from various data sources and evaluate mean, median, mode mean deviation and standard deviation.*
- ✓ *Identify the areas which we can apply the probability theory.*

TESTING OF HYPOTHESIS:

Testing large samples - single mean, two means, one proportion and two proportions. Testing small samples – single mean, two means (independent and paired samples), Chi square test -goodness of fit and independence of attributes.

PRACTICES:

- Correlation.
- Karl Pearson's coefficient of correlation.
- Regression and regression lines.
- Applications of statistical distributions.
- Testing the large sample tests-one mean and two sample means.
- One proportion and two proportion tests.
- Testing small samples-one, two samples and paired tests.
- Chi-square test for goodness of fit.
- Chi-square test for independence of attributes.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

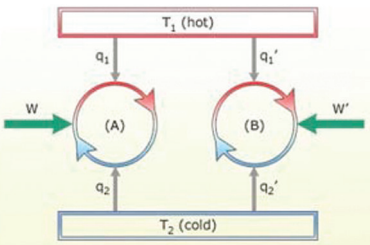
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply measures of central tendency, skewness, and Karl Pearson's coefficient of skewness to study the statistical data sets.	Apply	1	1,2
2	Apply the probability theory and their applications to measure the uncertainty.	Apply	1	1,2
3	Study the relations between statistical variables and can fit the mathematical models for association.	Analyze	2	1,2,3
4	Test the statistical significances for various samples.	Evaluate	2	1,2,4
5	Identify the distribution type to measure the occurrences of chance.	Evaluate	2	1,4,5

TEXT BOOKS:

1. Sheldon M. Ross, "An Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Academic Press, Elsevier.
2. S. C. Gupta and V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2012.

REFERENCE BOOKS:

1. P. R. Vittal, "Mathematical Statistics", Margham Publications, Chennai, 2018.
2. Kishore S. Trivedi, "Probability and Statistics with Realiability, Queueing and Computer Science Applications", 2nd edition, Wiley Student edition, 2008.
3. A. Singaravelu, "Probability and Statistics", 22nd edition, Meenakshi Agency, 2015.



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22CH201 CHEMICAL ENGINEERING THERMODYNAMICS-I

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course aims to connect the principles, concepts, and laws of classical and statistical thermodynamics to applications that require quantitative knowledge of thermodynamic properties from a macroscopic to a molecular level. The objective of this course is to train the students how to apply knowledge of the laws of thermodynamics, chemistry, physics, and engineering to analyze and solve physical and chemical problems encountered in chemical engineering.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS

Continuum and macroscopic approach; Thermodynamic systems; Thermodynamic equilibrium and properties; State of a system; Paths and processes on state diagrams; Reversible and irreversible processes; Concepts of heat and work; Zeroth law of thermodynamics; Concept of temperature; Energy - various forms of energy; Specific heats; First law of thermodynamics; Thermodynamic properties of pure substances in solid, liquid and vapor phases; P-v-T behaviour of simple compressible substances, phase rule; ideal and real gases; Equations of state.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS OF THERMODYNAMIC PRINCIPLES

Different modes of work transfer; Analysis of first law of thermodynamics - closed systems and control volumes, steady and unsteady flow analysis; Thermodynamic property tables and charts; Van der Waals equation of state; Law of corresponding states; Compressibility factor and generalized compressibility factors and chart.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

SECOND LAW OF THERMODYNAMICS AND ITS APPLICATIONS

Limitations of the first law of thermodynamics; Kelvin-Planck and Clausius statements and their equivalence; Heat engines and heat pumps/refrigerators; Carnot cycle and Carnot principles/theorems; Thermodynamic temperature scale; Clausius inequality and concept of entropy; Microscopic interpretation of entropy; Principle of increase of entropy; T-S diagrams; Joule-Thomson coefficient; Coefficient of volume expansion; Adiabatic and isothermal compressibility; Clapeyron and Clapeyron-Clausius equations; Third law of thermodynamics.

UNIT-2 **10L+6T+0P=16 Hours**

SECOND LAW APPLICATIONS

Second law analysis of control volume; Availability and irreversibility; T-dS relations; Carnot vapor cycle; Ideal Rankine cycle; Rankine reheat cycle; Air-standard Otto cycle; Air-standard Diesel cycle, Air-standard Brayton cycle, Vapor-compression refrigeration cycle; Absorption refrigeration; Helmholtz and Gibbs functions; Gibbs relations; Maxwell relations.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply fundamental concepts of thermodynamics to engineering applications.	Apply	1	1,2
2	Derive and discuss the first and second laws of thermodynamics.	Apply	2	4
3	Apply laws of thermodynamics to engineering applications.	Apply	1,2	6
4	Analyse problems using the properties and relationships of thermodynamic fluids.	Analyse	2	3,4
5	Evaluate thermodynamic properties of substances in gas and liquid states.	Evaluate	1	3

SKILLS:

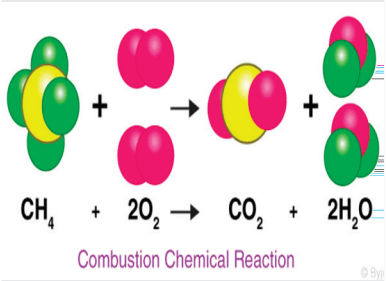
- ✓ *Estimation of thermodynamic properties.*
- ✓ *Determination of heat engine and pump efficiency.*
- ✓ *Identification of reversible and irreversible processes.*
- ✓ *Selection of refrigeration process and refrigerant.*
- ✓ *Describe the process in terms of the changes in system properties.*

TEXT BOOKS:

1. J. M. Smith, H. C. Vanness and M. M. Abbot, “Introduction to Chemical Engineering Thermodynamics”, 6th edition, McGraw-Hill, 2005.
2. Y. V. C. Rao, “Chemical Engineering Thermodynamics”, 1st edition, Universities Press, 2004

REFERENCE BOOKS:

1. Dodge B. F., “Chemical Engineering Thermodynamics”, 1st edition, McGraw-Hill, 1944.
2. Kyle B. G., “Chemical and Process Thermodynamics”, 1st edition, Prentice Hall of India, 1999.
3. P. K. Nag., “Engineering Thermodynamics”, 6th Edition, McGraw Hill, 2017.



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22CH202 CHEMICAL PROCESS CALCULATIONS

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Basic Chemical Engineering knowledge.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamentals of material and energy balance involved in chemical processes. The objective of this course is to develop basic understanding pertaining to principles of chemical engineering processes and calculations.

MODULE-1

UNIT-1 **10L+8T+0P=18 Hours**

STOICHIOMETRY, IDEAL GASES, VAPOR PRESSURE AND SATURATION

Basic Concepts, Units and Dimensions: Units and dimensions; Graphical integration and differentiation; Conversion of units; Stoichiometric relation; Basis of calculation; Method of expressing composition of mixture and solutions; Density and specific gravity.

Behaviour of Ideal Gases: Ideal gas law; Gaseous mixtures; Chemical reactions in gaseous mixtures; Volume changes with change in composition.

Vapor Pressure: Concept of vapor pressure; Liquefaction and liquid state; Vaporization; Boiling point; Effect of temperature on vapor pressure; Vapor pressure plots; Vapor pressure of solutions and immiscible liquids; Raoult's law and its limitations.

Humidity and Saturation: Relative saturation; Percent saturation; Dew point; Wet bulb and dry bulb temperatures; Humidity charts.

UNIT-2 **14L+8T+0P=22 Hours**

APPLICATIONS

Specific Use of log-log, semi-log and triangular graphs for experimental data representation; Practical applications of the ideal gas law in the field of chemical engineering; Determination of bubble point and dew point for various liquid mixture; Determination of vapour composition and liquid composition of various mixture like hydrocarbon mixture; Application of Humidity chart for finding different psychrometric properties for air-water mixture; Application of Humidity chart for finding different psychrometric properties for nitrogen-hexane system.

MODULE-2

UNIT-1 **10L+8T+0P=18 Hours**

MATERIAL BALANCE AND ENERGY BALANCE

Material Balance without Chemical Reaction: Formulation; Material balance calculations of unit operations- distillation, absorption, extraction, crystallization (single solute systems), drying, and evaporation.

Material Balance with Chemical Reaction: Material balance calculations- processes with chemical reactions, processes involving recycle, purge and bypass.

Thermo physics: Concept of energy; Energy balance equation; Heat capacity- gases, liquids and mixtures, Kopp's rule; Latent heat- heat of fusion, heat of vaporization, Trouton's ratio, Kistyakowski equation.

Thermochemistry: Heat of formation; Heat of combustion; Heat of reaction; Hess law; Heat of reaction from heat of formation/combustion; Effect of temperature and pressure on heat of reaction; Adiabatic reaction temperature; Fuel & combustion- heating value, theoretical and actual flame temperature.

UNIT-2 **14L+8T+0P=22 Hours**

APPLICATIONS

Determination of distillate and bottom product amount and composition in a distillation unit ; Determination of percentage of CO2 absorbed in a packed absorber; Determination of quantities and composition of extract and raffinate phase in an extraction unit; Application of dryer in various chemical process industries along with materials balance in continuous dryer; Determination of crystal formed through crystallization; Determination of steam consumption and final product composition in a forward-feed triple effect evaporator; Determination of proximate and ultimate analysis of coal; Determination of flue gas composition and percent excess air for complete combustion of coke; Determination of mean molal heat capacity and enthalpy change for a gas mixture; Determination of heat capacities of liquids; Estimation of heat of Fusion and heat of Vaporization; Determination of heat of reaction at constant pressure and constant volume; Determination of adiabatic film temperature; Application of Hess law.

SKILLS:

- ✓ *Material balance for processes without chemical reaction.*
- ✓ *Material balance for processes with chemical reaction.*
- ✓ *Energy balance for any unit operation.*
- ✓ *Energy balance for any chemical plant.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

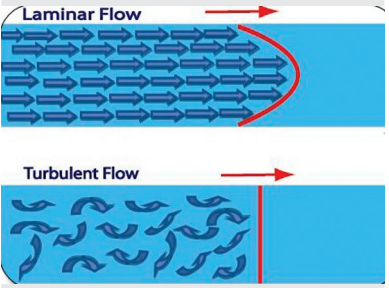
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concept of thermo physics and thermochemistry to determine heat of reaction & adiabatic flame temperature.	Apply	1, 2	1, 2, 3, 5, 9, 10
2	Estimate properties of gases using ideal gas mixtures.	Apply	2	1, 2, 3, 5, 9, 10
3	Analyze the heat capacity of gaseous mixture, liquids and solid.	Analyze	1	1, 2, 4, 5, 9, 10, 12
4	Evaluate material and energy balance for any chemical plant.	Evaluate	2	1, 2, 5, 9, 10, 12
5	Design of flow sheet for a chemical Process.	Create	1	1, 2,3, 5, 9, 10

TEXT BOOKS:

1. Hougen O. A., Watson K. M. and Ragatz. R. A., “Chemical Process Principles Part – I:Material and Energy Balance”, 2nd edition, CBS Publishers & Distributors, 2004.
2. Bhatt B. I., and Vora S. M., “Stoichiometry”, 4th edition, Tata McGraw Hill, New Delhi, 2004.

REFERENCE BOOKS:

1. Himmelblau D.M. and Rigges J. B., “Basic Principles and Calculations in Chemical Engineering”, 8th edition, Prentice Hall of India, 2011.
2. Richard M. F. and Ronald W. R., “Elementary Principles of Chemical Processes”, 3rd edition, John Wiley, 2004.



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22CH203 MOMENTUM TRANSFER

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of engineering mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamentals of fluid flow and its application to chemical process industries including pipe flow, fluid machinery. The objective of this course is to familiarize students with basic concepts of fluid statics, fluid dynamics, compressible and incompressible fluids, fluidization, transportation and metering of fluids.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

DEFINITIONSANDPRINCIPLES,BASICEQUATIONSOFFLUIDFLOW,FLOWOFINCOMPRESSIBLE FLUIDS

Unit operations; Unit systems; Dimensional analysis; Fluid statics-Nature of fluids, Hydrostatic equilibrium, Manometers.

Mass balance; Mass velocity; Momentum balance; Bernoulli equation; Mechanical energy balance equation; Correction factors; Pump work.

UNIT-2 **10L+10T+10P=30 Hours**

SHEAR STRESS AND FRICTION FACTOR

Shear stress distribution in pipes; Relation between skin friction parameters; Laminar flow in pipes; Hagen-poiseuille equation; Laminar flow of non-Newtonian liquids; Friction factor chart.

PRACTICES:

- Classification of flows by determining Reynolds number.
- Verification of Bernoulli's theorem for a convergent-divergent pipe.
- Determination of head and power loss due to sudden expansion.
- Determination of head and power loss due to sudden contraction.
- Determination of coefficient of discharge of V-notch.
- Estimation of friction loss in pipes.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

FLOW PAST IMMERSED BODIES

Drag; Drag Coefficient; Stagnation Point; Friction in flow through beds of solids; Motion of particles through fluids; Terminal velocity; Motion of spherical particles; Fluidization: Conditions for fluidization, minimum fluidization velocity.

UNIT-2 **8L+8T+8P=24 Hours**

TRANSPORTATION AND METERING OF FLUIDS

Pipes; Fittings, Valves; Joints; Pumps; Suction lift and cavitation; Reciprocating pump; Centrifugal pump; Measurement of flowing fluids: Venturi meter, Orifice meter, Rotameter.

PRACTICES:

- Estimation of coefficient of discharge of venturi meter.
- Estimation of coefficient of discharge of orifice meter.
- Determination of performance characteristics of centrifugal pump.
- Determination of performance characteristics of reciprocating pump.
- Estimation of pressure drop in fluidized bed.
- Estimation of pressure drop in packed bed.

SKILLS:

- ✓ *Application of fluid mechanics concepts to solve real-life problems.*
- ✓ *Estimate physical properties of fluids in motion and at rest.*
- ✓ *Measurement of flowing fluids.*
- ✓ *Selection of pumps for engineering applications.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze dimensionless groups using dimensional analysis.	Analyze	1	1, 2, 4, 5, 9, 10, 12
2	Design solutions for manometers and decanters using the principles of fluid statics.	Create	1	1, 2,3, 5, 9, 10
3	Apply solutions for problems related to pipe size / flow rate / power requirements under laminar and turbulent flow conditions.	Apply	1, 2	1, 2, 3, 5, 9, 10
4	Evaluate suitable machinery for fluid transportation.	Evaluate	2	1, 2, 5, 9, 10, 12
5	Interpretation of flow rate data for the fluid passing through closed channels.	Create	2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. W. L. McCabe, J. C. Smith and P. Harriot, “Unit Operations of Chemical Engineering”, 7th edition, McGraw-Hill, 2017.
2. Chattopadhyay. P., “Unit Operations of Chemical Engineering Vol-1”, Khanna publishers, 2012.

REFERENCE BOOKS:

1. Christie J. Geankoplis., “Transport Processes and Separation Process Principles”, 4th edition, Prentice Hall India Pvt. Ltd., 2003.
2. R. K. Bansal, “A Textbook of Fluid Mechanics and Hydraulic Machines”, Laxmi Publications, 10th edition, 2018.

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22CH204 MECHANICAL UNIT OPERATIONS

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basic knowledge of solid properties.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides knowledge in the basics of unit operations employed in chemical process industries. The objective of this course is to familiarize student on the principles and practices involved in transporting, separating and storing of solids and associated unit operations.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

PROPERTIES OF SOLIDS

Characterization of solid particles, mixed particle size and size analysis, Screen analysis, Pressures in masses of particles, Pressures in bins and silos, Storage and flow problems of solids in bins and silos. Mixers for cohesive and non-cohesive solids, Mixing index- mixing index for blending granular solids, mixing index at zero time; Rate of mixing, Conveying of solids. Energy and power requirements in comminution; Empirical relationships; Size reduction equipment, Industrial Screening equipment; Screen effectiveness.

UNIT-2 **10L+10T+10P=30 Hours**

NUMERICALS ON PROPERTIES OF SOLIDS

Estimation of various diameters of the mixture of particles, Estimation of the effectiveness of a screen for separating the oversize and undersize particles, Determination of mixing index, Calculation of power requirements in size reduction, Estimation of efficiency of a crusher in reducing the particles size, Verification of size reduction laws.

PRACTICES:

- Determination of particle size using screen analysis.
- Determination of the effectiveness of a screen.
- Case studies on verification of size reduction laws using jaw crusher.
- Case studies on verification of size reduction laws using ball mill.
- Case studies on finding efficiency of a roll crusher.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

FILTRATION AND SEPARATION TECHNIQUES

Filtration: Introduction to filtration; Types of filters, Principles of cake filtration, Pressure drop through filter cake.

Separation Techniques: Gravity settling processes, Centrifugal settling processes, Crystallization.

UNIT-2 **8L+8T+8P=24 Hours**

NUMERICELS ON SEPARATION TECHNIQUES

Estimation of Filter medium resistance and Cake resistance in constant pressure filtration, Determination of separating efficiency in separating low density and high density particles using Froth Flotation, Estimation of collection efficiency of high density and low density particles using cyclone separator, Estimation of dehusking efficiency of rubber roll sheller for a given feed.

PRACTICES:

- Case studies in separation techniques for determination of compressibility coefficient using sedimentation process.
- Determination of filter medium resistance and cake resistance using plate and frame filter press.
- Determination of percent recovery of coal from coal-sand mixture using froth flotation cell.
- Determination of the collection efficiency of a cyclone separator.
- Determination of the dehusking efficiency of rubber roll sheller.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic methods of characterization to determine the properties of solid particles.	Apply	1	1, 2, 4
2	Design of various unit operation devices to meet the desired specifications.	Analyze	1, 2	1, 2, 3
3	Investigate the problems encountered during working of equipments related to unit operations.	Analyze	1,2	1, 2, 5, 9
4	Formulate the solution for complex unit operations by using the principles of engineering mathematics.	Evaluate	1, 2	1, 2, 5
5	Conduct experiments of various unit operations for a given industry problem using modern tools.	Evaluate	1, 2	1, 2, 3, 4, 5, 9, 10,12

TEXT BOOKS:

1. McCabe, W. L., Smith J. C. and Peter Harriot, “Unit Operations of Chemical Engineering”, 7th edition, McGraw-Hill, 2005.
2. Foust A. S., Wenzel L. A., Clump C. W., Maus L. and Anderson L. B., “Principles of Unit Operations”, 2nd edition, Wiley, New York, 2004.

REFERENCE BOOK:

1. Perry R. H. and Green D. W., “Chemical Engineer’s Hand book”, 8th edition, McGraw-Hill, New York, 2007.

SKILLS:

- ✓ *Perform cumulative and differential particle size analysis.*
- ✓ *Identify the suitable mixer required for mixing cohesive and non cohesive solids.*
- ✓ *Recognize the required specifications of the size reduction equipment for a given feed.*
- ✓ *Identify the filtration equipment required for a specific application.*
- ✓ *Compare the efficiency of separation equipment.*

Source: https://www.geeksforgeeks.org/best-way-to-start-with-competitive-programming-geeksforgeeks-cp-live-course/

22TP203 ADVANCED CODING COMPETENCY

Hours Per Week :

L	T	P	C
-	-	2	1

PREREQUISITE KNOWLEDGE: Programming in C, Data Structures.

COURSE DESCRIPTION AND OBJECTIVES:

This course helps to understand the impact of the choice of data structures and design strategies to solve the problem in an efficient manner. This course also provides the understanding of advanced graph applications and also throw light in tractable intractable problems.

MODULE-1

UNIT-1 **0L+0T+8P =8 Hours**

STACKS, QUEUES AND SINGLE LINKED LISTS:

PRACTICES:

Problems On Stacks & Queues

- Check if given stack of integers are consecutive or not (could be ascending or descending).
- Find the maximum sum in a sliding window using queues.
- Given a queue of integers, rearrange the elements by interleaving the first half with the second half.
- Given an integer k and a queue of integers, reverse the order of the first k elements of the queue.
- Given a maze in the form of a rectangular matrix filled with O, X or M where O represents an open cell, X represents a blocked cell and M represents landmines, find the shortest distance of every open cell in the maze from its nearest mine.
- For a given parenthesis expression, check whether it is balanced parenthesis or not.
- Reverse a number using stack.
- You are given a string s consisting of lowercase English letters. A duplicate removal consists of choosing two adjacent and equal letters and removing them. We repeatedly make duplicate removals on s until we no longer can.
- Find first Unique character in a string (Queue).
- Implement Tower of Hanoi problem.

Problems On Linked Lists

- Given a random pointer to a random node in a singly linked list, clone the list.
- Given a list rotate the list to the right by k places.
- Remove duplicates from a sorted list.
- Find fractional node in a singly linked list.
- Sort a linked list using constant space complexity.
- Delete a node in start, middle, end of Singly linked list.
- Add a node in start, middle, end of Singly linked list.
- Find whether given single linked list is circular or not.
- Arrange a singly linked list in Descending order.
- Addition of two numbers using Singly Linked List.

UNIT-2 **0L+0T+8P =8 Hours**

DOUBLY LINKED LISTS, CIRCULAR LINKED LISTS:

PRACTICES:

Problems on Double Linked Lists and Circular Linked Lists

- Implement a clockwise rotation of a doubly linked list by N places.
- Count triplets in a sorted doubly linked list whose product is equal to a given value x.
- Find the product of all prime nodes in a doubly linked list.
- Find the count of common nodes in two doubly linked lists.
- Find pairs with given product in a sorted doubly linked list.
- Delete all the even nodes of a circular singly linked list.
- Count nodes in a circular linked list.
- Delete all prime nodes from a circular singly linked list.
- Exchange first and last nodes in a circular linked list.
- Reverse a doubly circular linked list.
- Linear search using a stack of incomplete sub problems.
- 1 2 3 4 5 6 in stack S is push X is pop, SSSSXXSSSXXX.
- Recursively remove all adjacent duplicates.
- Check if a given singly linked list is a palindrome using stack.
- Convert a multilevel singly linked list to a singly linked list.
- Remove duplicates from an unsorted doubly linked list.
- Sort a doubly linked list using insertion sort.
- Check if a doubly linked list of characters is palindrome or not.
- Swap Kth node from beginning with Kth node from end in a Double Linked List.
- Convert a Binary Tree into Double Linked List.

SKILLS:

- ✓ *Experienced to Store data and various types of data to handle.*
- ✓ *Ordering and sorting of data.*
- ✓ *Indexing and Searching of required data from large data sequences.*
- ✓ *Exposed to various characteristics such as Linear or non-linear, Homogeneous or heterogeneous and Static and Dynamic.*

MODULE-2

UNIT-1 **0L+0T+8P =8 Hours**

TREES:

PRACTICES:

Problems on Trees

- Given a sorted doubly linked list, convert it into a balanced BST.
- Given a singly linked list with data in the ascending order, convert it into a height balanced BST.
- Print the leaf to root path for every leaf node in a binary tree.
- Write a function to implement the reversed level order traversal of a binary tree.
- Truncate a given binary tree to remove nodes that lie on a path having sum less than K.
- Find the vertical sum in a given binary tree.
- Delete minimum & Maximum element from a BST.
- Implement Inorder, preorder and postorder tree traversal techniques.
- Print Kth largest element in a BST.
- Implement Zig-Zag tree traversal.

UNIT-2 **0L+0T+8P =8 Hours**

GRAPHS:

PRACTICES:

Problems on Graphs

- Given a directed acyclic graph, determine whether there is a path that visits every vertex exactly once.
- Reverse a directed graph such that each edge from v to w is replaced by an edge from w to v.
- Find the shortest path in a graph that visits each vertex at least once, starting and ending at the same vertex.
- Find the minimum number of throws required to win a snake and ladder game.
- Implement DFS of a Graph.
- Implement BFS of a Graph.
- Detect whether a cycle is present in an undirected graph.
- Detect cycle in a Directed Graph.
- Find Shortest Distance to goal node from root node in a graph.
- Find no. of nodes in Kth level of a Graph.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply various data structures to solve a different algorithm.	Apply	1,2	1
2	Investigate the various data structures to solve a given problem in an efficient manner.	Analyse	1,2	2
3	Design and implement an appropriate hashing function for an application.	Create	1,2	4

TEXT BOOKS:

1. Reema Thareja, “Data Structures Using C”, 2nd Edition, Oxford University Press, 2014.
2. Seymour Lipschutz, “Data Structures with C”, 1st Edition, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, illustrated edition, Computer Science Press, 2006.
2. Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd Edition, CENAGE Learning, 2005.
3. R G Dromey and Pearson, “How to solve it by Computer”, 2nd edition, Impression edition, 1998.

22CT201 ENVIRONMENTAL STUDIES

Image source: Biogas plant at VFSTR

Hours Per Week :

L	T	P	C
1	1	-	1

PREREQUISITE KNOWLEDGE: General awareness regarding environmental problems and importance of environmental protection.

COURSE DESCRIPTION AND OBJECTIVES:

It is a multidisciplinary subject where we deal with different aspects using a holistic approach. It is evolving to be the education for sustainable and ethical development both at a local and global level. It helps to prepare the next generation and to plan appropriate strategies for addressing environmental issues. It identifies and creates solutions that conserve to manage ecosystem and biodiversity and also helps to eliminate pollutants, toxicants to preserve air, water and soil quality. Environmental education recognizes impacts of global issues, enhances the public awareness and helps to take decisions towards environmentally responsible actions.

MODULE-1

UNIT-1 **4L+4T+0P=8 Hours**

INTRODUCTION TO ENVIRONMENT: NATURAL RESOURCES, ECOSYSTEMS AND BIODIVERSITY:

Environment and sustainable development; Natural resources- forest, water, energy and land resources; Ecosystem – basic structural components, function and interactions in ecosystem, ecological succession.

UNIT-2 **4L+4T+0P=8 Hours**

BIODIVERSITY AND CONSERVATION:

Introduction to biodiversity, types of biodiversity- species, genetic and ecosystem diversity; Threats to biodiversity - natural and anthropogenic, species extinctions, man wildlife conflicts; Biodiversity conservation - principles and strategies; in-situ and ex-situ conservation.

PRACTICES:

- Visit to a Biogas plant, Solar Power plant.
- Visit to a local area to document environmental assets – river / pond / lake / forest / grassland / hill / mountain.
- Set up an aquarium.
- Case study: Renewable energy use.

MODULE-2

UNIT-1 **4L+4T+0P=8 Hours**

ENVIRONMENTAL POLLUTION AND CLIMATE CHANGE:

Air, water, soil, radioactive and noise pollution; Study of different pollutants (SOx, NOx, PAN, PAH etc.); Toxicity study; Climate change - greenhouse effect, acid rain, ozone layer depletion.

UNIT-2 **4L+4T+0P=8 Hours**

POLLUTION CONTROL DEVICES AND WASTE WATER TREATMENT TECHNOLOGIES:

Air pollution control devices - Gravitational settling chambers, cyclonic separators, electrostatic precipitators, fabric filters and bio filters, Wastewater management.

SKILLS:

- ✓ *Create a bio-diversity map of any habitat/ ecosystem.*
- ✓ *Strategize different ways of using renewable energy resources.*
- ✓ *Design novel strategies and approaches for pollution control and waste management.*

PRACTICES:

- Visit to a sewage treatment plant and waste-water analysis.
- Case study: Recycling Technologies.
- Case study: Effects of contaminants on microorganisms.
- Report writing: 12 principles of green chemistry for environmental sustainability.
- Report writing: Environmental Impact Analysis, Local Disaster Management Plan.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic concepts of sustainable development, natural resource utilization and ecology for the purpose of environmental protection	Apply	1	1,6,7, 9, 10, 11, 12
2	Design remediation technologies for their abatement	Apply	2	1, 3,6,7, 9, 10, 11, 12
3	Analyze the biodiversity of different ecosystems and formulate various conservation approaches	Analyze	1	1, 7, 8, 9, 10, 11, 12
4	Analyze the presence of various environmental pollutants	Analyze	2	1, 6,7,9, 10, 11, 12
5	Recommend various waste management approaches and their implementation strategies	Evaluate	2	1,2, 7,8,9,10,11, 12

TEXT BOOK:

1. A. Kaushik and C. P. Kaushik, “Perspectives in Environmental Studies”, New Age International Publishers, 5th Edition, 2016.
2. Y. Anjaneyulu, “Introduction to Environmental Science”, B. S. Publications, 2015.

REFERENCE BOOKS:

1. B. Joseph, “Environmental Studies”, Mc Graw Hill Education, 2nd Edition, 2015.
2. S. Subash Chandra, “Environmental Science”, New Central Book Agency, 2011.
3. M. Basu and S. Xavier, “Fundamentals of Environmental Studies”, Cambridge University Press, 2016.
4. K. Mukkanti, “A Textbook of Environmental Studies”, S. Chand Company Ltd., 2009.
5. M. Anji Reddy, “A Textbook of Environmental Science and Technology”, B. S. Publications, 2008.

22MS201 MANAGEMENT SCIENCE

Image Source: https://xueqi326.wordpress.com/semester-3/management-science/

Hours Per Week :

L	T	P	C
2	2	-	3

PRE-REQUISITE KNOWLEDGE: Basic knowledge of management

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to analyze the importance of management, significance of operation management and carry out production operations through work-study. Students will be able to analyse the markets, customers, competitors, and then plan HR function effectively. These management practices, functional areas of the organisation will helps the students to build up their career in the corporate world.

MODULE- 1

UNIT- 1 **6L+6T+0P =12 Hours**

INTRODUCTION TO MANAGEMENT:

Concepts of Management and organization- nature, importance and Functions of Management, Systems approach to Management - Taylor's Scientific Management Theory, Fayol's Principles of Management, Mayo's Hawthorne Experiments, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Leadership Styles, Social responsibilities of Management.

UNIT- 2 **10L+10T+0P =20 Hours**

OPERATIONS MANAGEMENT:

Principles and Types of Plant Layout-Methods of production (Job, batch and Mass Production), Work Study -Basic procedure involved in Method Study and Work Measurement, Objectives, Need for Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Stores Records. Statistical Quality Control: control charts for variables and attributes (simple problems).

PRACTICES:

- Collect some examples with videos for types of production.
- Carry out production operations through work-study.
- Practice problems with Inventory control methods and Quality Control charts.

MODULE- 2

UNIT- 1 **8L+8T+ 0P =16 Hours**

HUMAN RESOURCES MANAGEMENT:

Concepts of Human Resource Management, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Placement, Wage and Salary Administration, Promotion, Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation, and Merit Rating.

UNIT- 2 **8L+8T+0P =16 Hours**

MARKETING MANAGEMENT:

Evolution of Marketing, Functions of Marketing Selling Vs Marketing, 4 P's of Marketing – Product Mix - Product Life Cycle – Place Mix – Channels of Distribution – Price Mix – Pricing Methods – Promotion Mix – Tools of Promotions.

SKILLS:

- ✓ *Expert in managerial skills.*
- ✓ *Maintain social relations.*
- ✓ *Evaluate pricing strategies.*

PRACTICES:

- Select any Designation in an organization and try to describe its job description and job specifications.
- How do you deal with grievances at your work.
- Analyze marketing mix in various situations.

COURSE OUTCOMES:

Upon successful completion of this course, students will have to ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Carry out production operations through work-study	Apply	1, 2	1, 2, 3, 5
2	Analyze the nature and importance of management	Analyze	1	1,2,4,6
3	Significance of Operations Management.	Analyze	1, 2	1,2,5
4	Analyze the markets, customers, and competition	Analyze	2	1,2,4,5,6
5	Plan and control the HR function effectively	Evaluate	1, 2	1,2,3,4,5,6

TEXT BOOKS:

1. Rajan Saxena: “Marketing Management”, 4th Edition, TMH, 2013.
2. Dilip Kumar Battacharya, “Principles of Management”, Pearson, 2012.

REFERENCES :

1. Philip Kotler, Kevin Lane Keller, Abraham Koshy and Mithleshwar Jha: “Marketing Management”, 13th Edition, Pearson Education, 2012.
2. Dipak Kumar Bhattacharyya, “Production and Operations Management”, Universities Press, 2012.
3. Gary Dessler, “Human Resource Management”, 12th Edition, Pearson- 2012.
4. K.Aswathappa, “Human Resource Management”, Text and Cases, TMH, 2011.
5. Harold Koontz, Heinz Weihrich, A.R. Aryasri, “Principles of Management”, TMH, 2010.

22TP204 PROFESSIONAL COMMUNICATION LABORATORY

Source: https://www.coursera.org/specializations/improve-english

Hours Per Week :

L	T	P	C
-	-	2	1

PREREQUISITE KNOWLEDGE: High School-level English.

COURSE DESCRIPTION AND OBJECTIVES:

To improve the overall professional communication skills (LSRW) of students and prepare them for their profession as engineers and managers. To provide them exposure to conventions of corporate communication and training them on how to function in the business world.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

BASICS OF BUSINESS WRITING SKILLS, PRACTICING BUSINESS CORRESPONDENCE AND REPORT WRITING:

Business English Vocabulary: Glossary of most commonly used words (formal and informal usage).

Elements of Technical Writing: Sentence structure, reducing verbosity, arranging ideas logically, building coherence, cohesive devices and transitional words.

Mechanics of Writing: Elementary rules of grammar, choice of diction, elementary principles of composition, matters of form, punctuation, conventions of business communication, language and professional tone, code of conduct (not sending illegal, offensive, disparaging personal remarks or comments) in written business communication.

Business Correspondence: E-mail: nature and scope, e-mail etiquette, clear call for action, common errors in composing e-mails, office communication such as meeting agenda and notice, circular and memo.

Letter-Writing: Formal and informal letters, structure of formal letters, expressions of salutations, different types of letters [such as sales letter, complaint letter, response to the complaint letter (dispute resolution), letter of permission, letter of enquiring, claim letter – letter of apology etc], introductory and concluding paragraphs and clear call for action.

Professional Proposal/Report: Differentiating proposals and reports, Drafting formal business proposals, types of reports such as factual reports, feasibility reports and survey reports, parts of a report (such as title page, declaration, acknowledgements, table of contents, abstract, introduction, findings, conclusion and recommendations).

New Age Corporate Communication Media: Importance of social media communication and Etiquettes, form and structure, sharing texts through Twitter, Whatsapp, instgram etc.

UNIT-2 **0L+0T+8P=8 Hours**

PRACTICING COMMUNICATIVE LANGUAGE IN VARIOUS PROFESSIONAL CONTEXTS:

Speaking: Speaking in business context, assertiveness, politeness, making requests, queries and questions, negotiations, asking for information, offering suggestions, conflict resolution, contacting clients, initiating, addressing delegates (in public), delivering the presentation effectively, telephone etiquettes, delivering seminar/proposal/report effectively, team meeting etiquettes (face to face and conference call), making effective one minute presentations(JAM) and participating in Group Discussions.

PRACTICES:

- Basic grammar practice, framing paragraphs on topics allocated, paraphrasing an article or a video in your own words, finding topic sentences in newspaper articles, finding out new words from a professional viewpoint and understanding the meaning and its usage.

SKILLS:

- ✓ *To enhance listening and spoken abilities of students needed for professional and social success in interpersonal situations, group interactions, and personal and professional presentations.*
- ✓ *Understand and practice specific functions and vocabulary in a business context.*
- ✓ *Produce short business reports, proposals and correspondence.*
- ✓ *Write various business documents through reading techniques.*

- Perusing samples of well-prepared business emails, memo, letter writing and short proposals and reports, students will draft business correspondence writing tasks and different proposals/ reports on topics assigned.
- Watching videos/listening to audios of business presentations, classroom activities of team and individual presentations, using PPTs, mock exercises for BEC speaking, agreeing, disagreeing politely, developing content, extended speaking in Group Discussion(s).

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

READING AND COMPREHENDING BUSINESS DOCUMENTS:

Reading: Reading and comprehending business documents, learning business register, regularizing the habit of reading business news, suitable vocabulary, skimming and scanning a text for effective and speedy reading and dealing with ideas from different sectors of corporate world in different business contexts.

UNIT-2 **0L+0T+8P=8 Hours**

IMPARTING AND PRACTICING LISTENING SKILLS:

Listening: Specific information in business context, listening to telephonic conversations / messages and understanding the correct intended meaning, understanding the questions asked in interviews or in professional settings, summarizing speaker's opinion or suggestion, enable active listening.

PRACTICES:

- Hand-outs; matching the statements with texts, finding missing appropriate sentence in the text from multiple choices, using right vocabulary as per the given context and editing a paragraph.
- Working out BEC/TOEFL/IELTS listening exercises with hand-outs; matching the statements with texts, finding missing appropriate sentence in the text from multiple choice- multiple choices, using right vocabulary in context-editing a paragraph, listening to a long conversation such as an interview and answer MCQ s based upon listening.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Possess comprehensive skills in listening and reading business texts in formal context.	Apply	2	7
2	Communicate effectively both in their academic as well as professional environment.	Apply	2 &1	10
3	Clear grasp on the register of business language.	Analyze	1	8
4	Possess the ability to write business reports and proposals clearly and precisely to succeed in their future.	Create	1	12
5	Make effective presentations and participate in formal context.	Create	2	10

TEXT BOOK:

1. S. Schnurr, "Exploring Professional Communication: Language in Action", London: Routledge, 2013

REFERENCE BOOKS:

1. Brook Hart Guy, "Cambridge English Business Bench Mark: Upper Intermediate", 2nd Edition: CUP, 2014.
2. Cambridge University Publication, "Cambridge: BEC VANTAGE Practice Papers", CUP, 2002.
3. J. Seely, "The Oxford Guide to Effective Writing and Speaking", Oxford University Press, 2005.

22CH205 CHEMICAL ENGINEERING THERMODYNAMICS-II

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Concept of Chemical Engineering Thermodynamics-I.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the theory and applications of solution thermodynamics. The objective of this course is to familiarize students with solution thermodynamics, thermodynamic properties, phase equilibria and methods used to describe and predict the vapor-liquid equilibrium and chemical reaction equilibrium.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

SOLUTION THERMODYNAMICS

Maxwell relations; Fundamental property relation; Chemical potential; Partial molar properties; Ideal gas mixtures; Fugacity and fugacity coefficient- pure species, species in solution; Generalized correlations; Ideal solution; Excess properties; Models for excess Gibbs free energy- Van Laar equations, Margules equations, NRTL model, UNIFAC and UNIQUAC models; Property changes of mixing.

UNIT-2 **8L+8T+0P=16 Hours**

SOLUTION THERMODYNAMICS APPLICATIONS

Liquid phase properties from VLE data; Fugacity and fugacity coefficients for pure species and in a solution; Model parameters of excess Gibbs free energy model.

MODULE-2

UNIT-1 **8L+8T+0P=16 Hours**

PHASE AND REACTION EQUILIBRIUM

Nature of equilibrium; Phase rule; Duhems theorem; Bubble and dew point; VLE qualitative behavior; Models for VLE- Raoult's law, Henry's law, modified Raoults law; Liquid-Liquid equilibria; Vapor-Liquid-Liquid equilibria; Solid-Liquid equilibria; Solid-Vapor equilibria; Reaction coordinate; Equilibrium criterion; Standard Gibbs free energy change and equilibrium constant; Effect of temperature on equilibrium constant; Phase rule for reacting systems; Multi reaction equilibria.

UNIT-2 **8L+8T+0P=16 Hours**

VLE CALCULATIONS

Bubble point and dew point: P-xy, T-xy diagram, Enthalpy and Gibbs free energy change; Equilibrium constant and equilibrium composition.

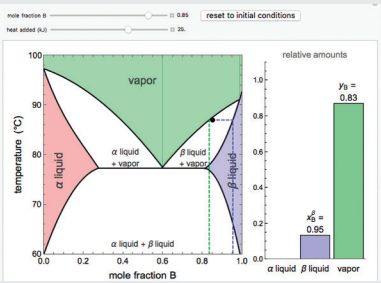


Image source: https://demonstrations.wolfram.com/Vapor-LiquidLiquidEquilibriumVLLE/img/popup_3.png

SKILLS:

- ✓ *Estimation of solution thermodynamic properties.*
- ✓ *Modelling of vapor liquid equilibrium.*
- ✓ *Estimation of equilibrium conversions.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply knowledge of phase equilibria in two-component and multi-component systems.	Apply	2	2
2	Estimate the equilibrium conversions for different chemical reactions.	Apply	2	3
3	Evaluate thermodynamic properties of substances in gas or liquid state of ideal and real mixture.	Evaluate	1	3
4	Analyze bubble and dew point calculations for ideal and non-ideal solutions using VLE data.	Analyze	2	2
5	Estimate the vapor liquid equilibria.	Analyze	2	3,4

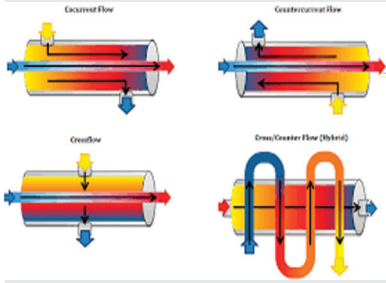
TEXT BOOKS:

1. J. M. Smith, H.C. Van Ness and M. M. Abbott, “Introduction to Chemical Engineering Thermodynamics”, 6th edition, Tata McGraw-Hill, 2005.

REFERENCE BOOKS:

1. Dodge B. F., “Chemical Engineering Thermodynamics”, 1st edition, Tata McGraw-Hill, 1960.
2. Sandler S. I., “Chemical and Engineering Thermodynamics”, 4th edition, John Wiley & Sons, 2006.
3. Kyle B. G., “Chemical and Process Thermodynamics”, 2nd edition, Prentice Hall of India,1990.

22CH206 PROCESS HEAT TRANSFER



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of differentiation, integration.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the phenomena of heat transfer. The objective of this course is to provide theoretical and practical knowledge in various modes of heat transfer and its application for designing of process equipment.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

MODES OF HEAT TRANSFER

Heat transfer by conduction: Modes of heat transfer- conduction, convection, radiation; Conduction- Fourier's law, concept of electrical analogy; thermal resistance; thermal contact resistance; Thermal conductivity; Specific heat capacity.

Heat transfer by convection: Principles of heat flow in fluids; Individual heat transfer coefficients; Overall heat transfer coefficient; Thermal boundary layer; Dimensional analysis- Buckinghum pi theorem; significance of dimensionless groups; Forced convection: heat transfer in laminar flow, heat transfer in turbulent flow, analogy between transfer of momentum and heat, Reynolds analogy, Colburn analogy; Natural convection- heat transfer by natural convection from vertical and horizontal shapes.

Heat transfer by radiation: Radiation; Emissivity; Absorptivity; Transmissivity; Laws of black body and grey body radiation; Radiation between black surfaces; Radiation between grey surfaces; Shape factors.

UNIT-2 **10L+10T+10P=30 Hours**

APPLICATIONS OF DIFFERENT MODES OF HEAT TRANSFER

Estimation of steady state heat flow through composite slab/cylindrical wall/spherical wall; Dimensional analysis of forced and natural convection; Correlations for natural and forced convection; Estimation of heat transfer coefficient in natural and forced convection.

Estimation of rate of heat transfer with conduction and convection; Radiation between black and non-black surfaces.

PRACTICES:

- Steady state conduction through constant area.
- One dimensional heat flow through slab/cylinder/sphere.
- Determination of thermal conductivity of insulating powder.
- Determination of thermal conductivity of metal rod.
- Heat flow through composite wall/cylinder and sphere.
- Determination of overall resistance in composite wall.
- dimensionless groups in natural and forced convection.
- Estimation of heat transfer coefficient in forced convection.
- Estimation of natural convection heat transfer coefficient.
- Determination of overall heat transfer coefficient of a given coil.
- Verification of Stefan-Boltzmann's law of radiation.
- Estimation of emissivity of a test plate.
- Combined heat transfers by conduction; Convection and radiation.

SKILLS:

- ✓ *Estimate the rate of heat flow.*
- ✓ *Calculate the insulation thickness for a specified heat loss target.*
- ✓ *Determine heat transfer coefficient in simple geometries for forced and natural convection.*
- ✓ *Estimate area of heat exchanger required for specified conditions.*
- ✓ *Design of heat exchanger.*
- ✓ *Determine the emissivity of a given body.*

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

HEAT EXCHANGE EQUIPMENT AND ITS APPLICATIONS

Heat Exchanger: Classification heat exchangers; Double pipe heat exchanger; Shell and tube heat exchanger; Plate type heat exchanger; Energy balance in heat exchangers; LMTD; General design of heat exchanger.

Heat transfer with phase change: Types of boiling; Pool boiling of saturated liquid; Heat transfer coefficient in dropwise and film type condensation; Evaporators- falling film, climbing film, forced circulation and agitated film type evaporators; Economy and capacity of evaporator; Multiple effect evaporator; Methods of feeding; Boilers – fire tube and water tube boilers with examples; Condensers.

UNIT-2 **8L+8T+8P=24 Hours**

DESIGN OF HEAT EXCHANGE EQUIPMENT

Design of double pipe of heat exchanger; Design of shell and tube heat exchanger; Material and energy balance of evaporator; Design of evaporator.

PRACTICES:

- Determination of heat transfer coefficient in double pipe heat exchanger.
- Determination of heat transfer coefficient in shell and tube heat exchanger.
- Determination of critical heat flux.
- Design of double pipe heat exchanger.
- Design of shell and tube heat exchanger.
- Design of Evaporator.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Estimate the heat transfer coefficient.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyse the performance of a heat exchanger.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate critical radius of insulation for any given system.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Estimate the rate of heat transfer.	Evaluate	1, 2	1, 2, 3, 4, 5, 9, 10, 12
5	Design heat exchange equipment.	Create	2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. W. L. McCabe, J. C. Smith and P. Harriot. “Unit Operations of Chemical Engineering’, 7th edition, McGraw-Hill, Inc., 2005.
2. D.Q. Kern, “Process Heat Transfer”, 2nd Edition, : McGraw-Hill Inc. 2019.

REFERENCE BOOKS:

1. J. P. Holman, S. Bhattacharyya, “Heat Transfer”, 10th edition, McGraw-Hill, Inc., 2017.
2. R. K. Rajput, “Heat and Mass Transfer”, 7th edition, S. Chand, 2020.
3. B. K. Dutta, “Heat Transfer: Principles and Applications”- Prentice Hall India Learning Private Limited; 1st edition 2000.
4. C. J. Geankoplis, “Transport Processes and Unit Operations”, 3rd edition, PHI, 2003.

III YEAR

B.Tech.

CHEMICAL ENGINEERING

COURSE CONTENTS

I SEM & II SEM

I SEMESTER

22TP301	-	Soft Skills Laboratory
22CH301	-	Chemical Reaction Engineering - I
22CH302	-	Mass Transfer Operations - I
22CH303	-	Process Dynamics and Control
	-	Department Elective – 2
	-	Open Elective – 2
22CH304	-	Inter-Disciplinary Project- Phase I
	-	NCC/ NSS/ SAC/ E-cell/ Student Mentoring/ Social activities/ Publication.
		Minor / Honors – 2

II SEMESTER

22TP302	-	Quantitative Aptitude and Logical Reasoning
22CH305	-	Chemical Reaction Engineering - II
22CH306	-	Mass Transfer Operations - II
	-	Department Elective – 3
	-	Department Elective – 4
	-	Open Elective – 3
22CH307	-	Inter-Disciplinary Project- Phase II
	-	Minor / Honors – 3

22TP301 SOFT SKILLS LABORATORY

Source: https://choosework.ssa.gov/blog/2019-07-23-soft-skills-an-intro-to-effective-communication

Hours Per Week :

L	T	P	C
-	-	2	1

PREREQUISITE KNOWLEDGE: Grasp on their own academic achievements.

COURSE DESCRIPTION AND OBJECTIVES:

To impart employability skills like resume preparation and facing interviews. To enable trainees to develop interpersonal and leadership skills and to train them on work place skills like making presentations, participating in group discussions etc.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

PERSONALITY DEVELOPMENT:

Soft Skills: Need for soft skills, professionalism, employability skills; Communication: Need for effective communication - the process of communication, levels of communication, flow of communication, choice of diction and style with reference to setting (formal, semi-formal or informal); communication networks, barriers to communication, miscommunication, noise and ways to overcome the barriers; Career Planning: Job vs. career, SWOT analysis.

UNIT-2 **0L+0T+8P=8 Hours**

LANGUAGE AND VOCABULARY:

Vocabulary Building: Word etymology, roots, prefixes & suffixes, synonyms & antonyms, collocations, one-word substitutes, analogies, idioms and phrases, contextual guessing of unfamiliar words, task-oriented learning; Reflection of language on Personality, Gender sensitive language in MNCs, Mind your language, Seven essential skills for a team player; attentive listening, intelligent questioning, gently persuading, respecting other's views, assisting others, sharing, participating actively.

PRACTICES:

- Self-Introduction.
- Personal and Academic SWOC.
- Johari Window.
- Giving and taking opinions of Self Vs others and assessing oneself.
- Goal setting.
- Short, Mid and Long Term goals planning the semester.
- Time management: four quadrant system.
- Stephen Covey Time Management Matrix planning a semester.
- Stress-management.
- Questionnaire to assess level of stress.
- 50 words towards resume preparation and interviews.
- Newly coined words.
- Gender sensitive words and Words acceptable in Indian context and objectionable international context.

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

LANGUAGE IN ACTION:

Functional English: Situational dialogues, Role plays (including small talk); Group Discussion: Articulation and flow of oral presentation, dynamics of group discussion, intervention, summarizing and conclusion, voice modulation, content generation, Key Word Approach (KWA), Social, Political, Economic, Legal

SKILLS:

- ✓ *Balance social and emotional intelligence quotients though SWOC, JOHARI etc. activities.*
- ✓ *Prepare tailor made resume and face various job interviews with enriched personality traits.*
- ✓ *Career planning with clear personal and professional goals.*
- ✓ *Solve personal and professional life hiccups with confidence and maturity.*

and Technical Approach (SPELT), View Point of Affected Part (VAP), language relevance, fluency and coherence – 11th and 12th weeks; Resume preparation: Structure and presentation, defining career objective, projecting one's strengths and skill-sets, summarizing, formats and styles and covering letter-Statement of Purpose.

UNIT-2 **0L+0T+8P=8 Hours**

PREPARING FOR PRESENTATIONS AND INTERVIEWS:

Facing Interviews: Interview process, understanding employer expectations, pre-interview planning, opening strategies, impressive self-introduction, answering strategies, other critical aspects such as body language, grooming, other types of interviews such as stress-based interviews, tele- interviews, video interviews, frequently asked questions (FAQs) including behavioral and HR questions and the aspect looked at by corporate during interviews; Presentation Skills: Selection of a topic, preparing an abstract, gathering information, organizing the information, drafting the paper, citing reference sources – writing striking introductions, discussing the methodology used, developing the argument, presentation style, language, presenting the paper and spontaneously answering audience questions.

PRACTICES:

- Opening and closing a telephonic conversation.
- Making an appointment.
- Making a query.
- Offering/Passing on information.
- Communicating with superiors.
- Expressing agreement/objection.
- Opening bank account (combination of prepared and impromptu situations given to each student).
- Group Discussions on various topics.
- Preparing SoP and Resume.
- Mock interviews on the FAQs including feedback.
- Oral presentation with the help of technology (Preparing PPT and presenting).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Have the ability to introspect on individual strengths and weaknesses, and emerge as a balanced personality with improved self-awareness and self-worth .	Apply	1	12
2	Observe gender sensitive language and workplace etiquette in his professional life.	Analyze	1	9
3	Be able to prepare a resume and gain the confidence to face an interview.	Create	1&2	10
4	Possess the interpersonal skills to conduct himself/herself effectively in everyday professional and social contexts.	Apply	2	8
5	Bring professionalism into his/her daily activities.	Create	2	8

TEXT BOOKS:

1. Adrian Furnham, "Personality and intelligence at work", Psychology Press, 2008.
2. S. P. Dhanvel, "English and Soft skills", Orient Blackswan, 2011.

REFERENCE BOOKS:

1. Edward Holffman, "Ace the corporate personality", McGraw Hill, 2001.
2. John Adair Kegan Page, "Leadership for innovation", Kogan, 2007.
3. Krishna Mohan & NP Singh, "Speaking English effectively", Macmillan, 2008.
4. Rajiv K. Mishra, "Personality Development", Rupa & Co. 2004.

22CH301 CHEMICAL REACTION ENGINEERING-I

Hours Per Week :

L	T	P	C
2	2	2	4

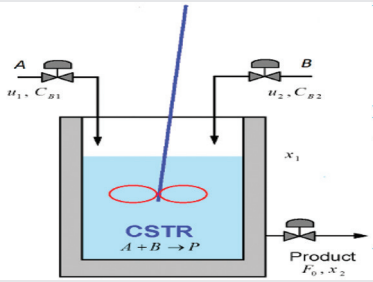


Image source : https://www.researchgate.net/profile/Farhad-Bayat2/publication/282999223/figure/fig1/ AS:315582563012608@1452252154658/Schematic-diagram-of-the-CSTR-process.png

PREREQUISITE KNOWLEDGE: Basics of integration, differentiation, algebra and plotting graph.

COURSE DESCRIPTION AND OBJECTIVES:

This course encompasses methodologies to design chemical reactors and also to solve related problems in process industries. The objective of this course is to train students to apply knowledge from calculus, differential equations, thermodynamics, chemistry and process calculations for designing chemical reactors.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

KINETICS OF HOMOGENEOUS REACTIONS & REACTORS

Basic definitions; Rate of reaction; Dependency of rate of reaction on concentration and temperature; Batch Reactor – constant volume reactor, variable volume reactor; Analysis of batch reactor data – integral analysis, differential analysis; Performance equation of ideal reactors- batch reactor, steady state mixed flow reactors, steady state plug flow reactor.

UNIT-2 **10L+10T+10P=30 Hours**

BATCH REACTOR KINETICS

Activation energy from different models; Application of integral method – zero order, first order, second order reactions and variable volume reactions; Reaction kinetics by applying differential and integral method for batch reactor data; Design and performance of batch reactor, plug flow reactor, mixed flow reactor.

PRACTICES:

- Determination of kinetics from the batch reactor data (activation energy and order of reaction).
- Determination of kinetics from the mixed flow reactor data.
- Determination of kinetics from the plug flow reactor data.
- Design of batch reactor.
- Design of mixed flow reactor.
- Design of plug flow reactor.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

IDEAL REACTORS FOR COMPLEX REACTIONS

Basic definitions of complex reactions; Contact patterns to optimize the product for series and parallel reactions; Quantitative treatment of product distribution and reactor size; Optimizing the productivity of desired product for irreversible reactions in series; Non idealities in ideal reactors; Importance of residence time distribution studies; Different input methods of tracer- E, F, C curves; RTD curves from experimental data; RTD curves for Ideal CSTR & PFR; RTD information; Macro fluid; Micro fluid; Tanks in series model; Axial dispersion model.

SKILLS:

- ✓ *Develop the rate laws of reaction.*
- ✓ *Carry out the experiments to obtain the kinetic data.*
- ✓ *Estimate the temperature and concentration dependency of rate of reaction.*
- ✓ *Identification best reactor and sizing of the reactor for the given reaction.*
- ✓ *Optimizing the selectivity in case of multiple reactions.*
- ✓ *Identify the non-idealities of reactor and modelling the reactor.*

UNIT-2 **8L+8T+8P=24 Hours**

PARALLEL AND SERIES REACTIONS

Design of reactor for parallel and series reactions; Modelling of real reactor (estimation of nonidealities); Conversion by using macro and micro fluid model; Conversion by using axial dispersion model and tanks in series model.

PRACTICES:

- Simulation of product distribution in series reactions.
- Simulation of product distribution in parallel reactions.
- Modelling and simulation of tubular reactor.
- Modelling and simulation of mixed flow reactor.
- Modelling and simulation of packed bed reactor.
- Modelling and simulation of fluidized bed reactor.

COURSE OUTCOMES:

Upon successful completion of this course, students will have to ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply rate laws for homogeneous reactions.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze kinetic data to estimate the kinetic parameters.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluating experimental reaction rate for kinetic studies.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design ideal reactors to meet the desired conversion and right contact pattern for multiple reactions.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of model of the ideal reactors and estimate conversion of ideal reactors.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. O. Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons, 2016.
2. Fogler H. S., “Elements of Chemical Reaction Engineering”, 6th edition, Pearson, 2020.

REFERENCE BOOK:

1. Smith J. M., “Chemical Engineering Kinetics”, 3rd edition, McGraw-Hill, 2014.

22CH302 MASS TRANSFER OPERATIONS-I

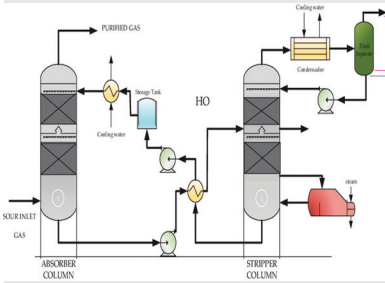


Image source : https://www.intechopen.com/media/chapter/57510/media/F1.png

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of integration, differentiation, and plotting graph.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals with mass transfer phenomena and its usage for engineering application. The general objectives of this course are to discuss the fundamental concepts of mass transfer principles such as diffusion phenomena, absorption, stripping, humidification, drying and design of various mass transfer equipments and to apply those concepts towards real problems in process industry.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

DIFFUSION AND INTERPHASE MASS TRANSFER

Diffusion and Mass Transfer: Mass transfer operations; Molecular diffusion in fluids; Fick's Law; Steady state equimolar counter current diffusion; Diffusion in fluids and solids; Mass transfer coefficients in laminar and turbulent flow; Mass transfer from falling film; Theories of mass transfer; Dimensionless groups in mass transfer; Mass transfer coefficients in wetted wall column.

Interphase Mass Transfer: Concept of equilibrium; Diffusion between phases; Material balance in- steady state, co–current and counter current stage processes; Intro: Sparged vessels, Agitated vessels, Venturi scrubbers; Sieve tray design for absorption tray tower verses packed tower; Loading and flooding in a packed column.

UNIT-2 **10L+10T+10P=30 Hours**

GAS – LIQUID CONTACT EQUIPMENT

Design consideration of sieve tray absorption tower and packed column for gas-liquid contacting; Recent advancement of packing materials for packed column operation; Application of interphase mass transfer in Drug delivery systems.

PRACTICES:

- Estimation of diffusivity in gas phase.
- Estimation of diffusivity in liquid phase.
- Determination of hydrodynamic characteristics of a packed column.
- Estimation of overall mass transfer coefficient for a gas –liquid contacting equipment.
- Determination of mass transfer coefficient for absorption of CO_2 in NaOH solution in a wetted wall column.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

ABSORPTION, HUMIDIFICATION & DRYING

Absorption and Stripping: Counter and co–current absorption; Isothermal absorption and stripping of single component; Operating lines; Minimum flow rate; Determination of number of transfer units and height of continuous absorber; Absorption factor; Kremser-Brown equations.

Humidification: Introduction; Vapor pressure curve; Definitions; Psychometric charts; Enthalpy of vapor gas mixtures; Humidification and dehumidification; Cooling towers.

SKILLS:

- ✓ *Estimation of diffusion coefficients for binary and ternary mixture.*
- ✓ *Design of various mass transfer equipment.*
- ✓ *Estimate the correlation of mass transfer coefficients in packed and fluidized bed absorption column.*
- ✓ *Parametric calculation of cooling tower.*
- ✓ *Design calculation of rotary dryer.*

Drying: Introduction; Definitions of various moisture contents; Drying conditions; Rate of batch drying under constant drying conditions; Mechanism of batch drying; Drying time through circulation drying; Batch and continuous drying.

UNIT-2 **8L+8T+8P=24 Hours**

APPLICATIONS OF ABSORPTION, HUMIDIFICATION AND DRYING

Application of several industrial gas absorption process; Application of psychrometric chart; Design calculation and application of forced draft and induced draft cooling tower; Importance of vapour pressure curve in gas cooling and water cooling operation; Design approach and operating principles of spray dryer; Determination of drying time through cross-circulation drying operation; Application of drying operation in food industry; Application of drying in pharmaceutical industry.

PRACTICES:

- Determination of overall mass transfer coefficient for absorption of CO_2 in aqueous MDEA solution in packed Column.
- Determination of HTU and NTU in a packed absorber.
- Absorption by Tray column using MATLAB software.
- Determination of no of ideal stage for counter current absorber and stripper.
- Estimation of overall tray efficiency for a given tray absorber.
- Determination of batch drying characteristics using tray dryer.
- Determination of batch drying characteristics using vacuum dryer.
- Estimation of drying characteristics curve under constant drying condition in rotary dryer.
- Design of absorption column.
- Design of dryer.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concept of various mass transfer operations and principle intended for a prototype or pilot plant setup for mass transfer.	Apply	1, 2	1, 2, 3, 5, 9, 10
2	Analyze the diffusion coefficients for binary and ternary mixture.	Analyze	1	1, 2, 4, 5, 9, 10, 12
3	Evaluate the equilibrium data of absorption and desorption process.	Evaluate	2	1, 2, 5, 9, 10, 12
4	Design of various packed and tray absorption column.	Create	1	1, 2,3, 5, 9, 10
5	Create model development of rotary dryer and various cooling tower.	Creative	2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Treybal R. E., “Mass Transfer Operations”, 3rd edition, McGraw-Hill, 2005.
2. Binay. K. Dutta, “Principles of Mass Transfer and Separation Processes”, 2nd edition, Prentice Hall of India, New Delhi, 2012.

REFERENCE BOOKS:

1. Christie J. Geankoplis., “Transport Processes and Separation Process Principles”, 4th edition, Prentice Hall India Pvt. Ltd., 2003.
2. Judson King C., “Separation Processes”, 2nd edition, McGraw-Hill, 2005.
3. Seader J. D., Henley E. J. and Keith Roper D., “Seperation Process Principles – Chemical and Biochemical Operations” 3rd edition, John Wiley & Sons, Inc, 2011.

22CH303 PROCESS DYNAMICS AND CONTROL

Hours Per Week :

L	T	P	C
2	2	2	4

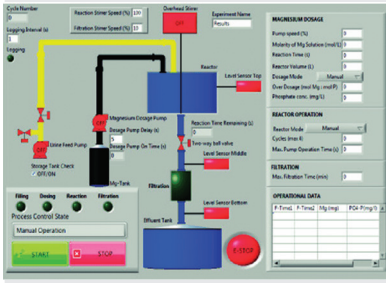


Image source : https://www.researchgate.net/profile/ChristopherBuckley/publication/281689647/figure/fig3/AS:667814922842115@1536230893148/Software-panel-for-reactor-control-programmed-in-LabView.png

PREREQUISITE KNOWLEDGE: Basics of integration, differentiation and laplace transformations.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamental concepts in process control and its industrial application. The objective of this course is to provide knowledge on various control mechanisms and strategies used in chemical process industries.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

FIRST ORDER SYSTEM, ADVANCED CONTROL STRATEGIES AND CONTROL VALVE CHARACTERISTICS

First Order Systems: Response of first-order systems, Physical examples of first-order systems, Response of first-order systems in series. Higher-order systems, Second-order systems and transportation lag.

Control System: Control System, Components of control system; Block diagram of control system; Controllers and final control elements, Closed-loop transfer functions.

UNIT-2 **10L+10T+10P=30 Hours**

DEVELOPMENT OF TRANSFER FUNCTION FOR VARIOUS SYSTEMS

Transfer function of the various chemical processes; Estimation of system parameters; Study of transient response of control system; Development of block diagram of the various chemical processes.

PRACTICES:

- Estimation of system parameters form the response of various input functions.
- Study of transient of interacting and non-interaction system.
- Study the Response of first-order systems in series.
- Study on effect of controller parameters in controlling of various processes such as level, flow and pressure control.
- Simulation of first and higher order systems.
- Simulation of transient response of control system.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

CONTROL SYSTEM DESIGN AND STABILITY

Stability Criteria: Stability, Routh array, Root locus, Frequency response, Bode diagrams. Advanced control strategies- Cascade control, Feed Forward control, Ratio control, Smith predictor, Dead-time compensation, Internal mode control. Controller tuning, Process Identification, Different types of control valves and their characteristics.

SKILLS:

- ✓ *Solve ODE using laplace transforms.*
- ✓ *Analyze dynamic behavior of physical systems.*
- ✓ *Select and design a suitable controller for a given application*

UNIT-2 **8L+8T+8P=24 Hours**

APPLICATIONS CONTROL SYSTEM CRITERION TO VARIOUS CONTROL SYSTEMS

Analysis of stability using Routh array, Application of Root locus to control systems, Control systems design by frequency response, Application of bode diagram for given control system.

PRACTICES:

- Simulation of cascade control system.
- Simulation of feed forward control system.
- Simulation of Smith predictor control system.
- Simulation of Internal model control system.
- Study of characteristics of various control valves.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Estimate time constant of a dynamic system.	Apply	1	1, 2
2	Development of block diagram for any control system.	Apply	1	3
3	Analyze the properties e.g. speed of response, frequency response of first order and second-order systems	Analyze	1, 2	2
4	Evaluate the working principle and application of different types of control valves	Evaluate	2	3
5	Design of controller for any chemical process.	Create	1	3

TEXT BOOKS:

1. Donald R Coughanowr, “Process System Analysis and Control” 3rd edition, McGraw- Hill, 2011.
2. G. Stephanepolous, “Chemical Process Control”, 1st edition, Prentice Hall of India, 1998.

REFERENCE BOOK:

1. Peter Harriott, “Process Control”, Tata McGraw-Hill, 2008.

22CH304 INTER-DISCIPLINARY PROJECT – PHASE I

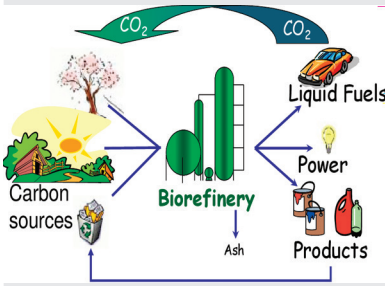


Image source : https://d3i71xaburhd42.cloudfront.net/94d4b4c9d2d9ab85d2092a9361a53fe1f5ff3bd7/12-Figure1-1.png

Hours Per Week :

L	T	P	C
-	-	2	-

PREREQUISITE KNOWLEDGE : Chemical Engineering concepts.

COURSE DESCRIPTION AND OBJECTIVES:

These projects are aimed at enabling students understand the relationship between the courses of various programs. Students will get an idea of how interesting technologies or processes, prototype or working model can be developed by culmination of technologies from courses of different programs

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Ability to map different courses to gain the knowledge of intra-disciplinary Engineering.	Apply		1, 2, 3, 5, 9, 10
2	Function effectively as an individual and as a member or leader in diverse teams.	Apply		1, 2, 3, 5, 9, 10
3	Analyze different experimental process parameters.	Analyze		1, 2, 4, 5, 9, 10, 12
4	Design the experimental set-up for desired process.	Create		1, 2, 3, 4, 5, 9, 10, 12
5	Comprehend and write effective reports and make effective presentations.	Create		1, 2, 3, 4, 5, 9, 10, 12

LIST OF INTER - DISCIPLINARY PROJECT – PHASE I

- Biorefineries and Value added chemicals from biomass.
  (Combination of Courses from the Programmes of Chemical Engineering, Biotechnology).
- Durable and Regenerable Antimicrobial Textiles.
  (Combination of Courses from the Programmes of Chemical Engineering, Biotechnology,Textile Technology).
- Optimal Groundwater remediation.
  (Combination of Courses from the Programmes of Chemical Engineering, Civil Engineering).
- Enzymatic route to polyurethanes.
  (Combination of Courses from the Programmes of Chemical Engineering, Biotechnology).
- Studies on plants extracts as corrosion inhibitor for metal in acidic environment.
  (Combination of Courses from the Programmes of Chemical Engineering, Biotechnology).
- Assessment of cold chain for perishable commodities.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Design of solid-state anaerobic digestion for methane production from food waste.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Profiling of cheddar cheese quality with time.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).

- Value addition of handloom cotton fabric through natural colour dyeing.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technology).
- CFD analysis of drug injection.
  (Combination of Courses from the Programmes of Chemical Engineering, Biotechnology).
- Fruit peels as efficient renewable adsorbents for removal of dissolved heavy metals and dyes from water.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technology).
- Fruit and vegetable waste: their extraction and possible utilization.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Extraction of colour from onion peel for dying the cloth material.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technology).
- Removal of colour from textile dyeing effluent using temple waste flower (twf) as eco-friendly adsorbent.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technology).
- Bioconversion of sugarcane biomass into ethanol as a source of fuel.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Desulfurization of fuel oil by oxidation and extraction.
  (Combination of Courses from the Programmes of Chemical Engineering, Petroleum Engineering).
- Biocolours: a new generation additive for industries.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technology).
- Ethanol production from potato peel waste.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Utilization of banana fibre for making grease proof paper.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Biodiesel production from waste cooking oil.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Application of UV/solar photo-fenton oxidation process towards the decolourisation of textile dyeing waste water.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technolgy).
- Defluoridation of fluoride laden drinking water using activated biochar of colocasiaesculenta stem.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Application of honey as a natural milk preservative.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).

NOTE: The afore - mentioned list is not exhaustive and the objective is to provide an idea of some of the projects that can be executed by students arising from a combination of courses. Students are given full flexibility to choose any projects of their choice under the supervision of faculty Mentors.

22TP302 QUANTITATIVE APTITUDE & LOGICAL REASONING

Source: https://images.app.goo.gl/kvtVgA8TkvDCqLhj7

Hours Per Week :

L	T	P	C
1	2	-	2

PREREQUISITE KNOWLEDGE: Basic Logical Thinking and Problem Solving Ability.

COURSE DESCRIPTION AND OBJECTIVES:

The Students will be introduced to various Arithmetic and Reasoning Problems. The students will have acquaintance with various problems like Time & Work, Time & distance, Percentages, Profit & Loss etc. besides solving puzzles and Critical Reasoning.

MODULE-1

UNIT-1 **4L+8T+0P=12 Hours**

Number system, LCM & HCF of numbers, Percentage, Ratio and proportion, Profit, loss and discount, Average & Mixtures, Simple Interest & Compound interest.

UNIT-2 **4L+8T+0P=12 Hours**

Time and work, Time & distance, Problems on trains, Problems on ages, Permutation & Combinations, Probability.

PRACTICES:

- Each concept would be taught in detail in the class followed by 10 problems solved in the class. Students would have to solve 10 additional problems as homework assignment in each concept.

MODULE-2

UNIT-1 **4L+8T+0P=12 Hours**

Number series, Letter series, Analogy, Odd man out, Coding and decoding, Syllogisms- Statement & Conclusions, Puzzle test.

UNIT-2 **4L+8T+0P=12 Hours**

Blood relations, Direction sense test, Order & Ranking, Seating Arrangements, Calendar & Clocks.

PRACTICES:

- Each concept would be taught in detail in the class followed by 10 problems solved in the class. Students would have to solve 10 additional problems as home work assignment in each concept.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Meet the demands of current job market besides equipping them higher studies like CAT, GMAT etc.	Apply	1	2, 5
2	Solve Arithmetic and Reasoning Problems within shortest possible time without paper work.	Apply	1	2, 5
3	Exhibit better analytical skills and aptitude skills.	Analyse	2	2, 4
4	Develop interpretational skills.	Evaluation	2	2, 4

SKILLS:

- ✓ *Helps in developing and improving problem solving skills*
- ✓ *Allow students to develop critical thinking skills*

TEXT BOOKS:

1. R. S. Aggarwal- Quantitative Aptitude for Competitive Examinations- S. CHAND Publications- Revised Edition-2017.
2. ARIHANT- A New Approach To Verbal & Non-Verbal Reasoning- Arihant Publication- Revised Edition-2021.

REFERENCE BOOKS:

1. Trishna Knowledge Systems- Quantitative Aptitude for Competitive Examinations- Pearson Publication- First Edition- 2013.
2. R. S. Aggarwal- A Modern Approach to Verbal & Non-Verbal Reasoning-S. CHAND Publications- Revised Edition-2018.

22CH305 CHEMICAL REACTION ENGINEERING-II

Hours Per Week :

L	T	P	C
2	2	2	4

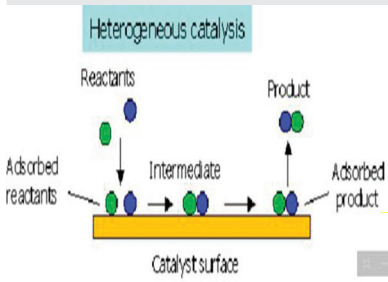


Image source : https://qsstudy.com/wp-content/uploads/2017/09/Heterogeneous-catalysis-1.jpg

PREREQUISITE KNOWLEDGE: Basics of integration, differentiation, algebra and plotting graph.

COURSE DESCRIPTION AND OBJECTIVES:

This course encompasses methodologies to design chemical reactors and also to solve related problems in process industries. The objective of this course is to train students to apply knowledge from calculus, differential equations, thermodynamics, chemistry and process calculations for designing chemical reactors for heterogeneous reactions.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

HETEROGENEOUS REACTIONS & KINETICS

Rate equation; Fluid particle reactions; Selection of a model; Shrinking core model for spherical particles of unchanging size; Rate equations - diffusion through gas film, diffusion through ash layer, chemical reaction; Rate of reaction for shrinking spherical particles- diffusion through gas film, chemical reaction. The rate equation; Kinetic regimes for mass transfer and reaction; Rate equations for- instantaneous fast, slow, intermediate and infinitely slow reactions; Hatta number and enhancement factor for first order reactions; Tower reactor design.

UNIT-2 **10L+10T+10P=30 Hours**

GAS-SOLID REACTION KINETICS

Development of rate equation for shrinking core- diffusion through gas film controls, diffusion through ash layer controls, chemical reaction controls; Development of rate equation for shrinking particle - diffusion through gas film controls, chemical reaction controls; Determination of rate controlling step.

PRACTICES:

- Simulation of concentration profiles of non-catalytic fluid particle reactions using shrinking core model.
- Simulation of concentration profiles of non-catalytic fluid particle reactions using unchanging size.
- Simulation of fluid-fluid reactions.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

HETEROGENEOUS CATALYSIS

The rate equation- adsorption, desorption, surface reaction; Surface phenomenon controls; Qualitative analysis of rate equation; Qualitative predictions from active - site theory; Quantitative interpretation of kinetic data; Pore diffusion resistance importance; Diffusion in single cylindrical pores; Diffusion in porous catalysts; Heat effects during reaction; Combination of resistances for isothermal particles; Comparison of experimental reactors. Mechanisms of catalyst deactivation; Rate and performance equations- rate equation from experiment, batch solid-batch fluid, batch solid-mixed flow of fluid, batch solid- plug flow of fluid.

SKILLS:

- ✓ *Develop the rate laws of reaction.*
- ✓ *Carry out the experiments to obtain the kinetic data.*
- ✓ *Estimate the temperature and concentration dependency of rate of reaction.*
- ✓ *Identification best reactor and sizing of the reactor for the given reaction.*
- ✓ *Identify the rate controlling mechanism of reaction and modelling the reactor.*

UNIT-2 **8L+8T+8P=24 Hours**

CATALYTIC REACTION

Rate equation in terms of fluid phase concentrations at the catalyst surface; Film resistance controls; Experimental methods for finding rates; Determination of controlling resistances and the rate equation; Determination of deactivation kinetics.

PRACTICES:

- Simulation of mass transfer with reaction in fluid-fluid reactions.
- Design of reactor for fluid-fluid reaction.
- Simulation of batch reactor with catalyst decay.
- Estimation of effect of mass transfer on reaction.
- Simulation of catalyst decay in fluidized bed.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply rate laws for heterogeneous reactions.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze kinetic data to estimate the kinetic parameters.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluating kinetics of fluid-solid, fluid-fluid and catalytic reaction.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design ideal and non-ideal reactors to meet the desired conversion and right contact pattern for fluid-solid, fluid-fluid and catalytic reactions.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of models for the Fluid particle reactions, fluid-fluid reaction and catalytic reactions.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

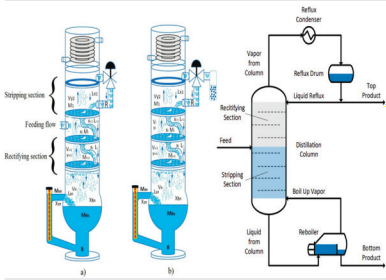
TEXT BOOKS:

1. O. Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons, 2016.
2. Fogler H. S., “Elements of Chemical Reaction Engineering”, 6th edition, Pearson, 2020.

REFERENCE BOOK:

1. Smith J. M., “Chemical Engineering Kinetics”, 3rd edition, McGraw-Hill, 2014.

22CH306 MASS TRANSFER OPERATIONS-II



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basic knowledge of Mass Transfer Operations-I.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals with mass transfer phenomena and its usage for engineering application. The general objectives of this course are to explain various separation mechanisms and fundamental concepts involved in separation operations such as distillation, extraction, leaching, adsorption and other modern separation techniques such as membrane separation and ion exchange. To educate the design aspects of various mass transfer operation equipment widely used in industry along with determination of number of equilibrium stages required for a desired separation.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

DISTILLATION AND SOLID-LIQUID EXTRACTION

Distillation: Introduction; Fields of application; VLE -miscible liquids, Immiscible liquids, VLE phase diagrams; Flash vaporization; Differential distillation-binary, multicomponent mixtures; Continuous fractionation of binary mixtures; McCabe -Thiele method & Ponchon –Savarit method - determination of no of ideal plates for binary mixtures; Optimum reflux ratio; Plate efficiencies; Condenser and reboiler duties; Principles of azeotropic and extractive distillation.

Solid-Liquid Extraction: Introduction; Fields of application; Preparation of solid for leaching; Types of leaching; Leaching equilibria; Constant under flow conditions; Equipment for leaching operation.

UNIT-2 **10L+10T+10P=30 Hours**

APPLICATIONS

Specific application of steam distillation; Determination of minimum reflux ratio for a binary separation through distillation; Determination of condenser and reboiler heat load for a continuous fractionating column; Estimation of product quality through batch distillation with variable reflux condition; Estimation of number of equilibrium trays in a tray distillation column; Parametric consideration and design calculation of a cross current extraction unit; Determination of number of ideal stages for a counter current extraction unit; Application of leaching in biological and food processing industries.

PRACTICES:

- Verification of Rayleigh's equation and modified Rayleigh's equation using batch distillation.
- Determination of VLE data for a binary mixture.
- Estimation of NTU, HTU & height of packed distillation column.
- Estimation of capacity coefficient of packing in a packed bed distillation column under total reflux condition.
- Determination of equilibrium data for solid-liquid extraction system.
- Determination and comparison of percentage recovery of solute by leaching operation employing different number of stages.
- Estimation of overall efficiency for a three-stage counter-current and cross current system.
- Design/simulation of distillation column.
- Design/simulation of leaching equipment.

SKILLS:

- ✓ *Estimation of vapour liquid equilibrium data.*
- ✓ *Assessment of working condition of fractionating column with varying reflux ratio.*
- ✓ *Design specification and equilibrium stage calculation of distillation column.*
- ✓ *Model development of multistage co-current and counter current extractor.*
- ✓ *Design of adsorption and leaching equipment's.*

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

LIQUID-LIQUID EXTRACTION, MEMBRANE SEPARATION AND ADSORPTION

Liquid-Liquid Extraction: Fields of application of ternary liquid systems; Triangular and solvent free coordinate systems; Choice of solvent and selectivity; Extraction with insoluble and partially soluble systems; Single stage extraction; Multi-stage extraction; Cross and counter current extraction with reflux; Equipment for liquid–liquid extraction.

Membrane Separation: Types of membranes; Principles and applications; Membrane characterization; Membrane m application of membrane technology in the pulp and paper industryodule; Microfiltration; Ultrafiltration; Osmosis; Reverse osmosis; Nanofiltration.

Adsorption & Ion Exchange: Principles and applications; Types of adsorption; Use of adsorbents; Adsorption equilibria; Adsorption isotherms for vapor and dilute solutions; Break through curve; Fixed bed adsorber; Ion exchange; Isotherm and separation factors in ion exchange.

UNIT-2 **8L+8T+8P=24 Hours**

APPLICATIONS

Application of solvent extraction in chemical processing industries; Application of Microfiltration, Ultrafiltration, Osmosis, Reverse osmosis, Nanofiltration; Application of membrane technology- waste water management, Food industry; Application of hybrid membrane technologies in the pharmaceutical industry; Application of adsorption chromatography; Application of adsorption in chemical analysis; Applications of PSA and TSA technique.

PRACTICES:

- Determination of LLE data for a ternary liquid mixture.
- Determination of ternary phase diagram and plait point for given ternary system.
- Determination of solubility characteristics of given ternary system.
- Estimation of different adsorption isotherm through batch study.
- Determination of mass transfer zone and breakthrough in a fixed bed adsorber.
- Design/simulation of solvent extraction column.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concept of various mass transfer operations and principle intended for a prototype or pilot plant setup for mass transfer.	Apply	1, 2	1, 2, 3, 5, 9, 10
2	Analyze vapor liquid equilibrium data.	Analyze	1	1, 2, 4, 5, 9, 10, 12
3	Evaluate the equilibrium data of solvent extraction process.	Evaluate	2	1, 2, 5, 9, 10, 12
4	Design of various packed and tray distillation column.	Create	1	1, 2,3, 5, 9, 10
5	Create model development of adsorber and leaching equipment.	Create	2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Treybal R. E., "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2005.
2. Binay. K. Dutta, "Principles of Mass Transfer and Separation Processes", 2nd edition, Prentice Hall of India, New Delhi, 2012.

REFERENCE BOOKS:

1. Christie J. Geankoplis., "Transport Processes and Separation Process Principles", 4th edition, Prentice Hall India Pvt. Ltd., 2003.
2. Judson King C., "Separation Processes", 2nd edition, McGraw-Hill, 2005.
3. Seader J. D., Henley E. J. and Keith Roper D., "Seperation Process Principles- Chemical and Biochemical Operations" 3rd edition, John Wiley & Sons, Inc, 2011.

22CH307 INTER-DISCIPLINARY PROJECT – PHASE II

Hours Per Week :

L	T	P	C
-	-	2	2

PREREQUISITE KNOWLEDGE: Chemical Engineering concepts.

COURSE DESCRIPTION AND OBJECTIVES:

These projects are aimed at enabling students understand the relationship between the courses of various programs. Students will get an idea of how interesting technologies or processes, prototype or working model can be developed by culmination of technologies from courses of different programs.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Ability to map different courses to gain the knowledge of intra-disciplinary Engineering.	Apply		1, 2, 3, 5, 9, 10
2	Function effectively as an individual and as a member or leader in diverse teams.	Apply		1, 2, 3, 5, 9, 10
3	Analyze different experimental process parameters.	Analyze		1, 2, 4, 5, 9, 10, 12
4	Design the experimental set-up for desired process.	Create		1, 2, 3, 4, 5, 9, 10, 12
5	Comprehend and write effective reports and make effective presentations.	Create		1, 2, 3, 4, 5, 9, 10, 12

LIST OF INTER - DISCIPLINARY PROJECT – PHASE II

- Recycling of water from textile industry effluents and its utilization as agricultural water source.
  (Combination of Courses from the Programmes of Chemical Engineering, Textile Technolgy, Food Technology).
- Extraction of d-limonene from sweet orange peels.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Preparation of Ionic Liquids.
  (Combination of Courses from the Programmes of Chemical Engineering, Engineering Chemistry).
- Production of bio diesel from foods (food wastes).
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Developing a Green Tea Based Natural Energy Drink.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Glucose production process from rice husk by solid state mermentation method.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Recovery of value added products from rice husk ash to explore an economic way for recycle and reuse of agricultural waste.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Study the presence of oxalate Ion content In guava fruit at different stages of ripening.

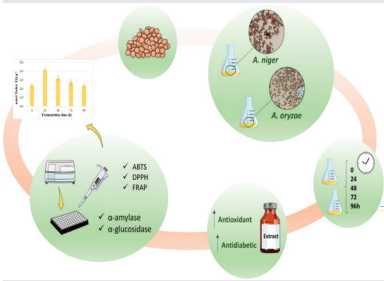


Image source : https://media.springernature.com/lw685/springer-static/image/art%3A10.1186%2Fs40643-019-0273-5/MediaObjects/40643_2019_273_Figa_HTML.png

(Combination of Courses from the Programmes of Food Technology and Biotechnology).

- Development of bakery products with high dietary fiber content.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).
- Study the presence of insecticides or pesticides (nitrogen containing) in various fruits and vegetables.
  (Combination of Courses from the Programmes of Chemical Engineering, Food Technology).

NOTE: The afore - mentioned list is not exhaustive and the objective is to provide an idea of some of the projects that can be executed by students arising from a combination of courses. Students are given full flexibility to choose any projects of their choice under the supervision of faculty Mentors.

IV

YEAR

CHEMICAL ENGINEERING

B.Tech.

I SEMESTER

22CH401	-	Chemical Engineering Plant Design and Economics
22CH402	-	Chemical Technology
	-	Department Elective – 5
	-	Department Elective – 6
	-	Department Elective – 7
	-	Department Elective – 8
	-	Industry interface course (Modular course)
	-	Minor / Honors – 4

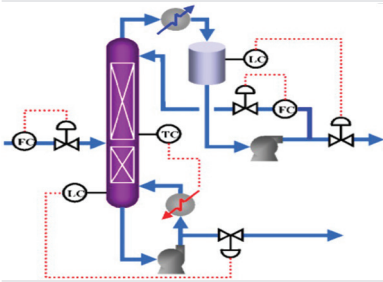
II SEMESTER

22CH403	-	Project Work
22CH404	-	Internship
	-	Minor / Honors – 5 (for Project)

COURSE CONTENTS

I SEM & II SEM

22CH401 CHEMICAL ENGINEERING PLANT DESIGN AND ECONOMICS



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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basics of differentiation.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamental concepts of process design and economics. The objective of this course is to familiarize the student with estimation of capital investments, Interest, investment cost, taxes, insurance, depreciation, profitability and optimum design in chemical process industries.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

BASICS OF PLANT DESIGN AND ECONOMICS

Introduction to process design development; Design project procedure; General design considerations, Cost and asset accounting, Cash flow for industrial operations; Cumulative cash position; Factors affecting investment and production costs; Estimation of capital investments, Cost indexes, Estimation of total product cost, Types of interest, simple interest, compound interest, nominal and effective interest rates, continuous interest; Present worth and discount; Annuities, Perpetuities and capitalized costs.

UNIT-2 **10L+10T+0P=20 Hours**

ADVANCES IN COST ESTIMATION

Case studies related to cost and asset accounting, Case studies on balance sheets of industrial projects, Case studies on estimating capital investment using cost indexes and six-tenths factor rule, Case studies on determination of total product cost, Case studies on finding various interest amounts, Determination of present worth and amount of annuity.

MODULE-2

UNIT-1 **6L+6T+0P=12Hours**

TAXES, INSURANCE, DEPRECIATION AND PROFITABILITY

Taxes, Insurance and Depreciation Types of taxes, Types of industrial insurance, Types of depreciation, Methods for determining depreciation, Single unit and group depreciation.

Profitability: Mathematical methods for profitability evaluation, Alternative investments, Replacements.

UNIT-2 **10L+10T+0P=20 Hours**

ADVANCES IN DEPRECIATION, PROFITABILITY AND ALTERNATIVE INVESTMENTS

Case studies on determination of Perpetuity and capitalized cost, Determination of depreciation charges using various methods, Case studies related to profitability evaluation, Case studies related to alternative investments, Case studies related to Replacements and Optimum design.

SKILLS:

- ✓ *Analyze, synthesize and design processes for manufacturing products commercially.*
- ✓ *Use commercial flow sheeting software to simulate processes and design process equipment.*
- ✓ *Recognize economic, construction, safety, operability and other design constraints.*
- ✓ *Estimate fixed and working capitals and operating costs for process plants.*
- ✓ *Evaluate the profitability of process industrial projects.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge of taxation, depreciation and investment incentives on the economic viability of a project.	Apply	1, 2	1, 2, 3, 5
2	Apply appropriate techniques involved in optimum designing.	Apply	2	1, 2, 5, 9
3	Analyse projects using the methods of net present value, discounted cash flow and equivalent minimum investment period.	Analyze	1	1, 2, 4, 5, 9
4	Design solutions for plant capital cost based on published data.	Analyze	1, 2	1, 2, 5, 9

TEXT BOOKS:

1. Timmerhaus K. D. and Peters M. S., “Plant Design and Economics for Chemical Engineers”, 4th edition, McGraw-Hill, 2004.
2. Gavin Towler and Ray Sinnott, “Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design”, 2nd edition, Elsevier Science, 2012.

REFERENCE BOOK:

1. Gavin Towler and Ray Sinnott, “Chemical Engineering Design”, 2nd edition, Butterworth Heinemann, 2013.

22CH402 CHEMICAL TECHNOLOGY

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basic knowledge of Chemical Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course comprises of detailed industrial processes and process flow sheets employed for manufacturing of various types of chemical products. The objective of this course is to provide exposure to the students on process flow and equipments used in large scale production of chemical products.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

CHLOR-ALKALI INDUSTRIES

Manufacture of soda ash, Caustic soda, Manufacture of glass, water gas, Producer gas, Manufacture of ammonia, Urea and complex fertilizers.

UNIT-2 **10L+10T+10P=30 Hours**

SULFURIC ACID AND OTHER CHEMICALS

Manufacture of sulfuric acid, Hydrochloric acid and other chemicals, Manufacture of alum, Barium salts and rare earth compounds.

PRACTICES:

- Case study on soda ash producing industry.
- Case study on Glass producing industry.
- Case study on Ammonia producing industry.
- Case study on Sulfuric acid producing industry.
- Case study on Alum producing industry.
- Case study on Extraction of rare earth compounds.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

CEMENT, SOAP AND PAPER INDUSTRIES

Manufacture of cement, Portland cement, Phenol formaldehyde, Manufacture of PVC & SBR.

UNIT-2 **10L+10T+10P=30 Hours**

SOAPS AND PAPER

Production of vegetable oils, Hydrogenation of oils, Production of soap, Methods of pulping, Production of sulfate and sulfite pulp, Production of paper–wet process.

PRACTICES:

- Case study on cement producing industry.
- Case study on PVC producing industry.
- Case study on Soap producing industry
- Case study on Paper producing industry.

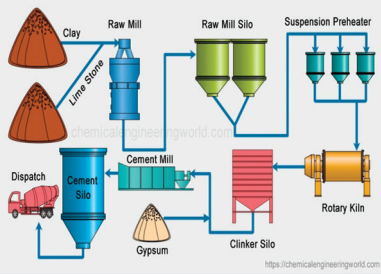

Image source : https://chemicalengineeringworld.com/wp-content/uploads/2020/09/Cement-Manufacturing-Process-1024x538.jpg

SKILLS:

- ✓ *Draw process flow sheet of chemical process industries.*
- ✓ *Constructing standardized flow sheet for new product development.*
- ✓ *Identify processing equipments in a process flow sheet.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concept of manufacturing processes of cement, phenol formaldehyde, PVC and SBR.	Apply	1, 2	1, 2, 3, 5, 9, 10
2	Analyze the manufacturing processes of chloro-alkali chemicals.	Analyze	1	1, 2, 4, 5, 9, 10, 12
3	Evaluate the manufacturing processes of sulfuric acid, alum and rare earth compounds.	Evaluate	2	1, 2, 5, 9, 10, 12
4	Design unit operations and unit processes involved in manufacturing process.	Create	1	1, 2,3, 5, 9, 10
5	Evaluate the process of extraction of oil, soap, detergent, paper and pulp.	Create	2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. M. Gopal Rao and M. Sittig, “Dryden’s outlines of Chemical Technology”, 2nd edition, East West Press, 2000.

REFERENCE BOOK:

1. Shreve. J. “Chemical Process Industries”, 5th edition, McGraw-Hill, 1999.

DEPT. ELECTIVES

B.Tech.

CHEMICAL ENGINEERING

22CH801	-	Conventional Energy Sources
22CH802	-	Energy Integration
22CH803	-	Energy Management and Auditing
22CH804	-	Green Fuels
22CH805	-	Non-Conventional Energy Resources
22CH806	-	Waste Heat Recovery
22CH807	-	Waste to Energy Conversion
22CH808	-	Air Pollution and Control
22CH809	-	Environmental Engineering
22CH810	-	Environmental Regulations and Impact Analysis
22CH811	-	Industrial Effluent Treatment Methods
22CH812	-	Solid Waste Management and Treatment
22CH813	-	Health, Environment and safety Management
22CH814	-	Industrial Safety Engineering
22CH815	-	Natural Gas Engineering
22CH816	-	Natural Gas Hydrates and Coal Bed Methane
22CH817	-	Petrochemicals
22CH818	-	Petroleum Refinery Engineering
22CH819	-	Surface Production Operations
22CH820	-	Aspen Plus: Chemical Engineering Application
22CH821	-	Computational Fluid Dynamics
22CH822	-	Fundamentals of Nanotechnology
22CH823	-	Industrial Instrumentation
22CH824	-	MATLAB Programming for Chemical Engineers
22CH825	-	Novel Separation Processes
22CH826	-	Optimization In Chemical Engineering
22CH827	-	Transport Phenomena

COURSE CONTENTS

I SEM & II SEM

22CH801 CONVENTIONAL ENERGY RESOURCES

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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic course designed for fresher after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides a comprehensive overview of conventional energies including coal, nuclear, petroleum, and natural gas options. The objective of this course is to teach overview of conventional energy sources, its availability, current status and basic principles for harnessing this resource.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

SOLID FUELS

Types of fuels; Energy and relative forms; Calorific value; Energy resources and future energy demands of India. COAL- Origin, Occurrence; Reserves; Petrography, Classification; Proximate and ultimate analysis; Ranking; Storage; Coal carbonization and by product recovery, Liquefaction of coal, Gasification of coal; Combustion of coal and firing mechanism; NUCLEAR ENERGY: Introduction, Energy and mass, Nuclear fission, Chain reaction, Critical mass, Power from nuclear fission reactors, Thermonuclear fusion, Difficulties, Fuel reserves, Safety and waste issues.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS

- Case study on energy production and energy requirement of a given state.
- Study on the availability of different rank coals in India and world-wide.
- Study on import and export of different rank coals.
- Ultimate and proximate analysis of coal.
- Comparative study on coal utilization technologies in India.
- Case study on safety issues of nuclear power plant.
- Case study on safety issues on disposal of nuclear waste and its adverse impact.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

LIQUID AND GASEOUS FUELS

Petroleum: Origin, Occurrence, Reserves, Composition, Classification, Characteristics, Fractionation, Reforming, Cracking, Petroleum products, Specification of petroleum products, Utilization.

Natural gas: Origin, Occurrence, Reserves, Composition and applications; Production, composition, Utilization of - Coke oven gas, Producer gas, water gas, LPG.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS

- Case study on petroleum reserves and import of crude petroleum.
- Case study on the production of petroleum products and its utilization in different sectors.
- Comparative study on the usage of CNG, Petrol and Diesel and advantages.
- Study on the industrial applications of coke oven gas, producer gas and water gas.

SKILLS:

- ✓ *Able to assess the viability of a coal power plant or nuclear power plant for a given site.*
- ✓ *Able to explain the impact of government regulations on the use of conventional energies.*
- ✓ *Able to analyze these conventional energy systems and will calculate savings fractions backup energy needs financing options and economic analyses.*
- ✓ *Able to investigate the potentials of conventional energy technologies to help solve environmental and economic problems within society.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply Identify the key concepts and terminologies related to conventional energy.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the different conventional energy techniques.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate the different types conventional energy.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design the different Quantitative Risk Assessments (QRA) on conventional energy.	Creating	2	1, 2, 5, 9, 10, 12

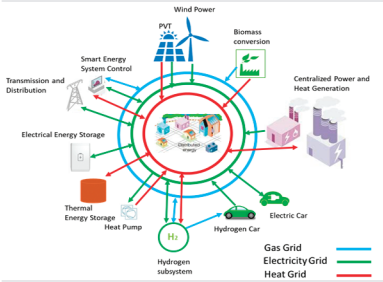
TEXT BOOKS:

1. Gupta O. P., “Elements of Fuels, Furnaces and Refractories”, 6th edition, Khanna Publishers, Delhi, India, 2008.
2. Sami Sarkar, “Fuels and Combustion”, 3rd edition, University Press, 1998.

REFERENCE BOOKS:

1. Christian Ngo and Joseph B. Natowitz, “Our Future Resources: Alternatives and the environment”, John Wiley & Sons, 2009.
2. Ristinen R. A., Kraushaar J. J. and Akraushaar J. P., “Energy and the Environment”, 2nd edition, John Wiley, 2006.

22CH802 ENERGY INTEGRATION



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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic knowledge of heat and mass transfer and engineering mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides a platform for strong interpretation associated to the phenomenon of integrating energy sources. The course is focussed on retrofit design, heat losses case study and required process change and modification. The objective of this course is to impart knowledge on efficient methods customary for analysis and design of thermally driven separation systems, heat exchanger networks and utility systems.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

PINCH ANALYSIS AND HEAT EXCHANGER NETWORK DESIGN

Key Concepts of Pinch Analysis: Pinch analysis- history and industrial experience, why does pinch analysis work, concept of process synthesis, Role of thermodynamics in process design, Heat recovery and heat exchange, pinch and its significance.

Heat Exchanger Network Design: Heat exchange equipment; Stream splitting and cyclic matching; Network relaxation- multiple pinches and near pinches, retrofit design; Case studies.

Energy Targeting: T min contributions for individual streams; Multiple utilities - types of utility, appropriate placement principle, constant temperature utilities, utility pinches, variable-temperature utilities, targeting heat exchange, Units, Area and shells.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS

- Heat and mass balance.
- Stream data extraction.
- Calculation of heat loads and heat capacities.
- Efficiency and heat recovery calculation of integrated Gasification Combined Cycle (IGCC) power plant.
- Choosing streams, mixing, heat losses case study.
- Threshold problems.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

PROCESS CHANGE AND TIME DEPENDENT PROCESSES

Process Change and Evolution: Basic objective, the plus-minus principle, Appropriate placement applied to unit operations, Reactor systems, distillation columns and other separation systems.

Batch and Time Dependent Processes: Introduction, Concepts, Types of streams in batch processes, Time intervals, Rescheduling, Debottlenecking.

SKILLS:

- ✓ *Model prediction and design of heat recovery and heat exchange equipment.*
- ✓ *Heat loads and heat capacity calculation in heat exchanger design.*
- ✓ *Analysis and design modification of reactor system, distillation column.*

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS

- Model prediction and design of heat recovery and heat exchange equipment.
- Calculation of heat exchanger network design.
- Heat loads and heat capacity calculation in heat exchanger design.
- Analysis and design modification of reactor system, distillation column.
- Calculating energy targets.
- Other time dependent applications.
- Analyze the reliability, technical efficiency and economic efficiency of an integrated system.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concept of process integration and pinch analysis.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Apply various concepts for power system equipment used for integration.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
3	Analyse heat exchanger equipment and network relaxation and cyclic matching.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Evaluate appropriate placement useful to unit operation, reactor systems, and distillation column.	Evaluate	1, 2	1, 2, 5, 9, 10
5	Design, analysis and modification of heat exchanger along with heat recovery and heat exchanger network.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Ian C Kemp, “Pinch Analysis and Process Integration”, 2nd edition, Elsevier Publications, 2007.
2. Bodo Linnhoff, “A User Guide on Process Integration for the Efficient use of Energy”, Institution of chemical engineers, 1994.

REFERENCE BOOKS:

1. Lorenz T Biegler, Ignacio E Grossmann and Aurthur W Westerberg, “Systematic Methods of Chemical Process Design”, Prentice Hall of India, 1997.
2. William D. Nordhaus, The efficient use of energy resources. Publisher: Yale Univ Pr. (Yale, 1979) (ISBN 0300022840).

22CH803 ENERGY MANAGEMENT AND AUDITING

Image source : https://sustainability.indoramaventures.com/storage/content/environmental/energy-management/img-energy-savings.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after intermediate.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides an understanding on the energy efficiency measures which can be implemented by industrial and domestic users. The objective of this course is to demonstrate energy technologies that include lighting, air conditioning, compressed air, steam, hot water, chilled water and a number of process specific technologies.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

ENERGY AUDIT AND ENERGY CONSERVATION

Energy Audit: Types and methodology; Energy audit reporting format; Understanding energy costs; Benchmarking and energy performance; Matching energy usage to requirement; Maximising system efficiency; Fuel and energy substitution; Energy audit instruments; Duties and responsibilities of energy auditors.

Energy Conservation: Energy conservation and its importance; Energy strategy for the future; The energy conservation act 2001 and its features. Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor – energy consumption & energy saving potentials – Design consideration.

UNIT-2 **10L+6T+0P=16Hours**

APPLICATIONS

- Case study on energy auditing in chemical processing industries.
- Case study on improvement of system efficiency by minimising the energy usage.
- Sankey diagram for different processes.
- Electrical Energy -Energy Efficiency in Lighting – Case studies.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

ENERGY ECONOMICS

Energy Economics: Costing techniques; Financial appraisal and profitability; Cost optimization; alternative investment; methods of profitability evaluation; Project management energy utilization and conversion systems.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS

- Case studies on alternative investment.
- Case studies on replacement of various processing equipment (energy consuming).
- Profitability evaluation of various processes.
- Case studies Optimization of energy consuming processes.
- Case study on analyzing issues related to the implementation of energy efficiency measures.

SKILLS:

- ✓ *Analyze energy systems from a supply and demand perspective.*
- ✓ *Develop energy efficiency solutions and demand management strategies.*
- ✓ *Apply energy efficiency technologies for engineering applications.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply modern techniques in energy auditing methods.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze and interpret energy efficiency and demand of management project proposals.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate different costing techniques.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design and develop energy efficient solutions for industry problems.	Create	1, 2	1, 2, 5, 9, 10, 12
5	Formulate thermal performance, energy management and audit.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. W. R. Murphy, G. McKay, “Energy Management”, 2nd edition, Bio Green Books, 2007.
2. Barun Kumar De, “Energy Management, Audit and Conservation”, 2nd edition, Vrinda Publications, 2014.
3. W. C. Turner, “Energy Management Handbook”, 7th edition, Fairmont Press, 2007.

REFERENCE BOOKS:

1. Fengyuan Wang and Andy Chen, “Energy Management Handbook”, 1st edition, BSR Publishers, 2012.
2. Y. P. Abbi and Shashank Jain, “Handbook on Energy Audit and Environment Management”,2nd edition, TERI Press, 2006.

22CH804 GREEN FUELS

Image source : https://www.man-es.com/images/default-source/default-album/dstage_green_fuels-jpg.png?sfvrsn=e4604f20_0

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to enrich students about knowledge and methodology of various green fuel technologies available worldwide, production of Bio-ethanol from crops, molasses and cellulosic bio mass, production of Bio-diesel from plant seeds, algae, and by utilizing supercritical process and Methane gas production utilizing bio digesters.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION

Plant based biofuels; World biofuels scenario; Thermochemical conversion of biomass to liquids and gaseous fuels; Green Chemistry and green engineering with examples; Green reagents and catalysis in green synthesis, Green chemistry metrics- atom economy, E factor, reaction mass efficiency and other green chemistry metrics, application of green metrics analysis to synthetic plans.

UNIT-2 **10L+6T+0P=16 Hours**

BIOETHANOL PRODUCTION

Production of ethanol from molasses; Bioethanol from starchy biomass; Production of starch Saccharifying enzymes; Hydrolysis and fermentation; Pretreatment of the substrates; Production of Cellulases and Hemicellulases; Hydrolysis and fermentation; Lipase-catalyzed preparation of biodiesel; Biodiesel from algae; Algaculture and Challenges.

PRACTICES:

- Biodiesel production with supercritical fluid technologies.
- Algaculture for biodiesel production.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

BIODIESEL FROM DIFFERENT PLANT SEEDS

Palm oil diesel production and its experimental test on a diesel engine; Biodiesel production using karanja (pongamia pinnata) and jatropha (jatropha curcas) seed oil; Biodiesel production form rubber seed oil and other vegetable oils.

UNIT-2 **10L+6T+0P=16 Hours**

MICROBIAL PRODUCTION OF METHANE

Different types of bio-digesters and biogas technology in India.

PRACTICES:

- Industrial case studies.

SKILLS:

- ✓ *What are green fuel technologies.*
- ✓ *How bio-ethanol, bio diesel & Methane are produced from crops, cellulosic biomass, plant seeds & bio digester.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply green fuel technologies.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze Palm oil diesel production.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluating bio-ethanol reaction.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design bio reactors and bio digester to meet the desired conversion and right contact pattern for bio fuel production.	Creating	1, 2	1, 2, 5, 9, 10, 12
5	Creation of models for the biodiesel and methane production.	Creative	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Biofuels Engineering Process Technology, Caye M. Drapcho, Nghiem Phu Nhuan, Terry H. Walker, McGraw-Hill, 2008.
2. Green Chemistry, An introductory text, M. Lancaster, RSC, 2010.

REFERENCE BOOKS:

1. Ashok Pandey , “Hand book of Plant Based Biofuels”, CRC Press, 2009.
2. Alexi Lapkin and david Constable ,”Green Chemistry Metrics: Measuring and Monitoring Sustainable Processes”, (Eds), Wiley publications, 2008. ISBN: 978-1-405-15968-5.

22CH805 NON-CONVENTIONAL ENERGY RESOURCES

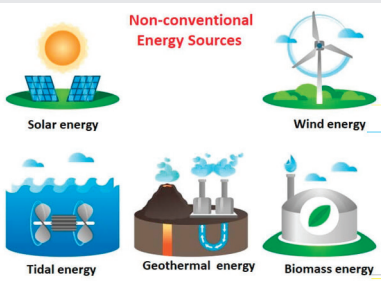


Image source : https://static.javatpoint.com/physics/images/non-conventional-sources-of-energy.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic course designed for fresher after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides a comprehensive overview of renewable energies including solar energy, wind power, hydropower, fuel cells, biomass, and alternative transportation options. The objective of this course is to teach overview of alternative energy sources, its availability, current status and basic principles for harnessing this resource.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

SOLAR, WIND AND BIO ENERGY:

Solar Energy: Solar radiation; Measurement and prediction; Solar collectors and its applications; Solar cell – principle, types, fabrication, applications.

Wind Energy: Atmospheric circulations; Classification; Factors influencing wind energy; Aerodynamics of wind turbine rotor site selection; Wind resource assessment; Wind energy conversion devices-classification, characteristics, applications; Hybrid systems; Safety and environmental aspects.

Bio-Energy: Biomass resources and their classification; Chemical constituents and physicochemical characteristics of biomass; Biomass conversion processes- thermo chemical, biochemical conversion, Chemical conversion.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

- Case study on uses of solar collectors in industrial applications.
- Case study on energy production from solar energy produced in a given location.
- Case study on factors influencing Wind shear, Turbulence; Wind speed monitoring.
- Case study on selection site for wind energy and suitable devices.
- Thermochemical conversion of biomass.
- Biochemical conversion of bio mass.
- Chemical conversion of biomass.
- Case study on power production from biomass.
- Comparative study on the energy production by solar, wind and biomass.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

HYDROGEN, FUEL CELLS AND OTHER TYPES OF ENERGY

Hydrogen And Fuel Cells: Thermodynamics and electrochemical principles; Basic design; Types and applications; Production methods; Biophotolysis; Hydrogen generation from algae biological pathways; Storage; Cryogenic and metal hydride transportation; Fuel cell- principle of working, various types, construction and applications.

SKILLS:

- ✓ *Assess the viability of a wind power hydropower or biomass system for a given site.*
- ✓ *Explain the impact of government regulations on the use of renewable energies.*
- ✓ *Analyze these renewable energy systems and will calculate savings fractions backup energy needs financing options and economic analyses.*
- ✓ *Investigate the potentials of renewable energy technologies to help solve environmental and economic problems within society.*

Other Types Of Energy: Ocean energy resources; Principles of ocean thermal energy conversion systems; Ocean thermal power plants; Principles of ocean wave energy conversion and tidal energy conversion; Hydropower; Site selection; Construction; Environmental issues; Geothermal energy- types of geothermal energy sites, site selection and geothermal power plants.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

- Production of hydrogen from fuel cell.
- Study on hydrogen generation from algae biological pathway.
- Case study on hydrogen as a fuel in power production.
- Case study on hydrogen as a fuel for transportation.
- Case study on energy from the ocean wave energy.
- Case study on site selection for the geothermal energy.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the technological basis for harnessing renewable energy sources	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Estimate different renewable energy technologies and choose the most appropriate based on local conditions.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Evaluate the effects that current energy systems based on fossil fuels have over the environment and the society.	Evaluate	1, 2	1, 2, 5, 9, 10
5	Design various components of different renewable energy systems.	Create	2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. G. D. Rai, “Non-Conventional Energy Sources”, 5th edition, Khanna Publishers, 2010.
2. G. N. Tiwari and R. K. Mishra, “Advanced Renewable Energy Sources”, RSC Publishing, 2012.

REFERENCE BOOKS:

1. S.P. Sukhatme and J.K. Nayak, “Solar Energy: Principles of Thermal Collection and Storage”, 3rd edition, Tata McGraw-Hill, 2008.
2. John Twidell and Tony Weir, “Renewable Energy Sources”, 3rd edition, Routledge Publisher, 2015.

22CH806 WASTE HEAT RECOVERY

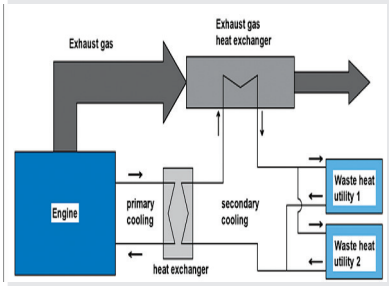


Image source : https://static.heinenhopman.com/img/figure-1-simplified-diagram-of-how-to-extract-waste-heat-1624524908.png

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic knowledge of heat and mass transfer and engineering mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

The proposed course introduces us to various methods of Waste Heat Recovery that has been employed by the industry to harness the energy stored in waste heat and use it for generation of additional electric power. The objective of this course is to provide the knowledge about upcoming concept of Cogeneration and Waste Heat Recovery Systems and also enables the students to think and analyze the techno economic viability of various energy efficient systems.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Introduction To Waste Heat: Importance of waste heat recovery; Review of thermodynamics –Entropy; Entropy Generation; First and second law efficiency; Introduction to heat exchanger, analysis LMTD and e-NTU method.

Power Plant Cycles: Energy cascading; Rankine cycle; Gas Turbine Cycle; steam turbine cycle.

UNIT-2 **10L+6T+0P=16 Hours**

HEAT RECOVERY:

Modification of Rankine cycle; Heat recovery steam generators ,Combined gas turbine-steam turbine power plant, Thermodynamics for low temperature applications cogenerations, special heat exchangers for waste heat recovery; synthesis of heat exchanger network; Determination of heat recovery from steam generators.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

HEAT PIPES AND ENERGY STORAGE TECHNIQUES:

Heat Pipes: Heat pipes and vapor chambers, thermo-electric generators, thermo ionic conversion, Thermo PV and MHD (magnetohydrodynamics).

Heat Pumps: Heat pumps.

Energy Storage Techniques: Pumped Hydro; Compressed air; Fly-wheel; Superconducting magnetic storage; Thermal storage (sensible & latent); Battery; Chemical energy storage; Fuel cells; Energy economics.

UNIT-2 **10L+6T+0P=16 Hours**

HEAT EXCHANGERS:

Application of Recuperator heat exchanger, Application of special heat exchanger devices, Synthesis of heat exchanger network, Design consideration of heat recovery from incinerators, Application of Thermoelectric generators, Specific application of superconducting magnetic storage, Development of

SKILLS:

- ✓ *Analyze the energy data of industries.*
- ✓ *Conduct energy audit and suggest methodologies for energy savings.*
- ✓ *Carryout energy accounting and balancing.*

Fuel cells for energy storage, Economic analysis of energy conversion and storage.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic knowledge of waste heat recovery systems, economic analysis, thermodynamics, power plant cycles and environmental considerations.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the techno economic viability of various energy efficient systems.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate and interpret power plant cycles to solve industry problems.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design appropriate energy storage device.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Hussam Jouhara, “Waste Heat Recovery in Process Industries” Wiley-VCH; 1st edition, 2022.
2. Institute of Fuel, London, “Waste Heat Recovery”, Chapman & Hall Publishers, London, 1963.

REFERENCE BOOKS:

1. Robert Goldstick, Albert Thumann P. E., “ Waste Heat Recovery Handbook” Spon Press,1983.
2. Yacov Y. Hamies, Marguerite A. H. Ruffner, “Energy Auditing and Conservation: Methods, Measurements, Management & Case Study”, Hemisphere, Washington, 1980.

22CH807 WASTE TO ENERGY CONVERSION

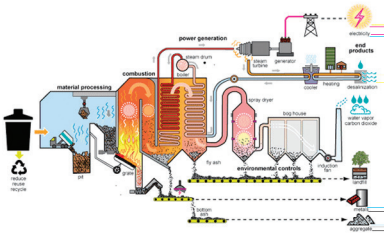


Image source : https://www.eia.gov/energyexplained/biomass/images/wastetoenergy.png

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic knowledge of heat and mass transfer and engineering mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with different wastes, characterization and their suitability towards energy production. This course is expected to provide an understanding of the numerous features of waste to energy. The objective of the course is to provide insights into waste management and stimulating the use of waste as a resource for alternative energy production.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Characterization of waste, Energy production from wastes-through- incineration, gasification, pyrolysis, Densification of solids efficiency improvement of power plant, gas cleaning.

UNIT-2 **10L+6T+0P=16 Hours**

ENERGY PRODUCTION FROM WASTES:

- Case study on power production from syngas.
- Case study on production of chemicals from syngas.
- Case study on energy production from pyrolysis of wastes.
- Case study on energy production from incineration of waste.
- Energy production from waste plastics.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

ENERGY PRODUCTION FROM ORGANIC WASTE:

Energy production from organic waste by - anaerobic digestion, fermentation, trans esterification, cultivation of algal biomass, energy production from algal biomass.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

- Case study on energy production from various organic wastes.
- Design of anaerobic digester.
- Energy production from algal biomass.
- Design of a fermentation cell.
- Design of a reactor for transeserification.

SKILLS:

- ✓ *Identification, classification and characterization of various wastes for energy Production.*
- ✓ *Several techniques of energy production through incineration from various waste feedstock.*
- ✓ *Model development and design of catalytic pyrolysis, pyrolysis reactors for energy production.*
- ✓ *Energy production techniques from waste plastics, algal biomass.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the principles and mechanism of various energy production methods from waste resources.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the efficiency and influencing factors for different energy production techniques.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Analyze and classify various different modes of energy production from waste such as incineration, gasification, and pyrolysis.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Identify and categorize the various wastes and understand the concept of waste to energy.	Evaluate	1, 2	1, 2, 5, 9, 10
5	Design procedure and energy production from several other sources such as algal biomass, some organic wastes.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1 Rogoff, M.J. and Screve, F., “Waste-to-Energy: Technologies and Project Implementation”, 3rd edition Elsevier Store, 2019.

2. Young G.C., “Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons”, 1st edition, John Wiley and Sons, 2010.

REFERENCE BOOKS:

1. Harker, J.H. and Backhusrt, J.R., “Fuel and Energy”, 1st edition, Academic Press Inc., 1981.
2. Mondal, P. and Dalai, A.K., “Sustainable Utilization of Natural Resources”. 1st edition, CRC Press, 2017.

22CH808 AIR POLLUTION AND CONTROL

Image source : https://i.ytimg.com/vi/lXl7N0x6XCk/hqdefault.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after intermediate.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with air pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability. The objective of this course is to impart knowledge in pollution prevention through planning and treatment technologies.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

SOURCES OF AIR POLLUTION AND REGULATIONS:

Effects of air pollution on plants, animals, human health, classification of pollutants, properties of gaseous and particulate matter, Air pollution regulatory framework history – Air pollution regulatory framework - Regulatory System – Laws and regulations – Clean air Act – Provisions for recent developments.

UNIT-2 **10L+6T+0P=16 Hours**

AIR POLLUTION SAMPLING AND MEASUREMENT:

Types of pollutant and sampling and measurement, ambient air sampling: Collection of gaseous air pollutants, Collection of particulate air pollutants; Stack sampling-Sampling system, Particulate sampling, and gaseous sampling; Analysis of air pollutants-Sulphur dioxide, Nitrogen oxides, Carbon monoxide, Oxidants and ozones, Hydrocarbons, Particulate matter.

- Case study on Real-time Air Quality Monitoring in different industrial area.
- Case study on Ambient Air quality monitoring system.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

AIR POLLUTION CONTROL METHODS AND EQUIPMENTS:

Source collection methods: Raw material changes, Process changes, and equipment modification. Cleaning of gaseous equipments, particulate emission control: Collection efficiency, Control equipment like gravitational settling chambers, Cyclone separators, Fabric filters, Scrubbers, Packed beds and plate columns, Venturi scrubbers, their design aspects. Control of gaseous emissions: Absorption by liquids, Absorption equipments, Adsorption by solids.

UNIT-2 **10L+6T+0P= 16 Hours**

APPLICATIONS:

- Case study on particulate emission control.
- Case study on several controlling measure of air pollution.
- Case study on several equipments for air pollution control.
- Case study on use of Cyclone separators for air pollution control.
- Case study on use of Venturi scrubbers for air pollution control.

SKILLS:

- ✓ *Implement industrial management strategies for pollution prevention.*
- ✓ *Sampling techniques of air quality.*
- ✓ *Techniques of Real-time Air Quality Monitoring.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply reasoning to identify the constituents accountable for air pollution and effect of pollutant on environment.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the impact of sampling, measurement and characterization of various air sampling to demonstrate the need for sustainable development.	Analyze	1	1, 2, 3, 5, 9, 10
3	Evaluate the various parameters for ambient air and stack air sampling from their sources to provide valid conclusions.	Evaluate	2	1, 2, 5, 9, 10
4	Design and demonstrate the knowledge to use suitable equipment for abatement of air pollution towards the control of air pollution.	Create	1,2	1, 2, 5, 9, 10, 12
5	Creation of treatment towards the control of air pollution.	Create	2	1, 2, 3, 4, 5, 9, 10, 12

TEXTBOOKS:

1. Kenneth Wark, Cecil Francis Warner, Wayne T. Davis, “Air pollution: its origin and control”, 3rd edition, John Wiley & Sons Inc, 1997.
2. Murali Krishna K.V.S.G., “Air Pollution and Control”, Kaushal Company, 1995.

REFERENCE BOOKS:

1. C.S. Rao, “Environmental Pollution Control Engineering”, 2nd Edition, New Age International Publishers, New Delhi, 2006.
2. M N Rao, H V N Rao, “Air pollution” 1st Edition, Tata McGraw-Hill, New Delhi, 1990.

22CH809 ENVIRONMENTAL ENGINEERING

Image source : https://idreamcareer.com/wp-content/uploads/2020/03/Environmental-Engineering.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic course designed for 10+2 level student.

COURSE DESCRIPTION AND OBJECTIVES:

Environmental Science and Technology offers technological aspects of environmental science and in maintaining environmental integrity in relation to human development. It helps every engineer to plan appropriate strategies for addressing environmental issues and also contribute to the development of innovative technologies for solving such issues. It produces professionals who will ensure sustainable development of the nation in general and environmental in particular.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Environment, its impact; Present scenario, Various Environmental standards and laws for water, air and land quality by Pollution Control boards and their working Modules, Mass and energy transfer within the environmental system, Law of conservation of energy and Law of conservation of mass, Material Balance in an environmental system, Steady state conservative Systems-Steady state systems with non-conservative pollutants.

UNIT-2 **10L+6T+0P=16 Hours**

WATER POLLUTION AND WATER QUALITY CONTROL:

Water Resources- Hydrologic Cycle, Water Quality Parameters, Physical characteristics like Color, Odour, Temperature, Turbidity and Total Solids; Chemical Characteristics like pH, Hardness, Alkalinity, Acidity, Oxygen Demanding (COD, BOD, Nitrates, Sulfates and phosphates; Microbiological characteristics). Effect of Oxygen Demanding Wastes on Rivers.

BOD and DO Profile: Deoxygenation and Reaeration of the polluted water, Exertion of BOD with ultimate BOD loading. -Streeter Phelps Model and Oxygen Sag Curve, -Self Purification Phenomenon.

Ground Water- Aquifers, Flow Rate and Hydraulic Gradient by Darcy's Law, Treatment of Water, Water Quality- Drinking water quality standards, Treatment Systems- Screening, Coagulation and Flocculation, Sedimentation, Filtration, Disinfection and Softening, Wastewater Treatment, Typical Range of Composition of Domestic Sewage and Regulatory Standards, Primary Treatment- Screening, Grit Chamber, Equalization Basins, Primary Settling, Sedimentation with Coagulation and Flocculation. Secondary Treatment Systems; Activated Sludge Process, Trickling Filter, RBC, Oxidation Ponds. Advanced Treatment- Nitrogen and Phosphorous Removal.

- Case studies.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

AIR POLLUTION:

Definition, Overview of Emissions, Type of Pollutants, Chemical Composition. Sources and Effects of Major Air Pollutants- CO, SOx, NOx, Hydrocarbons, Ozone, Photochemical Oxidants, Lead, Particulate Matter.

SKILLS:

- ✓ *Understand structural relationships, abstract models, symbolic languages and deductive reasoning.*
- ✓ *Gain perspectives to address the challenges, improvise and devise solutions.*
- ✓ *Identify solutions to environment and development issues, using planning, analysis, modeling, and new approaches.*
- ✓ *Acquire fieldwork techniques to study, observe and prepare documents, charts, PPTs, Models etc.*
- ✓ *Understand how natural resources should be used judiciously, to protect biodiversity and maintain ecosystem.*

Air Pollution and Metrology- Environmental Lapse Rate and Adiabatic Lapse Rate, Atmospheric Stability, Inversion, Type of Plumes., Gaussian Atmospheric Dispersion Model for Point Sources, Emission Controls., Control Devices for Particulate Pollutants- Gravity.

Settling Chambers, Centrifugal Separators, Wet Scrubber, Electrostatic precipitator, Control devices for Gaseous Pollutants- Adsorption, Absorption, Condensation and Combustion.

UNIT-2 **10L+6T+0P=16 Hours**

POLLUTION CONTROL:

Pollution Control Methodologies, Pollution Control in Process Industries like Cement, Paper, Petroleum -Petroleum Products-Textile- Tanneries-Thermal Plants-Eco-Friendly Energy and Environment, Hazardous Waste Treatment Technologies, Physical Treatment- Sedimentation, Adsorption, Aeration. Ion Exchange, Electro Dialysis. Chemical Treatment- Precipitation, Biological Remediation Techniques, Incineration and Land Disposal.

Environmental Impact Assessment and Environmental Management:

Introduction to EIA, Need and Scope of EIA; Objectives and Purpose of EIA Studies, Indian Policies requiring EIA- Enactment of EIA as a Law, EIA Notifications, Siting Criteria. Components and Types of EIA, Roles in the EIA Process, Environmental Audit- Need, Purpose, Criteria., Case studies.

- Case studies.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply and integrate the diverse information from sources outside the classroom.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze eco-friendly technologies in order to maintain hygienic conditions.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluating critically, creatively, resourcefully and strategically, including identifying steps needed to reach goals, manage projects, evaluate progress, and adapt approaches, developing both self-reliance, and civic mindedness.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design the human activities that are detrimental to environment.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of diverse disciplines to identify and create solutions that conserve and help maintain biodiversity in the long term and discuss the issues involved in the generation of renewable energy resources.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Anubha Kaushik and CP Kaushik, “Perspectives in Environmental Studies”, 5th edition, 2016.
2. Benny Joseph, “Environmental studies”, 2nd edition, McGraw Hill Education, 2015.

REFERENCE BOOKS:

1. Dr. M. Chandrasekhar, “A Text book of Environmental Studies”, HI-TECH publications, 2006.
2. Dr. M. Anji Reddy, “A Text book of environmental science and Technology”, B.S. Publications, 2008.
3. Dr. K. Mukkanti, “A Text book of Environmental Studies”, S. CHAND and Company Ltd, 2009.
4. EHILRS and ST, “Text book of Municipal and Rural Sanitation”, M.S Hill, 1998.
5. C. S. Rao, Wiley Eastern Ltd, “Environmental Pollution Control Engineering”, New Age International Ltd., 2001.
6. Dr. M. Anji Reddy, “Introduction to Remote Sensing”, B S Publications, 2004.

22CH810 ENVIRONMENTAL REGULATIONS AND IMPACT ANALYSIS

Image source : https://static.vecteezy.com/system/resources/previews/003/527/236/non_2x/eia-environmental-impact-assessment-concept-free-vector.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic course designed for 10+2 level student.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides an overall review of environmental protection, acts and procedures. The objective of this course is to make a student aware of environmental protection acts and policies.

MODULE-1

UNIT-1 **6L+10T+0P=16Hours**

INTRODUCTION:

Introduction of Indian constitution and environment; Environmental policy of India and the legislative framework; Institution mechanism and environmental policy; Environmental clearance and guidelines for Industries.

UNIT-2 **10L+6T+0P=16 Hours**

DESIGN AND OPTIMIZATION:

Design and optimize various unit operations and unit processes used in water treatment and Air treatment, Case studies of Municipal Wastewater Treatment Technologies, Application in Municipal wastewater treatment, Application in Pre-treatment, Application in Primary treatment, Application in Secondary treatment, Application in advanced treatments.

PRACTICES:

- Case studies of Location and boring of tube wells.
- Case studies of maintenance of tube wells and related machinery.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

ENVIRONMENTAL AUDIT AND ACTS:

Environmental standards; Hazardous wastes; Environmental audit and acts; Water pollution; Air pollution; Zero discharge; Public liability insurance; National environment appellate authority; National environment tribunal; Indian forest service; Environment protection.

UNIT-2 **10L+6T+0P=16 Hours**

INDUSTRIAL WASTE TREATMENT:

Industrial waste treatment studies of Specific treatment processes, Application of Gantt chart for the Water pollution and its control technologies, Case studies on Maintenance of effluent treatment plants, Case studies of Performance studies of a few typical treatment plants, Case studies of Water Quality Protection for open wells and Ponds, Case studies of Wastewater Disposal and Reuse, Case studies of Coastal Water Management.

SKILLS:

- ✓ *Analyze proposed development project plans for possible environmental effects and prepare appropriate initial studies.*
- ✓ *Solve environmental related issues according to the Indian environmental policy requirements.*

PRACTICES:

- Case studies of Industrial Wastewater Treatment Technologies.
- Case studies of industrial effluents.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the environmental attributes to be considered for the EIA study.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze and prevent water pollution and air pollution.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate and Plan the methodology to monitor and review the environmental regulations.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design environment protection methods.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of treatment towards the control of effluent wastes.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. R. K. Trivedi, “Handbook of Environmental Laws, Acts, Guidelines, Compliances & Standards”, 3rd edition, BS publications, 2010.

REFERENCE BOOK:

1. Barathwal, R. R., “Environmental Impact Assessment”, New Age International Publishers, 2002.

22CH811 INDUSTRIAL EFFLUENT TREATMENT METHODS

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic course designed for fresher after 10+2 completion.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with air pollution, industrial waste water treatment, toxicity and sludge management. The objective of this course is to impart knowledge in pollution prevention through planning and treatment technologies. This course also deals with the detailed understanding of various equipment's related to sampling, measurement and capturing process towards the control and treatment methods.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Types of waste from chemical industries and effects on environment; Environment legislation; Types of pollution; Sources of waste water; Effluent treatment guidelines and standards; toxicity of industrial effluents; Tolerance limits for effluents discharges into inland surface water's public sewers, and on land for irrigation – standards. Oxygen demands and their determination (BOD, COD and TOC); Oxygen sag curve; BOD curve mathematical; Controlling of BOD curve; Self-purification of running streams.

UNIT-2 **10L+6T+0P=16 Hours**

CHARACTERIZATION OF EFFLUENT:

Detailed analysis and environmental effect of several industrial effluents, Regulatory requirements for treatment of industrial wastewater, Effects of industrial effluents on sewers and Natural Water Bodies (case study), Detailed analysis (i.e., Physical, Chemical, Organic & Biological properties) of Industrial Wastes, Characterization techniques of several industrial effluent streams.

- Case studies.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

INDUSTRY SPECIFIC EFFLUENT TREATMENT:

General methods of control and removal of sulphur dioxide; Oxides of nitrogen and organic vapors from gaseous effluent; Treatment of liquid and gaseous effluent in fertilizer industry. Nitrification and De-nitrification; Phosphorous removal; Heavy metal removal; Membrane Separation Process; Air Stripping and Absorption Processes; Special Treatment Methods - Disposal of Treated Waste Water; Characteristics and Composition of waste water and Manufacturing Processes of Industries like Sugar, Characteristics and Composition of Industries like Food Processing Industries, Steel, and Petroleum Refineries; Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries – Joint Treatment of Raw Industries waste water and Domestic Sewage – Common Effluent Treatment Plants (CETP).

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

Wastewater characteristics, source reduction options and waste treatment flow sheet for Textile industry, wastewater characteristics, source reduction options and waste treatment flow sheet for Tannery industry,

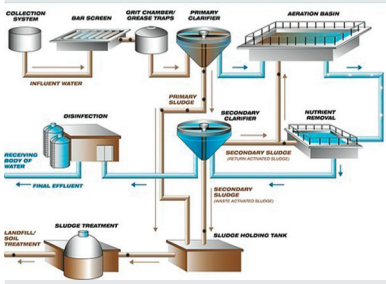


Image source : https://5.imimg.com/data5/DN/SY/MY-44176745/industrial-effluent-treatment-plant-installation-500x500.jpg

SKILLS:

- ✓ *Implement industrial management strategies for pollution prevention.*
- ✓ *Analyse and determine effluent toxicity.*
- ✓ *Develop solutions for industrial effluent toxicity.*

wastewater characteristics, source reduction options and waste treatment flow sheet for paper and pulp industry, wastewater characteristics, source reduction options and waste treatment flow sheet for petroleum refinery, wastewater characteristics, source reduction options and waste treatment flow sheet for pharmaceutical industry, wastewater characteristics, source reduction options and waste treatment flow sheet for food processing industry, wastewater characteristics, source reduction options and waste treatment flow sheet for fertilizers, wastewater characteristics, source reduction options and waste treatment flow sheet for thermal power plant.

PRACTICES:

- Case studies.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply reasoning to identify the constituents accountable for air pollution and different sources of effluent waste water and effect of pollutant on environment.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the impact of sampling, measurement and characterization of various air sampling and different effluent water and adopting advanced techniques to demonstrate the need for sustainable development.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate and characterize the various parameters for effluent samples, ambient air and stack air sampling from their sources to provide valid conclusions.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design and Identify and demonstrate the knowledge to use suitable equipment for abatement of air pollution and effluent waste water towards the control of air and water pollution.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of treatment towards the control of effluent waste water.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. G. L. Karia and R. A. Christian, “Waste Water Treatment: Concepts and Design Approach”,2nd Edition, Prentice Hall of India, 2013.
2. A. D. Patwardhan, “Industrial Waste Water Treatment”, 2nd Edition, Prentice Hall of India, 2009.
3. Metcalf & Eddy, “Wastewater engineering Treatment disposal reuse”, Tata McGraw Hill.

REFERENCE BOOKS:

1. Eckenfelder, W.W., “Industrial Water Pollution Control”, Mc Graw Hill, 2001.
2. Arceivala, S.J., “Wastewater Treatment for Pollution Control”, Tata McGraw-Hill, 2008.

22CH812 SOLID WASTE MANAGEMENT AND TREATMENT

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic course designed for fresher after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals with waste disposal and conversion techniques. The objective of this course is to identify key sources, typical quantities generated composition, and properties of solid and hazardous waste, the relevant regulations that apply for disposal, and destruction of waste.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Sources and types of solid wastes; Factors affecting generation of solid wastes; Characteristics; Methods of sampling and characterization; Effects of improper disposal of solid wastes; Public health effects; Principle of solid waste management; Social and economic aspects; Public awareness; Role of NGOs; Legislation; Methods of collection; Types of vehicles; Manpower requirement; Collection routes; Quantities of materials recovered from MSW; Waste handling and separation at Commercial and industrial facilities; Transfer stations; Selection of location; Operation and maintenance; Options under Indian conditions.

UNIT-2 **10L+6T+0P=16 Hours**

SOLID WASTE MANAGEMENT CONTROL:

Case study of factors affecting generation of solid wastes in nearby locality (Municipality), Sampling procedure, and various characterization techniques of MSW, Social awareness and economic aspects of MSWM, Public awareness campaign towards educate people regarding improper handling and related health and environmental effect of solid waste (NGO activity), Materials recovery facilities from generated MSW (case study), Criteria for selection of transfer stations for MSWM (case study), Several factors to be considered for improving MSW collection and transfer activity, Feasibility and categorization of operation & Maintenance of a Transfer Station".

- Case studies.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

STORAGE AND PROCESSING:

On-site storage methods; Materials used for containers; Onsite segregation of solid wastes; Public health and economic aspects of storage; Options under Indian conditions; Critical evaluation of options; Processing techniques and equipment; Resource recovery from solid wastes; Composting; Incineration; Pyrolysis; Combustion and energy recovery of municipal solid waste, effects of combustion, undesirable effects of Combustion; Dumping of solid waste; Landfill: Classification, planning, sitting, permitting, landfill processes, landfill design, landfill operation, use of old landfill; Sanitary landfills; Site selection; Design and operation of sanitary landfills; Leachate collection and treatment; Biochemical processes: Methane generation by anaerobic digestion, composting and other biochemical Processes.

Image source : https://thumbs.dreamstime.com/z/solid-waste-management-steps-processing-disposal-outline-diagram-labeled-educational-garbage-sorting-segregation-system-231523988.jpg

SKILLS:

- ✓ *Analyze the functional elements for solid waste management.*
- ✓ *Design waste management systems.*
- ✓ *Design modern sanitary landfill for waste disposal.*
- ✓ *Design the proper leachate treatment process.*

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

Public awareness, health and economic aspects of storage of MSW (Social activity), Economic study and design consideration of several waste processing methods, Controlling factors and design parameter for energy generation from SW through incineration, Controlling factors and design parameter for energy generation from SW through pyrolysis, Case study on combustion and energy recovery of municipal solid waste, Application of biochemical processes for waste disposal, Design consideration and location selection of sanitary land fill, Process intensification of Methane generation by anaerobic digestion, Controlling factors and potential methods of leachate collection and treatment, Compare disposal methods of MSW applying specific criteria.

- Case studies.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply reasoning to identify the constituents accountable for solid waste sources and their effective management and treatment.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the impact of storage, transportation and effective disposal of solid waste and adopting advanced techniques to demonstrate the need for sustainable development.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate and characterize the various sources and effective processing of municipal solid wastes and the harmful effects of the same on environment to provide valid conclusions.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design and demonstrate the knowledge to use suitable equipment for abatement of solid waste management.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of treatment towards the control of air and water pollution.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. George Tchobanoglous, “Integrated Solid Waste Management Engineering Principles and Management Issues”, McGraw-Hill, 1993.
2. Vesilind PA, Worrell W and Reinhart D, “Solid Waste Engineering”, Brooks Cole Thomson Learning Inc, 2002.

REFERENCE BOOKS:

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development,Government of India, New Delhi, 2000.
2. Qian X, Koerner RM and Gray DH, “Geotechnical Aspects of Landfill Design and Construction”, Prentice Hall of India, 2002.

22CH813 HEALTH, ENVIRONMENT AND SAFETY MANAGEMENT

Hours Per Week :

L	T	P	C
2	2	-	3

Image source : https://fiverrres.cloudinary.com/images/q_auto,f_auto/gigs/152497481/original/86b8c70e99bae9543bfba44323f6789630cde4de/help-you-make-your-hse-management-system-documentation.png

PREREQUISITE KNOWLEDGE: Basic course designed for fresher after 10+2 level.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides a comprehensive overview of management principles, industrial safety, Organization behavior, and accident prevention principles and practices. The objective of this course is to teach overview of status and future goals of computer utilization in safety, health and environment (SHE) services in industries.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

MANAGEMENT AND MANAGEMENT PRINCIPLES:

Management principles, general principles of management, managerial role, authority, responsibility and power, span of management, delegation and decentralization of authority, Safety, health and environment management(SHE), occupation Safety, health and Environmental Safety Management – Principal and Practices, Role of management in industrial safety, Organization behavioural human factors contributing to accident.

UNIT-2 **10L+6T+0P=16 Hours**

PLANNING AND ORGANIZATION FOR SAFETY:

Organization: definition, need, nature and principles. Organizing for safety, health and environment Organization structure, functions and responsibilities, safety committee: structure and functions, line and staff function for safety, health and environment, occupational safety, health and environment management system, bureau of Indian standards on safety and health: 14489-1998 and 15001-2000, ILO and EPA standards.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

PRINCIPLES OF ACCIDENT PREVENTION:

Definition: incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, errors, oversight, mistakes etc., Accident prevention: theories/models of accident occurrences. Principles of accident prevention. Accident and financial implication, Communication: purpose, process, types and channels, essential rules for communication. Two – way communication. Barriers in communication, essentials of effective commination, Communication and group dynamics.

UNIT-2 **10L+6T+0P=16 Hours**

PREVENTION AND TRAINING:

SHE: elements of training cycle, Assessment of needs. Techniques of training, design and development of training program. Training methods and strategies types of training. Evaluation and review of training programs, Competence building technique (CBT), concept for training, safety as an on-line function. Role of multi-media communication, Applications of computers. Relevance of WTO regarding safety,

SKILLS:

- ✓ *Able to assess the viability of Safety, health and environment management(SHE).*
- ✓ *Able to explain the theories/ models of accident occurrences.*
- ✓ *Able to analyze occupation Safety, health and Environmental Safety.*
- ✓ *Able to prevent the incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, errors, oversight, mistakes etc.*

health and Environment, Employee participation: purpose, areas of participation, methods. Role of trade Awards and suggestion schemes, safety competitions, safety incentives publicity schemes, Audio visual publicity, other promotional methods.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply Identify the key concepts and terminologies related to Safety, health and environment management.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the analyse occupation Safety, health and Environmental Safety.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate the different types safety measurements	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design models on the different accidental prevention techniques.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of theories/models of accident occurrences.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. By Frances Alston, Emily J. Millikin, “Guide to Environment Safety and Health Management Developing, Implementing, and Maintaining a Continuous Improvement Program”, CRC Press, 2016.
2. R. K. Jain, Sunil S. Rao, “Industrial Safety, Health and Environment Management Systems”, Khanna Publisher, 2000.

REFERENCE BOOKS:

1. Bill Taylor, “Effective Environmental, Health, and Safety Management Using the Team Approach”, Wiley, 2005.
2. Nicholas P. Cheremisinoff and Madelyn L. Graffia, “Environmental and Health and Safety Management”, Science Direct, 1995.

22CH814 INDUSTRIAL SAFETY ENGINEERING

Image source : https://knnindia.co.in/uploads/newsfiles/Industrial-Safety-18-2-19.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after intermediate.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with industrial safety programs and toxicology, industrial laws, and regulations. This course delivers identification of different types of hazard, toxic substance, fire and explosions. The objective of this course is to impart comprehensive knowledge of safety and hazards aspects in industries and management.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Introduction: Introduction to safety engineering; Key concepts and terminologies-safety domain ontology; Key concepts and terminologies-risk assessment and control; Safety engineering and accident-causing mechanisms.

UNIT-2 **10L+6T+0P=16 Hours**

HAZOP STUDY:

Hazard Identification Techniques: Preliminary Hazard List; Preliminary Hazard Analysis; Hazard and operability study (HAZOP); Failure Modes and Effects Analysis (FMEA)- Identification of Failure Modes.

- Case study on HAZOP related to different industry.
- Case study on application of Hazard Identification Techniques.
- Case study on accident-causing mechanisms.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

FAULT TREE AND EVENT TREE ANALYSIS:

Fault Tree Analysis (FTA- Construction; Fault Tree Analysis (FTA)- Gate by Gate Method; Fault Tree Analysis (FTA)- Cut-set method; Fault Tree Analysis (FTA): Importance measures; Event Tree Analysis (ETA).

UNIT-2 **10L+6T+0P=16 Hours**

SAFETY VS RELIABILITY – QUANTIFICATION OF BASIC EVENTS:

Quantification of Basic Events for Non-Repairable Components; Hazard Rate; Exponential Distribution; Weibull Distribution; Failure to Repair Process; Combined Process; Failure & Repair Intensities; Computation of combined process parameters- Laplace transform analysis, Markov Analysis.

SKILLS:

- ✓ *Suitable hazard identification techniques.*
- ✓ *Quantitative risk assessment procedure.*
- ✓ *Assessment of safety engineering and accident causing mechanisms.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the different Quantitative Risk Assessments (QRA).	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze several basic events like hazrad rate, exponential distribution, and failure to repair process, combined process and Markov analysis.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Analyze the key concepts and terminologies related to safety engineering.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Evaluate the different measures and analysis like FTA, ETA	Evaluate	1, 2	1, 2, 5, 9, 10
5	Evaluate the different hazard identification techniques.	Evaluate	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Komamoto and Henley, “Probabilistic Risk Assessment for Engineering and Scientists”, IEEE Press. 1995.
2. R.K. Jain and Prof. Sunil S. Rao., “Industrial Safety, Health and Environment Management Systems”. Khanna Publishers, ISBN: 978-81-7409-210-6.

REFERENCE BOOKS:

1. A.K. Gupta, “Industrial Safety and Environment”, Laxmi Publications, 2nd edition, 2015, ISBN-13:9788131804544.
2. Petersen D., “Techniques for safety management - A systems approach”, ASSE, 1998.

22CH815 NATURAL GAS ENGINEERING

Image source : https://www.rkk.com/wp-content/uploads/2019/09/Southside-Connector-Point-of-Delivery-Station_Photo1-1080x1080.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after completion of 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course emphasizes on providing the students with an overview of the Natural Gas (NG) segment. This course covers basic concepts and applications in natural gas engineering. The objective of this course is to train the student on the fundamental properties and technology for production, natural gas composition & processing, and transportation of natural gas.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

NATURAL GAS TECHNOLOGY AND COMPOSITIONS:

Natural Gas Technology and Earth Science: Sources for natural gas engineering and its applications; Geology and earth sciences-historical geology; Sedimentation process; Petroleum reservoirs- origin of petroleum, earth temperatures and earth pressure; Petroleum-natural gas; Gas hydrates; LPG; Condensate and crude oil.

Properties and Compositions of Natural Gas: Gas-specific gravity; pseudo critical properties- pressure and temperature, viscosity, density-vapor density, heat of combustion-energy content, Formation and expansion volume; Typical compositions.

UNIT-2 **10L+6T+0P=16 Hours**

GAS COMPRESSION:

Gas Compression: Positive displacement and centrifugal compressors; Fans- calculation of power requirements; Compressible flow in pipes- Fundamental equations of flow continuity, momentum, energy equations.

- Case studies on the effect of geology, temperature and pressure of petroleum reservoirs
- Design positive displacement and centrifugal compressors by autocad.
- Calculate of power requirements for positive displacement compressors
- Calculate of power requirements for centrifugal compressors.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

NATURAL GAS FLOW AND PROCESSING:

Isothermal Flow In Pipes: Weymouth equation; Static and flowing bottom-hole pressures in wells; Fundamentals of gas flow in porous media- steady state flow equations, gas flow in cylindrical reservoirs, general equation for radial flow of gases in symmetrical homogeneous reservoirs.

Natural Gas Processing: Separation of natural gas- Separate free liquid from gas stream, separator; Gravity segregation and centrifugal segregation; Separator design- vertical, horizontal and spherical separator, three phase separator; Dehydration of natural gas; Sweeting of natural gas; Compressor design; Natural gas transportation and measurement.

SKILLS:

- ✓ *Identification and process development of sedimentation process, gas hydrates, LPG.*
- ✓ *Analyze several properties and compositions of natural gas.*
- ✓ *Model development and design of numerous gas compressors.*
- ✓ *Separation and processing of natural gas through dehydration, sweeting.*

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

- Design oil-gas separators from hydrocarbon stream.
- Analysis and adjustment of models of well production decline for gas reserve estimation for any natural gas field.
- Design of different separator using software (Design expert/ Asphen / Autocad).
- Case studies on natural gas reservoir estimation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply for engineering/ managerial positions in oil and gas sector companies with an added advantage of having the exposure to such customised course curriculum.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the various typical compositions and properties of natural gas and mechanism of acid gas treating and condensate stabilization.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate various typical compositions and properties of natural gas and mechanism of acid gas treating and condensate stabilization.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design of cylindrical reservoirs, homogeneous reservoirs, compressor design, and natural gas transportation and measurement.	Create	1, 2	1, 2, 5, 9, 10, 12
5	Evaluate different alternatives for better economic efficiency.	Evaluate	2	1,2,6,7,8,9,11

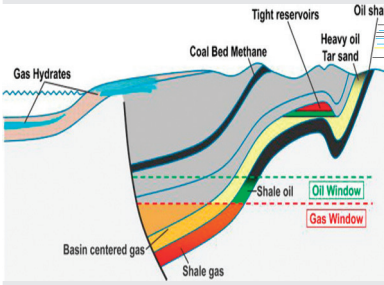
TEXT BOOKS:

1. Katz D.L., “Natural Gas Engineering: Production and Storage”, 2nd edition, McGraw-Hill, 1990.
2. B. Guo and A. Ghalambor, Natural Gas Engineering Handbook, Gulf Publishing Company, 2005.

REFERENCE BOOKS:

1. Lyons W. C. and Plisga G.C., Standard Handbook of Petroleum and Natural Gas Engineering Vol-2, 6th edition, Gulf Professional Publishing, 1996.
2. T. Ahmed and P. D. McKinney, Advanced Reservoir Engineering, Elsevier, 2005.

22CH816 NATURAL GAS HYDRATES AND COAL BED METHANE



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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basics of differentiation, petroleum reservoir, coal geology.

COURSE DESCRIPTION AND OBJECTIVES:

This course is designed to introduce a basic study of natural gas hydrates and coal bed methane and their properties. The student will be imparted the knowledge of overview of NGH and classification of NGH, Hydrate formation by using different methods, inhibiting hydrate formation, Different physical and chemical properties of NGH, Deacting with hydrates using heat and pressure and overall scenario of CBM.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

NATURAL GAS HYDRATES:

Introduction and Occurrences of Hydrate: Overview of natural gas hydrates- Natural gas- Water molecule- Hydrates- Water and natural gas- Free-Water- Heavy water- Units; Formation, accumulation and properties of gas hydrates; Indian scenario of gas hydrates; Thermodynamics, kinetics and phase behavior of gas hydrates; Hydrate types and formers: Type I hydrates- Type II hydrates- Size of the guest molecule- n-Butane-Other hydrocarbons and non-hydrocarbon molecules- Chemical properties of potential guests- Liquid hydrate formers- Type H hydrates- Hydrate forming conditions- Pressure-Temperature- Composition-Other hydrate formers- Mixtures- Examples.

Production of Hydrate: Drilling and production systems for gas hydrate wells; Extraction technologies from gas hydrates; Uses and applications of gas hydrates; producibility of gas hydrates and challenges.

UNIT-2 **10L+6T+0P=16 Hours**

RESERVE ESTIMATION AND SIMULATION:

Reserve Estimation- Future performance prediction: prediction process, sensitivity analyses, and validation of model predictions.

- Understanding the nature of distribution of gas hydrates in marine sediments.
- Developing techniques for detection and quantification of gas hydrates.
- Identifying promising sites on the regional scale and estimating the resource potential.
- Studying the impact of hydrate dissociation on climate and geological environment.
- CO2 Sequestration in Marine Hydrate Reservoir.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

COALBED METHANE

Basic introduction, generation and storage of CBM: CBM vs Conventional Reservoirs; Introduction & present status of coalbed methane – Global and Indian Scenario, Formation and properties of coalbed methane: properties of coal as reservoir rock, Generation of coalbed methane gas & its properties, CBM storage, sales and pricing in India; Geological influences CBM formations; Coal chemistry – Significance of rank–Cleat system and natural fracturing; Thermodynamics of coalbed methane: isotherm studies.

CBM Production: Overview of Drilling and Production systems of coalbed methane wells; Selection of

SKILLS:

- ✓ *Interpret coal specific tests such as sorption tests, sorption isotherms and well tests.*
- ✓ *Evaluate coal bed methane exploration and development opportunities.*
- ✓ *Compute gas in the reservoirs and estimate ultimate recovery.*
- ✓ *Develop skills in modelling single- and multiphase fluid flow in porous media.*

Artificial lift for CBM wells; Hydro-fracturing of coal seams; CBM produced water- Treating and disposing of CBM produced water; Testing of coalbed methane wells.

UNIT-2 **10L+6T+0P=16 Hours**

CBM RESERVE ESTIMATION AND SIMULATION :

Reserve Estimation: CH4 content determination in coal seams; Future performance prediction: prediction process, sensitivity analyses, and validation of model predictions.

- Simulation of flow of methane considering coal as a porous media through CFD.
- Mass, momentum, and energy transport in porous Media Determination of critical heat flux.
- Compute methane storage capacity for a particular reservoir/coalbed.
- Estimate ultimate recovery of CBM.
- Calculate water and gas production rate from a particular CBM well.
- Calculate cumulative water and gas production from a particular CBM well for a particular time spam (say 10 years).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge and exposure to contemporary energy recovery processes.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze various aspect of CO2 sequestration implementation in ECBM projects.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate various techniques / parameters affecting recovery of coal bed methane.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design various production methods from unconventional reservoirs.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, “Natural Gas Hydrates in Flow Assurance “ Elsevier, 2010.
2. Robert A. Lamarre, “Coal Bed Methane”, American Association of Petroleum Geologists, 2008.

REFERENCE BOOKS:

1. Y. Zee Ma and Stephen Holdich, “Unconventional Oil and Gas Resources – Exploitation and Development “ CRC Press, 2016.
2. Pramod Thakur , “Advanced Reservoir and Production Engineering for Coalbed Methane” , Gulf Publishing, 2016.
3. R. E. Roger, “Coal Bed Methane: Principles and Practice”, 3rd Edition, Prentice Hall, 1991.

22CH817 PETROCHEMICALS

Image source : https://5.imimg.com/data5/SB/MD/GLADMIN-58562601/petrochemicals-industries-500x500.png

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the conversion of crude oil and intermediate streams into finished products. The objective of this course is to get the familiarity with the various chemical processes deployed in petroleum industries.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

SOURCE OF PETROCHEMICALS AND SYNTHESIS GAS PRODUCTION:

Feed Stock and Source of Petrochemicals: Overview of petrochemical industry, feed stock selections for petrochemicals, steam cracking of gas and naphtha to produce olefins, diolefins and production of acetylene.

Synthesis Gas Production: Steam reforming of natural gas – naphtha and heavy distillate to produce hydrogen and synthesis gas; Production of methanol; Oxo process.

Primary Unit Processes: Fundamental and Technological principled involved in Alkylation– Oxidation; Nitration and hydrolysis.

UNIT-2 **10L+6T+0P=16Hours**

NAPHTHA AND NATURAL GAS:

- Case study and updated data calculation for gross consumption of naphtha and natural gas for Indian scenario.
- Case study and updated data calculation for gross consumption of naphtha and natural gas for global scenario.
- Yield calculation, quality of the product, estimation for the primary processes and treatment consideration.
- Report preparation on different petrochemicals production in India.

MODULE-2

UNIT-1 **10L+6T+0P=16 Hours**

UNIT PROCESSES AND CHEMICALS:

Secondary and Tertiary Unit Processes: Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerization, Halogenation and Esterification.

Chemicals From Gas Reforming: Methanol- Acetic acid- Ammonia and urea.

Chemicals from Ethylene: Ethylene Oxide-Mon ethylene Glycol-Ethyl Benzene-Styrene.

Polymers: LDPE, HDPE & LLDPE and Polypropylene – PVC - Polystyrene.

SKILLS:

- ✓ *Suitable hydro processing/treatment technologies to meet product qualities.*
- ✓ *Ability to process the opportunity crudes to maximize the throughput.*
- ✓ *Maximize the profitable products and minimize the quality give away.*

UNIT-2 **10L+6T+0P=16 Hours**

DESIGN OF PROCESS EQUIPMENTS:

- Design of sulphonation, sulfation unit.
- Design of isomerization unit.
- Design of Methanol production unit.
- Design of ammonia and urea production unit.
- Design of chemicals from ethylene production unit.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic knowledge of composition and related chemistry of petroleum and its characterization along with thermal properties in refining during treatment of petroleum.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the different reforming techniques used for petroleum industries that meet the specific requirements with approximate considerations.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Design various chemical process for production of petrochemicals.	Creating	1, 2	1, 2, 5, 9, 10, 12
4	Evaluate petrochemicals by advance techniques.	Evaluate	1, 2	1, 2, 5, 9, 10
5	Analyze the SCADA communication system, various industrial communication technologies and open standard communication protocols.	Create	2	1, 2, 5, 9, 10, 11

TEXT BOOKS:

1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2nd Edition, Gulf Publishing Company, 2000.

REFERENCE BOOKS:

1. Philip Herkimer Groggins. Unit processes in organic synthesis; Publisher: Tata McGraw-Hill.
2. Alireza Bahadori, Chikezie Nwaoha, Malcolm William Clark. Dictionary of Oil, Gas, and Petrochemical Processing. Publisher: CRC Press.

22CH818 PETROLEUM REFINERY ENGINEERING

Image source : https://miro. medium. com/max/1400/ 1*1IhAqt6VvbpL 4v3DGJuiAA.jpeg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the conversion of crude oil and intermediate streams into finished products. The objective of this course is to impart the student about the knowledge of distillation, cracking and reforming processes used in a typical refinery.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

CHARACTERIZATION AND CLASSIFICATION OF CRUDE OILS:

Composition of petroleum; Laboratory tests; Refinery feedstock and products; General definitions; Introduction to petroleum refinery; Crude oil-Classification, Characterization Composition, Physical properties; Analysis and distillation; Introduction to refinery feedstocks and refinery products.

UNIT-2 **10L+6T+0P=16 Hours**

DISTILLATION OF CRUDE OIL:

Evaluation of crude oil properties and design of crude oil distillation column; Dehydration and desalting of crude; Crude Assay - ASTM, TBP distillations; API gravity various average boiling points and mid percent curves; Evaluation of properties of crude oil and its fractions; Design concept of crude oil distillation column.

- Evaluation of properties of crude oil and its fractions.
- Design of Delayed coker unit through software.
- Design of crude distillation column and catalytic reforming unit.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

THERMAL AND CATALYTIC CRACKING:

Coking and thermal process; Delayed coking; Catalytic cracking- cracking reactions; zeolite catalysts, cracking feed stocks and reactors, effect of process variables, FCC cracking, catalyst coking and regeneration, design concepts, Catalytic reforming; Reforming catalysts; Reformer feed; Reforming reactor design- continuous and semi regenerative process.

UNIT-2 **10L+6T+0P=16 Hours**

HYDROTREATING AND HYDROCRACKING:

Hydrocracking feed stocks; Modes of hydrocracking; Effects of process variables; Hydro treating process and catalysts; Residue hydro processing; Effects of process variables; Reactor design concepts-isomerization, alkylation and polymerization.

- Case study on designs for fluidized-bed catalytic cracking units.
- Case study on application of catalytic reforming process.
- Case study on reforming reactor design.

SKILLS:

- ✓ *Recognize the essential specifications of the different types of distillation.*
- ✓ *Analyze the working condition of the vacuum and fractional distillation.*
- ✓ *Select suitable reforming process.*
- ✓ *Design waste water treatment from lube oil manufacturing unit.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic knowledge of composition and related chemistry of petroleum and its characterization along with thermal properties in refining during treatment of petroleum.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the different reforming techniques used for petroleum industries that meet the specific requirements with approximate considerations.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Conduct experiment through a cracking unit to obtain desired products, considering the impact of the processes on environment to assess the society.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design the crude distillation column and catalytic reforming unit.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. J. B. Maxwell, “Data Book of Hydrocarbons”, Krieger publishing company, 1975.
2. W. C. Edmister, “Applied Hydrocarbon Thermodynamics Vol-I and Vol-II”, Gulf Publishing, Company, 1988.

REFERENCE BOOKS:

1. Harker, J.H. and Backhusrt, J.R., “Fuel and Energy”, 1st edition, Academic Press Inc., 1981.
2. Mondal, P. and Dalai, A.K., “Sustainable Utilization of Natural Resources”. 1st edition, CRC Press, 2017.

22CH819 SURFACE PRODUCTION OPERATIONS

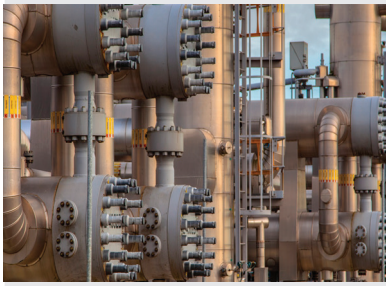


Image source : https://www.sogosacademy.com/wp-content/uploads/2015/09/Surface-Production-Operations_v2.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals with petroleum level and pressure systems, Field processing of oils, Storage of petroleum and its products, flow measuring equipment's and well stimulation technique. The objective of this course is to provide knowledge of production operations in the oil and gas wells.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

PRODUCTION FACILITIES:

Various types of facilities Controlling the process; Basic system, configuration design & selection of facilities, Stage Separation, Selection of Stages, Process flow sheets, P&IDs, monitoring well performance testing & optimization of flow.

UNIT-2 **10L+6T+0P=16 Hours**

PHASE SEPARATION:

Two Phase Liquid And Gas Separation: Functional sections of a gas, liquid separator; Inlet diverter section; Liquid collection section; Gravity settling section; Mist extractor section, Scrubbers.

Three Phase Oil, Gas And Water Separation: Equipment description; Horizontal separators; Derivation of equation; Free-water knockout; Flow splitter; Horizontal three-phase separator, Vertical separator; Selection considerations.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

CRUDE OIL TREATING AND OIL DESALTING SYSTEM:

Crude Oil Treating: Equipment description of various treaters and heaters; Indirect and fired heaters; Heater sizing; Vertical heater-treaters; Horizontal heater treaters; Electrostatic heater-treaters, Oil dehydrators, Emulsion treating theory Agitation, Emulsifying agents; Demulsifies.

Oil Desalting Systems: Oil desalting systems; Equipment description of desalters; Mixing equipment; Process description; Single stage desalting; Two stage desalting.

UNIT-2 **10L+6T+0P=16 Hours**

PRODUCED WATER TREATING SYSTEMS:

Characteristics of produced water; Sand and other suspended solids; Dissolved gases; Oil in water emulsions; Dissolved oil concentrations; Dispersed oil Toxicants; Gravity separation; Coalescence; Dispersion; Flotation; Filtration; Equipment description; Retention time and performance considerations- Design of produced water treating systems; Disposal standards- Disposal methods in Offshore & Onshore operations.

SKILLS:

- ✓ *Identification, classification and characterization of various heater treaters.*
- ✓ *Several techniques of three phase Oil, Gas and Water Separation.*
- ✓ *Design specification of desalter equipment.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basics of oil and gas production engineering techniques.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze various treating systems and their types for maintaining equipment in proper order.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate the performance of heater-treater in commercial use.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design of separators for industry purpose to check efficiency.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Ken Arnold & Maurice Stewart, Vol-1 & 2, “Surface Production Operations”, 3rd Edition, Gulf Professional Publishing, 2008.

REFERENCE BOOK:

1. H.K. Abdel-Aal and Mohamed Aggour and M.A. Fahim, “Petroleum and Gas Field Processing”, Marcel Dekkar Inc., 2003.

22CH820 ASPEN PLUS CHEMICAL ENGINEERING APPLICATION

Hours Per Week :

L	T	P	C
2	2	-	3

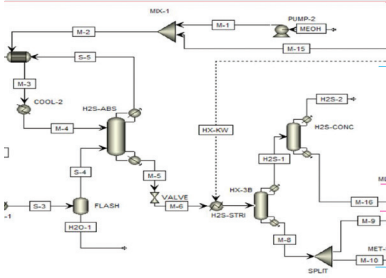


Image source : https://www.researchgate.net/profile/NaftaliMalka/publication/277013175/figure/fig1/AS:391998168158235@1470471054455/Simulation-of-Desulphurization-of-Synthesis-Gas-with-Aspen-Plus-Peter-Trop-et-al_Q640.jpg

PREREQUISITE KNOWLEDGE: Fundamental knowledge of chemical engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the identification of processes and their design for industrial viable route. The objective of this course is to explain the basic ASPEN application to design chemical manufacturing processes and reactor design.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION TO ASPEN PLUS:

Starting Aspen Plus, Graphic Users Interface, Simulation Options, Units, Components; Properties; Streams; Blocks, Viewing Results, Object Manager; Plotting Results. Pure Component Data Banks; Property Analysis; Property Estimation; Mixer Blocks, Splitter Blocks, Simple Separator Blocks: Sep Block and Sep2 Block; Manipulator Blocks: Dupl Block, Mult Block.

UNIT-2 **10L+6T+0P=16 Hours**

FLOWSHEETING AND MODEL ANALYSIS TOOLS:

Introduction to Fortran in Aspen Plus, Basic Interpreted Fortran Capabilities, Precedence of Calculations, Statement Format; Program Logic Control, Sensitivity Function, Design Specification, Calculator Function, Transfer Function.

PRACTICES:

- Design of Distillation Column.
- Design of ideal and non-ideal reactors.
- Design manufacture of acetone/ iso-octane/ Butyl acetate/ Cumene/ Ethyl Benzene/ Methanol/ Methoxy Methyl Heptane/ Methyl Acetate/ Dimethyl Ether/ Mono-iso Propyl Amine/ Styrene processes.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

DATA REGRESSION, MODEL AND SIMULATION:

Parameters of Equations of State; Parameters of Activity Coefficient Equations; Basic Ideas of Regression; Mathematics of Regression; Newton–Raphson Method for Solution of Nonlinear Equations; Direct Optimization of an Objective Function, Regression of VLE Data; Regression of LLE Data; Flashes and decanter; pressure changers; heat exchangers; reactors: R Stoic Block; R Yield Block; R Equil Block; R Gibbs Block; Reactions for the Rigorous Models: Equilibrium Class, Power law Class; Langmuir–Hinshelwood–Hougen–Watson Class; Multistage equilibrium separators.

UNIT-2 **10L+6T+0P=16 Hours**

ANALYSIS, SYNTHESIS AND DESIGN:

Design of Dimethyl Ether manufacture Process, Design of Ethyl Benzene manufacture Process, Design of Maleic Anhydride manufacture Process, Design of Ethylene Oxide manufacture Process, Design

SKILLS:

- ✓ *Property estimation using ASPEN Plus.*
- ✓ *Basic Interpreted Fortran Capabilities.*
- ✓ *Design of Distillation Column.*
- ✓ *Design of ideal and non-ideal reactors.*
- ✓ *Design of chemical processes.*

of Formalin manufacture Process, Design of Acrylic Acid manufacture Process, Design of Acetone manufacture from IPA Process, Design of Heptane from Propylene Process case studies on RTD in fluidized bed reactor.

PRACTICES:

- Design of Phenol hydrogenation to Cyclohexanone Process.
- Design of Alkylation of Benzene by Propylene to Cumene.
- Design of Vinyl Chloride Monomer manufacturing process.
- Design of Vinyl Acetate Monomer.
- Design of Vinyl Acetate Monomer.
- Design of Production of Acetic Acid via Partial Oxidation of Ethylene Gas.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply basics of ASPEN flow sheeting.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze design solution of chemical processes.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate regression problems using ASPEN.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design models on industrial chemical processes.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of thermodynamic non-ideal models using ASPEN.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1 Amiya K. Jana, “Process simulation and Control Using Aspen Plus”, PHI, 2009.

REFERENCE BOOKS:

1. Ralph Schefflan, “Teach Yourself The Basics of Aspen Plus”, Willy, 2011.
2. Kamal I.M. Al-Malah., “Aspen Plus: Chemical Engineering Applications’, Willy, 2016.

22CH821 COMPUTATIONAL FLUID DYNAMICS

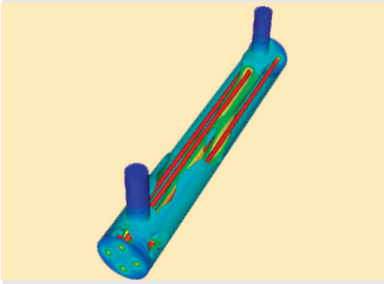


Image source : https://www.worldofchemicals.com/Article/11/Computational-fluid-dynamics.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Fundamental knowledge of chemical engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides an understanding of the major approaches and methodologies used in CFD. The objective of this course is to increase skills in implementing and using of basic CFD.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Mass conservation; Momentum and energy equation; Differential and integral forms; Conservation and non-conservation form; Characteristics of turbulent flows; Time averaged Navier Stokes equations; Turbulence models – one and two equations, Reynolds stress, LES and DNS.

UNIT-2 **10L+6T+0P=16 Hours**

FINITE VOLUME METHOD:

Diffusion problems; Explicit and implicit time integration; Convection diffusion problems; Properties of discretisation schemes- central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

PRACTICES:

- Explain how to classify and computationally solve Euler and Navier-Stokes equations.
- Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.
- Identify and implement numerical techniques for space and time integration of partial differential equations.
- Conduct numerical experiments and carry out data analysis.
- Simulating air and fuel flow inside the modified inlet duct to visualize Flow.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

FLOW FIELD COMPUTATION:

Pressure velocity coupling; Staggered grid; SIMPLE algorithm; PISO algorithm for steady and unsteady flows.

UNIT-2 **10L+6T+0P=16 Hours**

GRID GENERATION:

Physical aspects; Simple and multiple connected regions; Grid generation by PDE solution, Grid generation by algebraic mapping.

SKILLS:

- ✓ *Establish the best CFD model for the targeted problem.*
- ✓ *Articulate how to execute both steady state and transient (time dependent) fluid flow simulations.*
- ✓ *Comprehend mathematical components of governing equations.*
- ✓ *Establish the methodical application of the model equations and problems used in CFD.*

PRACTICES:

- CFD analysis of supersonic exhaust in a scramjet engine.
- Flow simulation (CFD) and wind tunnel experiment of cricket ball.
- A comprehensive study on multiphase flow through annular pipe using CFD approach.
- Numerical study of different types of fins.
- Interface forces calculation for multiphase flow simulation through CFD.
- Analyze the liquid and gas flow behavior in venture scrubber.
- Separation efficiency estimation of oil and gas separator.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply modern CFD software tools to build flow geometries.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Apply appropriate solvers to obtain a flow solution, and visualize the resulting flow field.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Develop an adequate mesh for an accurate solution.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Identify the type of fluid flow that is occurring in a particular physical system and to use the appropriate model equations to investigate the flow.	Create	2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Pletcher, r. H., Tannehill, j. C., Anderson, d., “Computational fluid mechanics and heat transfer”, 3rd ed., Crc press, 2011, ISBN 9781591690375.
2. T.j. chung, Computational Fluid Dynamics, Cambridge University Press.
3. Ghoshdastidar, Computational fluid dynamics and heat transfer, Cengage learning, 2017.
4. Charles Hirsch, Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 &Vol 2, Butterworth- Heinemann, 2007.

REFERENCE BOOKS:

1. Moin, p., Fundamentals of engineering numerical analysis, 2nd ed., Cambridge university press, 2010, ISBN 9780521805261.
2. Ferziger, j. H., Peric, m., Computational methods for fluid dynamics, 3rd ed., Springer, 2002.

22CH822 FUNDAMENTALS OF NANOTECHNOLOGY

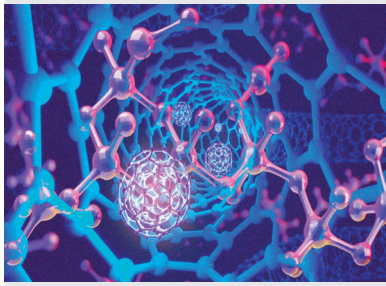


Image source : https://www.analyticsinsight.net/wp-content/uploads/2022/02/Nanotechnology-is-more-than-just-a-buzzword-Big-Things-from-a-Tiny-World.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Fundamental knowledge of chemical engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals about various types of nano materials and their importance. It includes the study of nanotechnology with their characterization, nano science, nano products etc. The objective of this course is to impart the student about the knowledge of nano particle synthesis, processing, characterization and various nano engineering applications.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION:

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires, ultra-thin-films, multi layered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT-2 **10L+6T+0P=16 Hours**

GENERAL METHODS OF PREPARATION:

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

PRACTICES:

- Case studies on in Nano computer.
- Case studies on Application in Nano InfoTech: Information storage.
- Case studies on Nano computer.
- Case studies on Molecular switch.
- Case studies on Super chip.
- Case studies on Nanocrystal.
- Case studies on Nano bio technology: nanoprobes in medical diagnostics and biotechnology.
- Case studies on Nano medicines, Targeted drug delivery.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

NANOMATERIALS:

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis (arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2, MgO, ZrO2, NiO, nano alumina, CaO, AgTiO2, Ferrites, Nano clays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

SKILLS:

- ✓ *How to synthesize the nano material.*
- ✓ *Determine the step towards the formation of special nano material.*
- ✓ *Find the characteristics of nano material as a several form.*
- ✓ *Know the importance of different nano structure and their specific utilization.*

UNIT-2 **10L+6T+0P=16 Hours**

CHARACTERIZATION TECHNIQUES:

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply of the basics of nanoscale hypothesis along with nanomaterials properties and their applications.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Identify and analyze estimated instrumental techniques for characterization of nanoparticles with a considerate of their limitations to assess for future.	Apply	1	1,2,9,11
3	Perceptive.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Formulate and design suitable fabrication technique for the synthesis of nanoparticles and nanomaterial.	Evaluate	1, 2	1, 2, 5, 9, 10
5	Demonstrate the numerous applications of nanotechnology towards electronics, chemical, automobile and aerospace engineering to evaluate the societal health and safety.	Create	2	1, 2, 5, 9, 10, 12

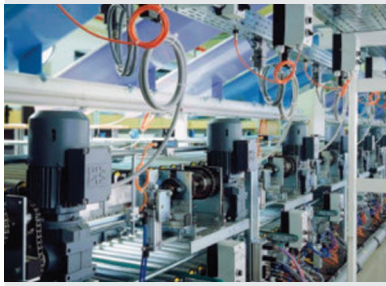
TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, “Nanoscale Charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCE BOOKS:

1. G Timp, “Nanotechnology”, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia,“The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

22CH823 INDUSTRIAL INSTRUMENTATION



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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Fundamental knowledge of chemical engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The course delivers insight into instruments that are used to measure physical properties, composition analysis in chemical process industries. This course encompasses knowledge of pressure, flow, temperature, head & level, viscosity, density and color measurements. The objective of this course is to familiarize student with the working principles of standard measurement devices used in industries.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

MEASUREMENT OF PARAMETERS:

Different types of load cells: Hydraulic, Pneumatic, Strain gauge, Magneto-elastic and Piezoelectric load cells – Different methods of torque measurement: Strain gauge, Relative angular twist, Accelerometers: LVDT, Piezoelectric, Strain gauge and Variable reluctance type accelerometers – Mechanical type vibration instruments – Seismic instruments as accelerometer – Vibration sensor – Calibration of vibration pickups – Units of density and specific gravity – Baume scale and API scale, Viscosity, Consistency Meters – Humidity: Dry and wet bulb psychrometers, Dew cell – Commercial type dew meter. Moisture: Different methods of moisture measurements –Thermal, Conductivity and Capacitive sensors, Microwave, IR and NMR sensors.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

Application in Sped measurement: Capacitive tacho, Drag cup type tacho, D.C and A.C tacho generators – Stroboscope, Application in Densitometers: Pressure type densitometers, Float type densitometers, Ultrasonic densitometer and gas densitometer, Application in Viscosity measurements- Say bolt viscometer, Rotameter type and Torque type viscometers, Application in moisture measurement – Moisture measurement in solids, Application of Resistive and capacitive type hygrometers.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

TEMPERATURE AND PRESSURE MEASUREMENT:

Definitions and standards – Primary and secondary fixed points – Different types of filed in system thermometers – Sources of errors in filed in systems and their compensation – Bimetallic thermometers – IC sensors – Thermocouples: Laws of thermocouple, Reference junction's compensation, Signal conditioning for thermocouple, Commercial circuits for cold junction compensation, Response of thermocouple, Radiation fundamentals, Units of pressure – Manometers: Different types, Elastic type pressure gauges: Bourdon tube, Bellows, Diaphragms and Capsules – Electrical methods: Elastic elements with LVDT and strain gauges – Capacitive type pressure gauge – Piezo resistive pressure Sensor-Resonator pressure sensor – Measurement of vacuum: McLeod gauge, Thermal conductivity gauge, lionization gauges, Cold cathode type and hot cathode type.

SKILLS:

- ✓ *Flow measurement techniques using various devices.*
- ✓ *Temperature and thermal coefficient of resistance measurement.*
- ✓ *Composition, analysis and color measurement through several chromatography, spectrometry.*
- ✓ *Suitable measurement device selection for a specific application.*

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATIONS:

Application in Radiation methods of temperature measurement- Total radiation pyrometers – Optical pyrometers – Two color radiation pyrometers, Fabrication of industrial thermocouples, Application in Fiber optic sensor for temperature measurement – Thermograph, Application of Special techniques for measuring high temperature using thermocouple, Application in Pressure gauge selection, installation and calibration using dead weight ester.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply and explain the concept of instrumentation in numerous application of process industries.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Elucidate the construction and working principle of various industrial devices used to measure pressure, temperature and flow.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Illustrate the different methods for the measurement of various physico-chemical properties.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Analyze and formulate suitable sensor for the several industrial applications.	Evaluate	1, 2	1, 2, 5, 9, 10
5	chromatography such as GC, HPLC, GCMS, and LCMS.	Create	2	1, 2, 5, 9, 10, 12

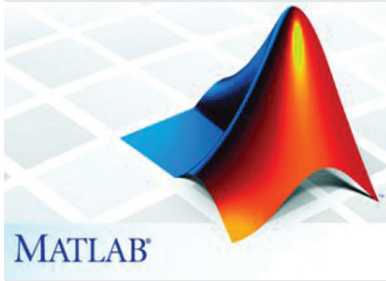
TEXT BOOKS:

1. D. Patranabis, “Principles Of Industrial Instrumentation 3e”, Tata Mac Grow Hill Education Private Limited, 2010.
2. K. Krishnaswamy, “Industrial Instrumentation”, New Age International Publisher, 2020.

REFERENCE BOOK:

1. William C. Dunn, “Fundamentals of Industrial Instrumentation and Process Control”, Mc GrawHill Professional, 2005.

22CH824 MATLAB PROGRAMMING FOR CHEMICAL ENGINEERS



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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basic engineering mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

MATLAB is a popular language for numerical computation. This course introduces students to MATLAB programming, and demonstrate its use for scientific computations. The basis of computational techniques is expounded through various coding examples and problems, and practical ways to use MATLAB will be discussed. The objective of this course is to introduce undergraduate students to computational methods using MATLAB. At the end of this course, a student would: Learn basics of MATLAB programming get introduced to numerical methods for engineering problems will be able to use MATLAB to solve computational problems software used.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

INTRODUCTION TO MATLAB PROGRAMMING:

Basics of MATLAB programming; Array operations in MATLAB; Loops and execution control; Scripts and Functions; Plotting and program output. Defining errors and precision in numerical methods; Truncation and round-off errors; Error propagation; Global and local truncation errors; Numerical differentiation in single variable; Numerical differentiation- higher derivatives; Differentiation in multiple variables; Newton-Cotes integration formulae; multi-step application of trapezoidal rule; MATLAB functions for integration.

UNIT-2 **10L+6T+0P=16 Hours**

LINEAR AND NONLINEAR EQUATIONS:

Linear algebra in MATLAB; Gauss elimination; LU decomposition and partial pivoting; Iterative methods-Gauss Siedel; Special Matrices- tridiagonal matrix algorithm; Nonlinear equations in single variable; MATLAB function zero in single variable; Fixed-point iteration in single variable; Newton-Raphson in single variable; MATLAB function solve in single and multiple variables; Newton-Raphson in multiple variables.

PRACTICES:

- Estimation of Pressure by Raoult's Law using MATLAB.
- Determination of bubble point temperature for a mixture using MATLAB.
- Estimation of vapor-liquid equilibrium by modified Raoult's Law using MATLAB.
- Estimation of Laminar flow of water in a horizontal annulus using MATLAB.
- Estimation of Reaction rate constant and Reaction order using MATLAB.
- Determination of mass transfer in a Falling Laminar Film using MATLAB.
- Estimation of steam consumption in a single effect evaporator using MATLAB.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

REGRESSION AND INTERPOLATION:

Introduction; Linear least squares regression (including lsqcurvefit function); Functional and nonlinear regression (including isqnonlin function); Interpolation in MATLAB using spline pchip. Introduction to ODEs; Implicit and explicit Euler's methods; Second order Runge-Kutta methods; MATLAB ode 45 algorithm in single variable; Higher order Runge-Kutta methods; Error analysis of Runge-Kutta method.

SKILLS:

- ✓ *Solve higher derivatives numerically.*
- ✓ *Solve linear equations using MATLAB.*
- ✓ *Solve nonlinear equations using numerical methods.*
- ✓ *Approximate the solution by using linear least squares regression.*
- ✓ *Solve differential equations using various numerical methods.*

UNIT-2 **10L+6T+0P=16 Hours**

ORDINARY DIFFERENTIAL EQUATIONS:

MATLAB ode45 algorithm in multiple variables; Stiff ODEs and MATLAB ode15s algorithm; Practical example for ODE-IVP; Solving transient PDE using method of lines.

PRACTICES:

- Determination of column diameter in a packed bed absorber using MATLAB.
- Estimation of column height in a packed bed absorption column using MATLAB.
- Determination of number of theoretical stages in binary distillation using McCabe Thiele method using MATLAB.
- Determination of minimum number of theoretical stages using Fenske Equation using
- MATLAB.
- Estimation of heat flux through the slab in heat transfer through a Multilayer Slab using MATLAB.
- Estimation of heat transfer in A Laminar Flow through a cylinder using MATLAB.
- Estimate the overall heat transfer coefficient in a double pipe heat exchanger using MATLAB.
- Estimate the overall heat transfer coefficient in a shell and tube heat exchanger using MATLAB.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply basics of MATLAB programming.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze nonlinear equations using MATLAB.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate linear equations using MATLAB.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design models on approximate solution by using regression methods.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of MATLAB ode45 algorithm.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. L. V. Fausett, “Applied Numerical Analysis Using MATLAB” 2nd edition, Pearson Education, 2009.
2. Rudra Pratap, “Getting started with MATLAB”, Oxford University Publication, 2009.

REFERENCE BOOKS:

1. S. C. Chapra, R. P. Canale, Numerical methods for engineers, 5th edition, McGraw Hill, 2006.
2. Srimanta Pal and Subodh C. Bhunia, “Engineering Mathematics”, Oxford Publications, 2015.
3. 2. B. V. Ramana, “Advanced Engineering Mathematics”, McGraw Hill education, 25th reprint, 2015.

22CH825 NOVEL SEPARATION PROCESSES

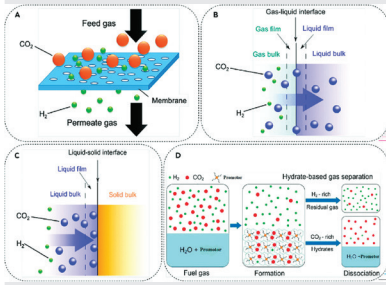


Image source : https://www.researchgate.net/profile/Ali-Davoodabadi-2/publication/347590664/figure/fig2/AS:973814422839298@1609186859528/Hydrogen-purification-techniques-Membrane-method-that-selectively-separates-CO-2_W640.jpg

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Fundamental knowledge of chemical engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers the fundamentals of Novel and advanced separation techniques. The objectives of the course are to discuss the innovative concepts, mechanism, and application of several advanced separation techniques such as membrane separation, ionic separations, thermal separations and several other novel separation techniques.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

FUNDAMENTALS OF SEPARATION PROCESSES:

Membrane Separations: Types and choice of membranes, their merits, commercial, pilot plant polarization of membrane processes and laboratory membrane permeators, dialysis, reverse osmosis, ultra-filtration, Concentration and economics of membrane operations, Design controlling factors. Types and choice of adsorbents, chromatographic techniques, Types, Retention theory mechanism, recent advances and economics.

UNIT-2 **10L+6T+0P=16 Hours**

APPLICATION AND TECHNIQUES:

Design controlling factors ion exchange chromatography equipment, Design and controlling factors for commercial processes, Economics and feasibility study of membrane operations in a pilot scale study, Design estimation and controlling factors for membrane separation by reverse osmosis, Several applications of different membrane separation techniques in water purification (case study), Specific application of chromatographic techniques (case study), Novel adsorbent preparation and various characterization techniques, Applicability of various adsorbents towards industrial effluent treatment.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

IONIC AND THERMAL SEPARATIONS:

Controlling factors, applications, Theory mechanism and-equipment's for electrophoresis, Di electrophoresis and electrodialysis, Thermal diffusion: Basic rate law, phenomenological theories of thermal diffusion for gas and liquid mixtures, Equipment design and applications. Zone melting: Equilibrium diagrams, controlling factors, Apparatus and applications, Adductive crystallization molecular addition compounds, Clathrate compounds and adducts, Equipment, Applications, Economics and commercial processes. Foam Separation: Surface adsorption, Nature of foams, Apparatus, Applications, and Controlling factors.

UNIT-2 **10L+6T+0P=16 Hours**

DESIGN AND APPLICATION:

Design considerations of Di electrophoresis and electrodialysis, Commercial applications of Di electrophoresis and electrodialysis, controlling factors and various application of ionic separation methods, Equipment design and applications of thermal separation, Design consideration and controlling

SKILLS:

- ✓ *Design specification and controlling factors of several different types of membrane and related processes.*
- ✓ *Handling and design controlling factors of ion exchange chromatography equipment.*
- ✓ *Design concerns of various ionic separation processes.*
- ✓ *Equipment design and applications of thermal separation, foam separation, surface adsorption.*

factors of thermal separation process, Specific application zone melting process (case study), Equipment design and applications of Adductive crystallization operation, Cost estimation and feasibility study towards commercial application.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply of the principles of novel separation process to evaluate societal, health and safety by subsequent responsibilities.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze the mechanism of chromatography techniques and recent advancement.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate the principles and characterization techniques of various membrane separation processes and resolve separation problems associated to membrane.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design several ionic separation process and thermal separation technique and specific applications.	Create	2	1, 2, 5, 9, 10, 12
5	Creation of numerous other advanced separation process, controlling factors and applications.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

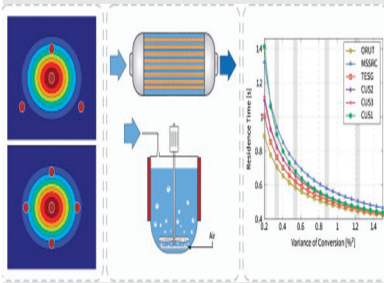
TEXT BOOKS:

1. H.M. Schoen, New Chemical Engineering Separation Techniques, Wiley Interscience, New York, 1972.
2. C.J. King, Separation Processes, Tata McGraw Hill, New Delhi, 1982.
3. B. Sivasankar, Bioseparations – Principles and Techniques, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Kaushik Nath, Membrane Separation processes, PHI, 2008.

REFERENCE BOOKS:

1. R.E. Lacey and S. Loeb, Industrial Processing with Membranes, Wiley–Inter sciences, New York, 1972.
2. Ronald W.Roussel, Hand book of Separation Process Technology, John Wiley, New York, 1987.
3. H.R.C. Pratt, Counter-Current Separation Processes, Elsevier, Amsterdam, 1967.
4. J.D. Seader, Ernest J.Henley and D. Keith Roper, Separation process Principles, 3rd Ed., John Wiley & Sons Australia, Limited, 2010.

22CH826 OPTIMIZATION IN CHEMICAL ENGINEERING



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Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Fundamental knowledge of chemical engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with optimization algorithms, modeling skills to describe and formulate optimization problems. The objective of this course is to familiarize the student with formulation of optimization problems, single and multivariable optimization, linear programming and optimization of chemical processes.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

MATHEMATICAL MODELS OF CHEMICAL ENGINEERING SYSTEMS:

Fundamentals: Fundamental laws: Continuity equations, Energy equation, Equation of motion.

Examples Of Mathematical Models Of Chemical Engineering Systems : Gravity flow tank, Constant and variable volume CSTRs in series; Two heated tanks, Gas phase pressurized CSTR; Non-isothermal CSTR.

Examples of Mathematical Models Of Chemical Engineering Systems: Single component vaporizer; Batch reactor; Reactor with mass transfer; Ideal binary distillation column; Batch distillation with holdup.

UNIT-2 **10L+6T+0P=16 Hours**

NUMERICAL METHODS:

Numerical Methods: Newton–Raphson method, False position method.

Numerical Integration of Odes: Euler method, Runge-Kutta fourth order method.

Nature and Organization of Optimization Problems: What optimization is all about; Why optimize; Essential features of optimization problems; General procedure for solving optimization problems.

Basic Concepts of Optimization: Continuity of functions; Unimodal versus multimodal functions; Convex and concave functions; Convex region.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

MULTIVARIABLE OPTIMIZATION :

Unconstrained Multivariable Optimization: Direct methods - random search, grid search, univariate search, simplex method, conjugate search, Powell's methods; Indirect methods for first order- gradient method, conjugate method; Indirect method for second order- Newton's method.

UNIT-2 **10L+6T+0P=16 Hours**

LINEAR PROGRAMMING AND APPLICATIONS:

Linear Programming And Applications: Geometry of linear programs; Standard LP form; Degenerate LP's–graphical solution; Simplex method.

SKILLS:

- ✓ *Model development for a given engineering system.*
- ✓ *Solve process model equations using numerical techniques.*
- ✓ *Formulation of optimization problems.*
- ✓ *Optimize the engineering process.*

Applications of Optimization: Optimizing recovery of waste heat; Optimization of multi effect evaporator; Optimal design of staged distillation column; Optimal pipe diameter; Optimization of thermal cracker.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the fundamental laws for formulation of mathematical model equation.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analyze different optimization techniques.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Develop algorithms for different chemical systems using appropriate numerical method.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Creation of simulation programs to various chemical systems.	Create	2	1, 2, 5, 9, 10, 12
5	Optimization of different chemical engineering systems.	Create	1, 2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. W. L. Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2nd edition, McGraw-Hill, 1990.
2. T. F. Edgar and D. M.. Himmelblau, “Optimization of Chemical Processes”, 2nd edition, McGraw- Hill, 2001.

REFERENCE BOOKS:

1. K. Balu and K. Padmanabhan, “Modeling and Analysis of Chemical Engineering Processes”, IK International Private Limited, 2007.
2. Santosh. K. Gupta, “Numerical Methods in Engineering”, 2nd edition, New Age International (P) Ltd., 2003.
3. S. S. Rao, “Engineering Optimization”, 4th edition, John Wiley & Sons, Inc., 2009.

22CH827 TRANSPORT PHENOMENA

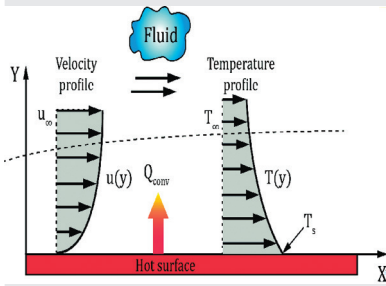

Image source : https://www.researchgate.net/profile/Nageswaran-Tamil Alagan/publication/320471113/ figure/fig15/AS:551178124447756@1508422513671/Velocity-and-temperature-profile-for-convection-heat-transfer-from-a-hot-surface-to-fluid.png

Hours Per Week :

L	T	P	C
2	2	-	3

PREREQUISITE KNOWLEDGE: Basics engineering mathematics and chemical engineering fundamental concept.

COURSE DESCRIPTION AND OBJECTIVES:

The course provides fundamental understanding of various transport processes occurring in process industries. The objective of this course is to train the student to analyse and develop the relevant distributions in momentum transfer, heat transfer and mass transfer phenomena.

MODULE-1

UNIT-1 **6L+10T+0P=16 Hours**

TRANSPORT PROPERTIES AND MOMENTUM TRANSPORT:

Laws of momentum, energy and mass transfer; Transport properties; methods to estimate the transport properties; analogy between transport properties; Momentum; Momentum balance equation; Momentum flux; Forces; Boundary conditions; Continuity equation; Equation of Motion.

UNIT-2 **10L+6T+0P=16 Hours**

VELOCITY DISTRIBUTIONS:

Transport properties estimation from different methods; Velocity distributions – Flow over a plate, flow through tube and slit; flow though annulus, flow of non-Newtonian fluid, flow of immiscible liquids; Velocity distributions form equations of change.

MODULE-2

UNIT-1 **6L+10T+0P=16 Hours**

ENERGY AND MASS TRANSPORT:

Energy; Energy balance equation; Energy flux; Energy generation; Boundary conditions; Mass; Mass balance equation; Mass flux; Mass generation; Boundary conditions.

UNIT-2 **10L+6T+0P=16 Hours**

TEMPERATURE AND CONCENTRATION DISTRIBUTIONS:

Temperature distributions – with and without heat generation; Diffusion through stagnant film; Diffusion through stagnant film; Equimolal counter diffusion; Diffusion with homogeneous and heterogeneous reaction.

PRACTICES:

- Determination of heat transfer coefficient in double pipe heat exchanger.
- Determination of heat transfer coefficient in shell and tube heat exchanger.
- Determination of critical heat flux.
- Separation of alcohol by using distillation.
- Extraction of caffeine using liquid-liquid extraction.
- Preparation of carbonated water using absorption.
- Removal of impurities from water by Adsorption.

SKILLS:

- ✓ *Estimation of transport properties.*
- ✓ *Predict appropriate boundary conditions for fluid flow.*
- ✓ *Develop velocity, temperature and concentration distribution profiles for simple geometries.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic knowledge of mathematics and engineering fundamentals to solve various chemical engineering problems.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the steady state operations for momentum, heat & mass transfers to interpret practical data to provide valid conclusions.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate the transport properties.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Develop the velocity, temperature and concentration distributions.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Bird R. B., Stewart W. E. and Lightfoot. B., “Transport Phenomena”, 3rd edition, Mc Graw-Hill, 2003.

REFERENCE BOOKS:

1. James. R. Welty, Robert. E. E. Wilson, “Fundamentals of Momentum, Heat and Mass Transfer”, 2nd edition, John Wiley & Sons, 2002.
2. Theodore L., “Transport Phenomena”, 2nd edition, John Wiley & Sons, 2002.
3. Geankoplis J., “Transport Processes & Unit Operations”, 3rd edition, Prentice Hall of India, 2003.

HONOURS

CHEMICAL ENGINEERING

B.Tech.

- 22CH951 - Natural Gas Engineering
- 22CH952 - Natural Gas Hydrates and Coal Bed Methane
- 22CH953 - Petrochemicals
- 22CH954 - Petroleum Refinery Engineering
- 22CH955 - Surface Production Operations

COURSE CONTENTS

I SEM & II SEM

22CH951 NATURAL GAS ENGINEERING

Image source : https://www.gousa.study/images/masters-in-natural-gas-engineering-usa.jpg

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course emphasizes on providing the students with an overview of the Natural Gas (NG) segment. This course covers basic concepts and applications in natural gas engineering. The objective of this course is to train the student on the fundamental properties and technology for production, natural gas composition & processing, and transportation of natural gas.

MODULE-1

UNIT-1 **16L+4T+0P=20 Hours**

NATURAL GAS TECHNOLOGY AND COMPOSITIONS

Natural Gas Technology and Earth Science: Sources for natural gas engineering and its applications; Geology and earth sciences-historical geology; Sedimentation process; Petroleum reservoirs- origin of petroleum, earth temperatures and earth pressure; Petroleum-natural gas; Gas hydrates; LPG; Condensate and crude oil.

Properties and Compositions of Natural Gas: Gas-specific gravity; pseudo critical properties-pressure and temperature, viscosity, density-vapor density, heat of combustion-energy content, Formation and expansion volume; Typical compositions

UNIT-2 **8L+12T+0P=20 Hours**

GAS COMPRESSION

Gas Compression: Positive displacement and centrifugal compressors; Fans- calculation of power requirements; Compressible flow in pipes- Fundamental equations of flow continuity, momentum, energy equations.

- Case studies on the effect of geology, temperature and pressure of petroleum reservoirs
- Design positive displacement and centrifugal compressors by autocad.
- Calculate of power requirements for positive displacement compressors
- Calculate of power requirements for centrifugal compressors.

MODULE-2

UNIT-1 **16L+4T+0P=20 Hours**

NATURAL GAS FLOW AND PROCESSING

Isothermal Flow In Pipes: Weymouth equation; Static and flowing bottom-hole pressures in wells; Fundamentals of gas flow in porous media- steady state flow equations, gas flow in cylindrical reservoirs, general equation for radial flow of gases in symmetrical homogeneous reservoirs.

Natural Gas Processing: Separation of natural gas- Separate free liquid from gas stream, separator; Gravity segregation and centrifugal segregation; Separator design- vertical, horizontal and spherical separator, three phase separator; Dehydration of natural gas; Sweeting of natural gas; Compressor design; Natural gas transportation and measurement.

SKILLS:

- ✓ *Identification and process development of sedimentation process, gas hydrates, LPG.*
- ✓ *Analyze several properties and compositions of natural gas.*
- ✓ *Model development and design of numerous gas compressors.*
- ✓ *Separation and processing of natural gas through dehydration, sweeting.*

UNIT-2 **8L+12T+0P=20 Hours**

- Design oil-gas separators from hydrocarbon stream.
- Analysis and adjustment of models of well production decline for gas reserve estimation for any natural gas field.
- Design of different separator using software (Design expert/ Asphen / Autocad).
- Case studies on natural gas reservoir estimation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply for engineering/ managerial positions in oil and gas sector companies with an added advantage of having the exposure to such customised course curriculum.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the various typical compositions and properties of natural gas and mechanism of acid gas treating and condensate stabilization.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate various typical compositions and properties of natural gas and mechanism of acid gas treating and condensate stabilization.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design of cylindrical reservoirs, homogeneous reservoirs, compressor design, and natural gas transportation and measurement.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Katz D.L., “Natural Gas Engineering: Production and Storage”, 2nd edition, McGraw-Hill, 1990.
2. B. Guo and A. Ghalambor, Natural Gas Engineering Handbook, Gulf Publishing Company, 2005.

REFERENCE BOOKS:

1. Lyons W. C. and Plisga G.C., Standard Handbook of Petroleum and Natural Gas Engineering Vol-2, 6th edition, Gulf Professional Publishing, 1996.
2. T. Ahmed and P. D. McKinney, Advanced Reservoir Engineering, Elsevier, 2005.

22CH952 NATURAL GAS HYDRATES AND COAL BED METHANE

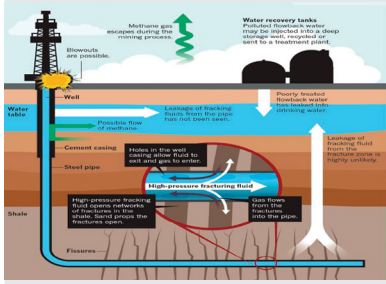

Image source : https://www.pmfias.com/wp-content/uploads/2016/01/Hydro-fracturing-or-Fracking-extraction-of-shale-gas-Copy.jpg

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Basics of differentiation, petroleum reservoir, coal geology.

COURSE DESCRIPTION AND OBJECTIVES:

This course is designed to introduce a basic study of natural gas hydrates and coal bed methane and their properties. The student will be imparted the knowledge of overview of NGH and classification of NGH, Hydrate formation by using different methods, inhibiting hydrate formation, Different physical and chemical properties of NGH, Deacting with hydrates using heat and pressure and overall scenario of CBM.

MODULE-1

UNIT-1 **14L+6T+0P=20 Hours**

NATURAL GAS HYDRATES

Introduction and Occurrences of Hydrate: Overview of natural gas hydrates- Natural gas- Water molecule- Hydrates- Water and natural gas- Free-Water- Heavy water- Units; Formation, accumulation and properties of gas hydrates; Indian scenario of gas hydrates; Thermodynamics, kinetics and phase behavior of gas hydrates; Hydrate types and formers: Type I hydrates- Type II hydrates- Size of the guest molecule- n-Butane-Other hydrocarbons and non-hydrocarbon molecules- Chemical properties of potential guests- Liquid hydrate formers- Type H hydrates- Hydrate forming conditions- Pressure-Temperature- Composition-Other hydrate formers- Mixtures- Examples.

Production of Hydrate: Drilling and production systems for gas hydrate wells; Extraction technologies from gas hydrates; Uses and applications of gas hydrates; producibility of gas hydrates and challenges.

UNIT-2 **10L+10T+0P=20 Hours**

RESERVE ESTIMATION AND SIMULATION

Reserve Estimation- Future performance prediction: prediction process, sensitivity analyses, and validation of model predictions.

- Understanding the nature of distribution of gas hydrates in marine sediments.
- Developing techniques for detection and quantification of gas hydrates.
- Identifying promising sites on the regional scale and estimating the resource potential.
- Studying the impact of hydrate dissociation on climate and geological environment.
- CO2 Sequestration in Marine Hydrate Reservoir.

MODULE-2

UNIT-1 **14L+6T+0P=20 Hours**

COALBED METHANE

Basic introduction, generation and storage of CBM: CBM vs Conventional Reservoirs; Introduction & present status of coalbed methane – Global and Indian Scenario, Formation and properties of coalbed methane: properties of coal as reservoir rock, Generation of coalbed methane gas & its properties, CBM storage, sales and pricing in India; Geological influences CBM formations; Coal chemistry – Significance of rank – Cleat system and natural fracturing; Thermodynamics of coalbed methane: isotherm studies.

SKILLS:

- ✓ *Interpret coal specific tests such as sorption tests, sorption isotherms and well tests.*
- ✓ *Evaluate coal bed methane exploration and development opportunities.*
- ✓ *Compute gas in the reservoirs and estimate ultimate recovery.*
- ✓ *Develop skills in modelling single- and multiphase fluid flow in porous media.*

CBM Production: Overview of Drilling and Production systems of coalbed methane wells; Selection of Artificial lift for CBM wells; Hydro-fracturing of coal seams; CBM produced water- Treating and disposing of CBM produced water; Testing of coalbed methane wells.

UNIT-2 **6L+14T+0P=20 Hours**

CBM RESERVE ESTIMATION AND SIMULATION

Reserve Estimation- CH4 content determination in coal seams; Future performance prediction: prediction process, sensitivity analyses, and validation of model predictions.

- Simulation of flow of methane considering coal as a porous media through CFD.
- Mass, momentum, and energy transport in porous Media Determination of critical heat flux.
- Compute methane storage capacity for a particular reservoir/coalbed.
- Estimate ultimate recovery of CBM.
- Calculate water and gas production rate from a particular CBM well.
- Calculate cumulative water and gas production from a particular CBM well for a particular time spam (say 10 years).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge and exposure to contemporary energy recovery processes.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze various aspect of CO2 sequestration implementation in ECBM projects.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate various techniques / parameters affecting recovery of coal bed methane.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design various production methods from unconventional reservoirs.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, “Natural Gas Hydrates in Flow Assurance “ Elsevier, 2010.
2. Robert A. Lamarre, “Coal Bed Methane”, American Association of Petroleum Geologists, 2008.

REFERENCE BOOKS:

1. Y. Zee Ma and Stephen Holdich, “Unconventional Oil and Gas Resources – Exploitation and Development “ CRC Press, 2016.
2. Pramod Thakur , “Advanced Reservoir and Production Engineering for Coalbed Methane” , Gulf Publishing, 2016.
3. R. E. Roger, “Coal Bed Methane: Principles and Practice”, 3rd Edition, Prentice Hall, 1991.

22CH953 PETROCHEMICALS

Image source : https://www.globalenco.com/site-upload/site-images/buyuk/1576445886-kimyasal-ve-petrokimya.jpg

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the conversion of crude oil and intermediate streams into finished products. The objective of this course is to get the familiarity with the various chemical processes deployed in petroleum industries.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

SOURCE OF PETROCHEMICALS AND SYNTHESIS GAS PRODUCTION

Feed Stock and Source of Petrochemicals: Overview of petrochemical industry, feed stock selections for petrochemicals, steam cracking of gas and naphtha to produce olefins, diolefins and production of acetylene.

Synthesis Gas Production: Steam reforming of natural gas – naphtha and heavy distillate to produce hydrogen and synthesis gas; Production of methanol; Oxo process.

Primary Unit Processes: Fundamental and Technological principled involved in Alkylation– Oxidation; Nitration and hydrolysis.

UNIT-2 **16L+8T+0P=24 Hours**

NAPHTHA AND NATURAL GAS

- Case study and updated data calculation for gross consumption of naptha and natural gas for Indian scenario.
- Case study and updated data calculation for gross consumption of naptha and natural gas for global scenario.
- Yield calculation, quality of the product, estimation for the primary processes and treatment consideration.
- Report preparation on different petrochemicals production in India.

MODULE-2

UNIT-1 **16L+4T+0P=20 Hours**

UNIT PROCESSES AND CHEMICALS

Secondary and Tertiary Unit Processes: Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerization, Halogenation and Esterification.

Chemicals From Gas Reforming: Methanol- Acetic acid- Ammonia and urea.

Chemicals from Ethylene: Ethylene Oxide-Mon ethylene Glycol-Ethyl Benzene-Styrene.

Polymers: LDPE, HDPE & LLDPE and Polypropylene – PVC - Polystyrene.

SKILLS:

- ✓ *Suitable hydro processing/treatment technologies to meet product qualities.*
- ✓ *Ability to process the opportunity crudes to maximize the throughput.*
- ✓ *Maximize the profitable products and minimize the quality give away.*

UNIT-2 **8L+12T+0P=20 Hours**

DESIGN OF PROCESS EQUIPMENTS

- Design of sulphonation, sulfation unit.
- Design of isomerization unit.
- Design of Methanol production unit.
- Design of ammonia and urea production unit.
- Design of chemicals from ethylene production unit.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic knowledge of composition and related chemistry of petroleum and its characterization along with thermal properties in refining during treatment of petroleum.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the different reforming techniques used for petroleum industries that meet the specific requirements with approximate considerations.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate petrochemicals by advance techniques.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design various chemical process for production of petrochemicals.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2nd Edition, Gulf Publishing Company, 2000.

REFERENCE BOOKS:

1. Philip Herkimer Groggins. Unit processes in organic synthesis; Publisher: Tata McGraw-Hill, 5th Edition, 1995.
2. Alireza Bahadori, Chikezie Nwaoha, Malcolm William Clark. Dictionary of Oil, Gas, and Petrochemical Processing. Publisher: CRC Press, 1st Edition, 2013.

22CH954 PETROLEUM REFINERY ENGINEERING

Image source : https://www.fluor.com/SiteCollectionImages/projectsgallery/cilacap-refinery-epc-10-l.jpg

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the conversion of crude oil and intermediate streams into finished products. The objective of this course is to impart the student about the knowledge of distillation, cracking and reforming processes used in a typical refinery.

MODULE-1

UNIT-1 **8L+4T+0P=12 Hours**

CHARACTERIZATION AND CLASSIFICATION OF CRUDE OILS

Composition of petroleum; Laboratory tests; Refinery feedstock and products; General definitions; Introduction to petroleum refinery; Crude oil-Classification, Characterization Composition, Physical properties; Analysis and distillation; Introduction to refinery feedstocks and refinery products.

UNIT-2 **16L+12T+0P=28 Hours**

DISTILLATION OF CRUDE OIL

Evaluation of crude oil properties and design of crude oil distillation column; Dehydration and desalting of crude; Crude Assay - ASTM, TBP distillations; API gravity various average boiling points and mid percent curves; Evaluation of properties of crude oil and its fractions; Design concept of crude oil distillation column.

- Evaluation of properties of crude oil and its fractions.
- Design of Delayed coker unit through software.
- Design of crude distillation column and catalytic reforming unit.

MODULE-2

UNIT-1 **8L+6T+0P=14 Hours**

THERMAL AND CATALYTIC CRACKING

Coking and thermal process; Delayed coking; Catalytic cracking- cracking reactions; zeolite catalysts, cracking feed stocks and reactors, effect of process variables, FCC cracking, catalyst coking and regeneration, design concepts, Catalytic reforming; Reforming catalysts; Reformer feed; Reforming reactor design- continuous and semi regenerative process.

UNIT-2 **16L+10T+0P=26 Hours**

HYDROTREATING AND HYDROCRACKING

Hydrocracking feed stocks; Modes of hydrocracking; Effects of process variables; Hydro treating process and catalysts; Residue hydro processing; Effects of process variables; Reactor design concepts-isomerization, alkylation and polymerization.

- Case study on designs for fluidized-bed catalytic cracking units.
- Case study on application of catalytic reforming process.
- Case study on reforming reactor design.

SKILLS:

- ✓ *Recognize the essential specifications of the different types of distillation.*
- ✓ *Analyze the working condition of the vacuum and fractional distillation.*
- ✓ *Select suitable reforming process.*
- ✓ *Design waste water treatment from lube oil manufacturing unit.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic knowledge of composition and related chemistry of petroleum and its characterization along with thermal properties in refining during treatment of petroleum.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze the different reforming techniques used for petroleum industries that meet the specific requirements with approximate considerations.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Conduct experiment through a cracking unit to obtain desired products, considering the impact of the processes on environment to assess the society.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design the crude distillation column and catalytic reforming unit.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. J. B. Maxwell, “Data Book of Hydrocarbons”, Krieger publishing company, 1975.
2. W. C. Edmister, “Applied Hydrocarbon Thermodynamics Vol-I and Vol-II”, Gulf Publishing, Company, 1988.

REFERENCE BOOKS:

1. Harker, J.H. and Backhusrt, J.R., “Fuel and Energy”, 1st edition, Academic Press Inc., 1981.
2. Mondal, P. and Dalai, A.K., “Sustainable Utilization of Natural Resources”. 1st edition, CRC Press, 2017.

22CH955 SURFACE PRODUCTION OPERATIONS

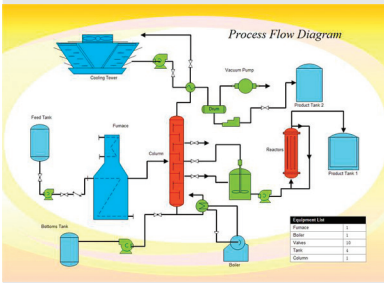

Image source : https://i.pinimg.com/736x/2a/13/43/2a1343b4db63693e00e7097e90583ba8--process-flow-diagram-process-engineering.jpg

Hours Per Week :

L	T	P	C
3	2	-	4

PREREQUISITE KNOWLEDGE: Any fresher can take this subject as introductory subject after 10+2.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals with petroleum level and pressure systems, Field processing of oils, Storage of petroleum and its products, flow measuring equipments and well stimulation technique. The objective of this course is to provide knowledge of production operations in the oil and gas wells.

MODULE-1

UNIT-1 **10L+10T+0P=20 Hours**

PRODUCTION FACILITIES

Various types of facilities Controlling the process; Basic system, configuration design & selection of facilities, Stage Separation, Selection of Stages, Process flow sheets, P&IDs, monitoring well performance testing & optimization of flow.

UNIT-2 **14L+6T+0P=20 Hours**

PHASE SEPARATION

Two Phase Liquid And Gas Separation: Functional sections of a gas, liquid separator; Inlet diverter section; Liquid collection section; Gravity settling section; Mist extractor section, Scrubbers.

Three Phase Oil, Gas And Water Separation: Equipment description; Horizontal separators; Derivation of equation; Free-water knockout; Flow splitter; Horizontal three-phase separator, Vertical separator; Selection considerations.

MODULE-2

UNIT-1 **10L+10T+0P=20 Hours**

CRUDE OIL TREATING AND OIL DESALTING SYSTEM

Crude Oil Treating: Equipment description of various treaters and heaters; Indirect and fired heaters; Heater sizing; Vertical heater-treaters; Horizontal heater treaters; Electrostatic heater-treaters, Oil dehydrators, Emulsion treating theory Agitation, Emulsifying agents; Demulsifies.

Oil Desalting Systems: Oil desalting systems; Equipment description of desalters; Mixing equipment; Process description; Single stage desalting; Two stage desalting.

UNIT-2 **14L+6T+0P=20 Hours**

PRODUCED WATER TREATING SYSTEMS

Characteristics of produced water; Sand and other suspended solids; Dissolved gases; Oil in water emulsions; Dissolved oil concentrations; Dispersed oil Toxicants; Gravity separation; Coalescence; Dispersion; Flotation; Filtration; Equipment description; Retention time and performance considerations- Design of produced water treating systems; Disposal standards- Disposal methods in Offshore & Onshore operations.

SKILLS:

- ✓ *Identification, classification and characterization of various heater treaters.*
- ✓ *Several techniques of three phase Oil, Gas and Water Separation.*
- ✓ *Design specification of desalter equipment.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basics of oil and gas production engineering techniques.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze various treating systems and their types for maintaining equipment in proper order.	Analyze	1, 2	1, 2, 3, 5, 9, 10
3	Evaluate the performance of heater-treater in commercial use.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Design of separators for industry purpose to check efficiency.	Create	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Ken Arnold & Maurice Stewart, Vol-1 & 2, “Surface Production Operations”, 3rd Edition, Gulf Professional Publishing, 2008.

REFERENCE BOOK:

1. H.K. Abdel-Aal and Mohamed Aggour and M.A. Fahim, “Petroleum and Gas Field Processing”, Marcel Dekkar Inc., 2003.