GOVERNMENT OF TAMIL NADU
DEPARTMENT OF TECHNICAL EDUCATION

Diploma in Chemical Engineering
Regular Curriculum

Regulation 2023
Program Structure

1076 Diploma in Chemical Engineering

Program Outcomes (PO's)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude, and behavior that students acquire through the program.

The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of an engineering diploma graduate.

NBA has defined the following seven POs for an Engineering diploma graduate:

PO1: Basic and Discipline-specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and an engineering specialization to solve the engineering problems.

PO2: Problem analysis: Identify and analyze well-defined engineering problems using codified standard methods.

PO3: Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO4: Engineering Tools, Experimentation, and Testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO5: Engineering practices for society, sustainability and environment: Apply appropriate technology in the context of society, sustainability, environment and ethical practices.

PO6: Project Management: Use engineering management principles individually, as a team member or as a leader to manage projects and effectively communicate about well-defined engineering activities.

PO7: Life-long learning: Ability to analyze individual needs and engage in updating in the context of technological changes.

Credit Distribution

Semester	No of Courses	Periods	Credits
Semester I	8	640	20
Semester II	9	640	20
Semester III	8	640	20
Semester IV	7	640	20
Semester V	8	635#	21
Semester VI	3	660	19
		Total	**120**

Industrial Training during summer vacation for Two Weeks has to be completed to earn the required two credits.

Semester I

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Humanities & Social Science	Theory	1000231110	Tamil Marabu	2-0-0	30	2	Theory
2	Basic Science	Theory	1000231210	Basic Mathematics	3-1-0	60	4	Theory
3	Basic Science	Practicum	1000231330	Basic Physics	2-0-2	60	3	Theory
4	Basic Science	Practicum	1000231430	Basic Chemistry	2-0-2	60	3	Theory
5	Humanities & Social Science	Practicum	1000231540	Communicative English I	1-0-2	45	2	Practical
6	Engineering Science	Practicum	1000231640	Basic Workshop Practices	1-0-2	45	2	Practical
7	Engineering Science	Practicum	1000231740	Digital Workplace Skills	0-0-4	60	2	Practical
8	Open Elective	Advanced Skill Certification	1000231860	Basic English for Employability	0-0-4	60	2	Practical
9	Humanities & Social Science	Integrated Learning Experience	1000231880	Growth Lab	-	15	0	-
10	Audit Course	Integrated Learning Experience	1000231881	Induction Program - I	-	40	0	-
11	Audit Course	Integrated Learning Experience	1000231882	I&E / Club Activity / Community Initiatives	-	30	0	-
12	Audit Course	Integrated Learning Experience	1000231883	Shop floor Immersion	-	8	0	-
13	Audit Course	Integrated Learning Experience	1000231884-	Student-Led Initiative	-	22	0	-
14	Audit Course	Integrated Learning Experience	1000231886	Health & Wellness	-	30	0	-
Total						**565**	**20**	

Note: Test & Revisions – 60 Periods \| Library Hours – 15 Periods

Semester II

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Humanities & Social Science	Theory	1000232110	Tamil and Technology	2-0-0	30	2	Theory
2	Program Core	Theory	1076232210	Industrial Chemistry	3-0-0	45	3	Theory
3	Basic Science	Practicum	1000232340	Applied Mathematics – 1 *	1-0-4	75	3	Practical
4	Basic Science	Practicum	1000232440	Applied Physics – 1 *	1-0-2	45	2	Practical
5	Basic Science	Practicum	1000232540	Applied Chemistry – 1 *	1-0-2	45	2	Practical
6	Basic Science	Practicum	1000232640	Basic Engineering Practices *	1-0-2	45	2	Practical
7	Engineering Science	Lab	1000232720	Drafting Practices – 1 *	0-0-4	60	2	Practical
8	Humanities & Social Science	Practicum	1000232840	Communicative English II *	1-0-2	45	2	Practical
9	Open Elective	Advanced Skill Certification	1000232860	Advanced Skills Certification – 2 *	1-0-2	45	2	NA
10	Humanities & Social Science	Integrated Learning Experience	1000232880	Growth Lab	-	30	0	-
11	Audit Course	Integrated Learning Experience	1000232882	I&E/ Club Activity / Community Initiatives	-	30	0	-
12	Audit Course	Integrated Learning Experience	1000232883	Shop Floor Immersion	-	8	0	-
13	Audit Course	Integrated Learning Experience	1000232884	Student Led Initiative	-	24	0	-
14	Audit Course	Integrated Learning Experience	1000232885	Emerging Technology Seminars	-	8	0	-
15	Audit Course	Integrated Learning Experience	1000232886	Health & Wellness	-	30	0	-
Total						565	20	

Note: Test & Revisions – 60 Periods \| Library Hours – 15 Periods

Semester III

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Core	Theory	1076233110	Basic Chemical Engineering	4-0-0	60	4	Theory
2	Program Core	Theory	1076233210	Momentum Transfer*	3-1-0	60	4	Theory
3	Program Core	Practical	1076233320	Momentum Transfer Practical*	0-0-4	60	2	Practical
4	Program Core	Practical	1076233420	Chemical CAD Practical*	0-0-4	60	2	Practical
5	Program Core	Practical	1076233520	Technical Analysis Practical	0-0-4	60	2	Practical
6	Program Core	Practicum	1076233640	General Engineering*	1-0-4	75	3	Practical
7	Open Elective	Advanced Skill Certification	1076233760	Advanced Skills Certification-III	1-0-3	60	2	NA
8	Humanities & Social Science	Integrated Learning Experience	1076233880	Growth Lab	-	30	0	NA
9	Audit Course	Integrated Learning Experience	1076233881	Induction Program - II	-	16	0	-
10	Audit Course	Integrated Learning Experience	1076233882	I&E / Club Activity / Community Initiatives	-	16	0	-
11	Audit Course	Integrated Learning Experience	1076233883	Shop floor Immersion	-	8	0	-
12	Audit Course	Integrated Learning Experience	1076233884	Student – Led Initiative	-	22	0	-
13	Audit Course	Integrated Learning Experience	1076233885	Emerging Technology Seminars	-	8	0	-
14	Audit Course	Integrated Learning Experience	1076233886	Health & Wellness	0-0-2	30	1	-
Total						565	20	

Note: Test & Revisions – 60 \| Library Hours – 15 Periods # Common with all programs * Common with Chemical Engineering Program

Semester IV

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Core	Theory	1076234110	Process Heat Transfer*	3-1-0	60	4	Theory
2	Program Core	Theory	1076234210	Mechanical Operations*	3-1-0	60	4	Theory
3	Program Core	Theory	1076234310	Chemical Technology	3-0-0	45	3	Theory
4	Program Core	Practical	1076234420	Heat Transfer Practical*	0-0-4	60	2	Practical
5	Program Core	Practical	1076234520	Mechanical Operations Practical*	0-0-4	60	2	Practical
6	Program Core	Practicum	1076234640	Process Instrumentation and Control*	1-0-4	75	3	Practical
7	Open Elective	Advanced Skill Certification	1076234760	Advanced Skills Certification - IV	1-0-3	60	2	NA
8	Audit Course	Integrated Learning Experience	1076233882	I&E/ Club Activity/ Community Initiatives	-	30	0	-
9	Audit Course	Integrated Learning Experience	1076233883	Shop floor Immersion	-	8	0	-
10	Audit Course	Integrated Learning Experience	1076233884	Student-Led Initiative	-	24	0	-
11	Audit Course	Integrated Learning Experience	1076233885	Emerging Technology Seminars	-	8	0	-
12	Audit Course	Integrated Learning Experience	1076233886	Health & Wellness	-	30	0	-
13	Audit Course	Integrated Learning Experience	1076233887	Special Interest Groups (Placement Training)	-	30	0	-
Total						550	20	

Note: Test & Revisions – 75 Periods / Library – 15 Periods # Common with all programs * Common with Chemical Engineering Program

Semester V

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Core	Theory	1076235110	Chemical Process Calculations*	3-1-0	60	4	Theory
2	Program Core	Theory	1076235210	Mass Transfer - I	3-1-0	60	4	Theory
3	Program Elective	Theory	-	Elective-1	3-0-0	45	3	Theory
4	Program Core	Practical	1076235420	Mass Transfer Practical*	0-0-4	60	2	Practical
5	Program Elective	Practical	-	Elective-2	0-0-4	60	2	Practical
6	Humanities &Social Science	Practicum	1076235654	Innovation & Start up	1-0-2	45	2	Project
7	Project/Internship	Project/Internship	1076235773	Industrial Training [Summer Vacation]	-	-	2	Project
8	Open Elective	Advanced Skill Certification	1076235860	Advanced Skills Certification – V	1-0-3	60	2	NA
9	Audit Course	Integrated Learning Experience	1076235881	Induction program III	-	40	0	-
10	Audit Course	Integrated Learning Experience	1076235884	Student-Led Initiative	-	30	0	-
11	Audit Course	Integrated Learning Experience	1076235886	Health & Wellness	-	30	0	-
12	Audit Course	Integrated Learning Experience	1076235987	Special Interest Groups (Placement Training)	-	40	0	-
Total						530	21	

Note: Test & Revisions – 90 Periods / Library – 15 Periods # Common with all programs * Common with Chemical Engineering Program.

* **Internship shall be offered in the summer break between 4th and 5th semester followed by a review and award of credits in the 5th semester.**

Semester VI

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Open Elective	Theory	-	ELECTIVE 3	3-0-0	45	3	Theory
2	Open Elective	Theory	-	ELECTIVE 4	3-1-0	60	4	Theory
3	Industrial Training/Project	Project / Internship	1076236352	In – house Project / Internship / Fellowship	-	540	12	Project
	Total					645	19	

Note:

1. *Test & Revisions – 40 Periods.*
2. *For all semesters, the types of End Semester examination for practicum subjects are based on the higher credits towards the theory or practical component of the respective course.*
3. *Some of the audit courses are non-credited but compulsory courses that are a part of the program initiative and the implementation process has to be recorded.*
4. *1 Credit for Project is equivalent to 45 periods for projects / internships / fellowship.*
5. *Electives 3 & 4 are considered as open Elective provisioning the option for students to take courses from other departments also if suitable with approval from the Head of the Institution*

Elective 1

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Elective	Theory	1076235311	Industrial safety and Pollution control	3-0-0	45	3	Theory
2	Program Elective	Theory	1076235312	Plant Utilities	3-0-0	45	3	Theory
3	Program Elective	Theory	1076235313	Renewable Energy Engineering	3-0-0	45	3	Theory

Elective 2

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Elective	Practical	1076235521	Chemical Process Simulation Lab	0-0-4	60	2	Practical
2	Program Elective	Practical	1076235522	Petroleum Testing Lab	0-0-4	60	2	Practical
3	Program Elective	Practical	1076235523	Environmental Engineering Lab	0-0-4	60	2	Practical

Elective 3 (Pathway)

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Elective | Higher Education	Theory	1076236111	Chemical Engineering Thermodynamics and Reaction Engineering	3-0-0	45	3	Theory
2	Program Elective | Higher Education	Theory	1076236112	Fertilizer Technology	3-0-0	45	3	Theory
3	Program Elective | Technocrats	Theory	1076236113	Petroleum and Energy Engineering	3-0-0	45	3	Theory

Elective4(Specialization)

#	Course Category	Course Type	Course Code	Course Title	L-T-P	Period	Credit	End Exam
1	Program Elective	Theory	1076236211	Mass Transfer - II	3-1-0	60	4	Theory
2	Program Elective	Theory	1076236212	Natural Gas Engineering	3-1-0	60	4	Theory
3	Program Elective	Theory	1076236213	Electrochemical Engineering	3-1-0	60	4	Theory

1076233110	BASIC CHEMICAL ENGINEERING	L	T	P	C
Theory		4	0	0	4

Introduction:

This subject allows the students to gain knowledge in understanding the types and nature of industries, gain basic knowledge of unit operations and unit process in chemical plants, and know his role and responsibilities as a process technician in chemical process Industry.

Course Objectives:

On completion of the units of the course, students must be able to understand the following:

- To impart the knowledge on fundamental concepts in chemical engineering and the role & the responsibility of a chemical engineer.

Course Outcomes:

After successful completion of this course, the students should be able to

CO1: Understand the importance of chemical industry and his role and responsibility as a process technician.

CO2: Understand the various types of unit operations and unit process.

CO3: Understand the various types of tanks and vessels.

CO4: Understand about various materials of construction and their uses.

CO5: Understand the importance of laboratory and analysis of samples.

Pre-requisites:

High School Chemistry and Physics

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	-	-	3	3	1	1	-
CO2	1	-	3	2	1	1	-
CO3	1	1	3	2	2	2	1
CO4	2	-	2	2	2	1	2
CO5	-	-	-	3	2	1	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

1076233110	BASIC CHEMICAL ENGINEERING	L	T	P	C
Theory		4	0	0	4

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

1076233110	BASIC CHEMICAL ENGINEERING	L	T	P	C
Theory		4	0	0	4

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

SYLLABUS CONTENTS

Unit - I	**ROLE OF CHEMICAL ENGINEERS**
Definition of Chemical Engineering and Chemical Industry - Importance of Chemical Industry- List of ten major chemical industries in India- raw materials, products and their end uses - List of ten major chemical industries in Tamilnadu - raw materials, products and their end uses. List the duties and tasks of a process technician in chemical industry- various job opportunities in chemical engineering.	12
Unit - II	**CHEMICAL PROCESS**
Chemical Process – Definition – Different types of chemical process-Batch, Semi batch and Continuous process- steady state and unsteady state process- comparison between them. Brief description about PFD Diagram and P&ID Diagram and their importance. Difference between Unit operations and unit process-Unit operations- Evaporation, Distillation, Absorption, Extraction, Drying and Filtration. (Brief descriptions only). Unit Process- Sulphonation, Polymerization, Oxidation, Hydrogenation, Alkylation, Nitration and Chlorination. (Brief descriptions only).	12

1076233110	BASIC CHEMICAL ENGINEERING	L	T	P	C
Theory		4	0	0	4

Unit - III	TANKS AND VESSELS	
Tanks- Types of Tanks- Fixed roof tanks and Floating roof tanks. (Brief descriptions only and its uses) Vessels- Types of vessels- Purpose of Spherical vessel, Bullet vessel and Hemispheroid vessel.(Brief descriptions only) Common components of vessel ant its functions- Agitator, Baffle, Gauge hatch, Level indicator, Mist eliminator, Pressure Safety Valve (PSV) and Pressure Relief Valve (PRV). (Brief descriptions only) Function of Tank breather vent in storage tanks- purpose of blanketing in a tank.		10
Unit -IV	**MATERIALS OF CONSTRUCTION**	
Properties, composition and applications of the following metallic materials in chemical industries- Cast iron, Mild steel, Low carbon steel ,Hastelloy and Titanium. Stainless steel- composition of stainless steel- various grades of stainless steel and their applications in chemical process industry. Properties, composition and applications of the following Non- Ferrous alloys in chemical industries- Copper alloys, Aluminium alloys and Fiber-Reinforced Plastic (FRP).		14
Unit -V	**QUALITY CONTROL**	
Quality- importance of Quality in process industries- importance of sampling and sampling procedures. Common scientific terms: P^H value & its importance, Total Dissolved solids, Alkalinity, Acidity, Turbidity, Conductivity, BOD and COD. Method of analysis of liquid samples using HPLC - Method of analysis of gas samples using Gas Chromatography.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Learning Chemical Engineering for Process Industries - Nikhlesh Mathur - Authors press.
2. Introduction to Chemical Engineering by Kenneth A. Solen, Wiley Publications.
3. Introduction to Chemical Engineering by Pushpavanam.S, PHI Learning Pvt Ltd, New Delhi.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://global.oup.com/academic/category/science-and-mathematics/engineering-and-technology/technology-of-industrial-chemistry/
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076233210	MOMENTUM TRANSFER	L	T	P	C
Theory		3	1	0	4

Introduction:

The knowledge of fluid flow is very essential because all chemical plants involved fluid flow. The examples are flow of stream and gases in pipes, flow of liquid in pipes and open Channels etc. This subject aims at the basic concepts of fluid flow, measurement Techniques involved for the same and equipment used for the transportation of fluids. With this background, students will be able to quantitatively find out material and power Requirement for a process.

Course Objectives:

The primary objective of this course is to provide a foundational understanding of fluid flow phenomena. This includes:

- Deriving mass and momentum balance equations from fundamental principles.
- Exploring the transportation of fluids and various flow measuring devices.

Course Outcomes:

After successful completion of this course, the students should be able to

CO1: To understand the basic properties, classification of fluid and pressure measurement under the conditions of fluid statics, which will empower them to tackle real-world challenges in engineering and science.

CO2: To grasp the concept of fluid flow and their various types, analyze fluid flow through Reynolds' experiment, interpret fluid energies using Bernoulli's equation and apply the continuity equation for fluid flow calculations

CO3: To understand the concept of flow of incompressible fluid through pipes and conduit, Fluid Friction, Energy losses in pipes due to sudden expansion and contraction, and also basic principles of fluidization engineering.

CO4: To gained comprehensive knowledge and practical insights into pipes, tubes, gaskets, valves, and water hammer prevention in industrial settings, enabling them to apply this knowledge effectively in their respective roles within the chemical industry.

CO5: To acquire a comprehensive understanding of various types of pumps, including centrifugal pumps and reciprocating pumps, as well as the working principles of gear pumps and steam jet ejectors.

1076233210	MOMENTUM TRANSFER	L	T	P	C
Theory		3	1	0	4

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	3	2	1	3
CO2	3	3	1	3	2	1	3
CO3	3	3	1	3	2	1	3
CO4	3	3	1	3	2	1	3
CO5	3	3	2	3	2	1	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Pre-requisites

Knowledge of basic Mathematics and basic Physics.

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076233210	MOMENTUM TRANSFER	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076233210	MOMENTUM TRANSFER	L	T	P	C
Theory		3	1	0	4

Syllabus Contents

Unit I	FLUID STATICS	
Fluids – definition- Properties of Fluids – Density, Specific Gravity, Viscosity - Dynamic Viscosity & Kinematic Viscosity, Specific weight - simple problems in properties of fluids - variation of Viscosity of Gases and Liquids with temperature. Classification of Fluids - Compressible and Incompressible Fluids - Newton's Law of Viscosity - Newtonian Fluids and Non-Newtonian Fluids with examples. Pressure – Types of Pressure – Atmospheric, Gauge & Absolute Pressure - List of Pressure measuring devices - U-Tube Manometer – computation of Pressure difference using U-Tube manometer - Inclined Manometer – Simple Problems in U-Tube manometer.		12
Unit II	**FLUID FLOW PHENOMENA**	
Types of Flow – Laminar & Turbulent Flow, Potential Flow. Reynolds's Experiment – Critical velocity, Reynolds's Number and Its Significance, Velocity Profile for Laminar Flow & Turbulent Flow, Simple problems using Reynolds's Number. Energies of fluids - Potential energy, pressure energy and kinetic energy (Statement only) - Statement of Bernoulli's Equation (derivation excluded) - Significance of Bernoulli's Equation. Mass flow rate & Volumetric flow rate, Average velocity, Mass Velocity, Relation between maximum velocity & Average velocity (derivation excluded). Continuity equation & its Significance, Simple problems in Continuity equation.		12
Unit III	**FLOW OF INCOMPRESSIBLE FLUIDS**	
Pressure drop – Skin Friction & Form Friction – Fanning Friction factor – Relation between Skin friction & Friction Factor (derivation excluded) -Friction factor Chart & its use- Application of Hagen Poiseuille's equation & Fanning Equation in calculating energy loss- Simple problems. Energy Loss due to sudden expansion and sudden contraction (derivation excluded) – Equivalent length concept – Hydraulics radius & Equivalent diameter. Drag – Drag Co-efficient – Stokes' Law - Fluidization –Mechanism of Fluidization- Advantages & disadvantages of Fluidization- Applications of Fluidization.		12

1076233210	MOMENTUM TRANSFER	L	T	P	C
Theory		3	1	0	4

Unit IV	PIPES, FITTINGS AND VALVES	
Difference between Pipes & Tubes- Schedule Number- BWG Number - International standards of pipes and fittings API and ASME – Color coding in industry. Gaskets – List of commonly used Gasket materials in Chemical Industry & its applications. Valves – Functions of Valves, Types of Valves – Gate Valve, Globe Valve, Ball Valve, Diaphragm Valve, Butterfly Valve & Check valve (Lift check valve) - Brief description of the above valves with line diagram - Water Hammer & its Prevention.		12
Unit V	**TRANSPORTATION OF FLUIDS**	
Pumps – Classification of Pumps – Centrifugal Pump -Principle of operation and Working - Types of Impellers and its uses – Priming – Negative suction and positive suction- Priming procedure - Cavitation - Symptoms and Causes of Cavitation & It's prevention - $NPSH_R$ & $NPSH_A$ - Concept of multistage centrifugal pump. Working principle of Reciprocating pump (single acting) and Gear pump (External gear pump only) – working principle of steam jet ejector. Difference between Fans, Blowers & Compressors - Principle of Operation and Working of Centrifugal Compressor- Surge & its prevention.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Unit Operations of Chemical Engineering - W.L. McCabe and J.C. Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L. Badger and J.T. Banchero - Tata McGraw Hill Publishing Co. Ltd. New Delhi - 1997.
3. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.
4. Ghoshal, Sanyal and Dutta - Introduction to chemical Engineering - 1st Edition - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.
5. Fluid mechanics - Frank M. White - 7th Edition - McGraw Hill - 2010.
6. Fluid Mechanics & Fluid power engineering - Kumar D. S - S. K. Kataria & Sons - 2004.
7. Engineering Mechanics - Timoshenko S. P. and Young D. H - McGraw Hill - 1937.
8. Perry's, Handbook of Chemical Engineering, 7th Edition, McGraw Hill, 1997.
9. Fluid Mechanics and Hydraulic Machines - R.K. Bansal - 7th Edition - Laxmi Publication - 2017.

1076233210	MOMENTUM TRANSFER	L	T	P	C
Theory		3	1	0	4

Web-based/Online Resources:

- https://www.youtube.com/watch?v=clD2eSV0DGo
- https://archive.nptel.ac.in/courses/103/104/103104044/

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration: 3 Hrs . Max. Marks: 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Introduction:

Momentum transfer is a fundamental concept in physics that deals with the transfer of momentum from one object to another. In practical terms, momentum transfer finds numerous applications across various fields, from engineering to fluid mechanics to astrophysics. One common practical application of momentum transfer is in fluid dynamics, where it plays a crucial role in understanding the behavior of fluids such as liquids and gases. For instance, in the design of aircraft wings or propellers, engineers must consider how momentum is transferred from the air to the wing or propeller blades to generate lift or thrust.

Course Objective:

- To provide hands-on experience in the working of fluid handling equipment and measuring devices.

Course Outcomes (CO):

On successful completion of this course, the student will be able to:

CO1: Measurement of flow rate through flow meter by using flow measuring device such as Orifice meter, Venturi meter, Rota meter and weir.

CO2: Computation of the velocity profile and frictional losses in Straight and helical pipes.

CO3: Evaluation the characteristics of a centrifugal pump and reciprocating pump.

CO4: Evaluation of Minimum fluidization velocity of fluid by using fluidized bed column.

CO5: Evaluation the pressure drop through a packed column.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	3	2	3
CO2	3	2	3	2	3	2	3
CO3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation.

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory-demonstrate-practice-activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Syllabus Contents

Unit I	**MEASUREMENT OF FLOW RATE THROUGH FLOW METER BY USING FLOW METERS**	20
Measurement of fluid flow – Types of flow meters – Principle, Construction and working of Orifice meter- Venturi meter – Rota meter – Weirs – Application, Advantages and Disadvantages of flow meters.		
Ex. 1	Determination of flow rate using Orifice meter.	
Ex. 2	Determination of flow rate using Venturi meter.	
Ex. 3	Determination of flow rate using Rota Meter.	
Ex. 4	Flow through pipe fittings.	
Unit II	**COMPUTATION OF THE VELOCITY PROFILE AND FRICTIONAL LOSSES IN PIPES**	10
Velocity profile – Introduction - Friction factor – Definition – Reason for friction losses – computational of friction losses in straight and helical pipes.		
Ex. 5	Computing pressure drop of a fluid flowing through a straight pipe by using conventional method or Virtual method.	
Ex. 6	Computing pressure drop of a fluid flowing through a helical coil.	

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Unit III	**EVALUATION THE CHARACTERISTICS OF PUMPS.**	15
Transportation of fluids – Pump – Introduction – Types of pumps – Construction, Working, Application, Advantages and Disadvantages of Centrifugal pump and Reciprocating pump – Charactertics of centrifugal and Reciprocating pump.		
Ex. 7	Centrifugal pump characteristics.	
Ex. 8	Reciprocating pump characteristics.	
Unit IV	**EVALUATION OF MINIMUM FLUIDIZATION VELOCITY**	7
Fluidization bed column – Introduction – Construction and Working - Minimum Fluidization velocity – Definition – calculation of minimum fluidization velocity – Application, Advantages and Disadvantages.		
Ex. 9	Flow through fluidization column by using conventional method or Virtual method.	
Unit V	**EVALUATION THE PRESSURE DROP THROUGH A PACKED COLUMN.**	8
Packed bed column – Introduction – Construction and Working – Pressure drop – Definition – calculation of pressure drop – Ergun Equation - Application, Advantages and Disadvantages.		
Ex. 10	Flow through packed column by using conventional method or Virtual method.	
	Total Hours	60

Note : Out of 10 experiments, the above mentioned three experiments (Ex. 5, 9 &10) may be done by conventional method or by using virtual lab simulator developed by Initiative of Ministry of Education under the National Mission on Education using the below link.

http://www.vlab.co.in/ba-nptel-labs-chemical-engineering.

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076233320	MOMENTUM TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment	Quantity Required
1	Orifice meter.	1 No.
2	Venturi meter.	1 No.
3	Rota Meter.	1 No.
4	Pipe Fittings	1 No.
5	Flow through straight pipe	1 No.
6	Flow through a helical coil.	1 No.
7	Centrifugal pump.	1 No.
8	Reciprocating pump.	1 No.
9	Fluidization column.	1 No.
10	Packed column.	1 No.

1076233420	CHEMICAL CAD PRACTICAL	L	T	P	C
Practical		0	0	4	2

Introduction:

This subject allows the students to interpret the chemical engineering drawings commonly used in Industries and gain Practice to draw Chemical Engineering Equipment with 2D & 3D using AutoCAD commends.

Course Objectives:

The objective of this course is to enable the student to

- In this practical subject, the students are required to learn the basic Concepts of AutoCAD like screen inter face, various commands and co- Ordinate system used.
- This practical subject will also impart them requisite knowledge of creating 2D objects using various draw commands.
- The students will also learn to draw the isometric drawings and isometric Projections.
- The students will also learn the 3D fundamentals and 2D to 3D conversions.

Course Outcomes (CO):

After successful completion of this course, the students should be able to

CO1: Summarize Computer Aided Design.

CO2: Illustrate the basic commands in AutoCAD.

CO3: Sketch block and Isometric 2D drawing in AutoCAD.

CO4: Illustrate 3D modelling in AutoCAD.

CO5: Sketch various chemical engineering equipment using AutoCAD.

Pre-requisites:

Engineering Graphics

Computing Fundamentals

1076233420	CHEMICAL CAD PRACTICAL	L	T	P	C
Practical		0	0	4	2

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	-	-	-	2
CO2	3	2	3	-	-	-	2
CO3	3	2	3	-	-	-	2
CO4	3	2	3	-	-	-	2
CO5	3	2	3	-	-	-	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory-demonstrate-practice-activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

1076233420	CHEMICAL CAD PRACTICAL	L	T	P	C
Practical		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	First Cycle / 50 % Exercises	Second Cycle / 50 % Exercises	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
InternalMarks	40				60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Basic Command	5
B	Schematic Diagram, Schematic Diagram & Procedure	20
C	Printout & Result	25
TOTAL MARKS		**50**

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

1076233420	CHEMICAL CAD PRACTICAL	L	T	P	C
Practical		0	0	4	2

The details of the documents to be prepared as per the instruction below.

Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Basic Command	10
B	Schematic Diagram	20
C	Procedure	20
D	Printout	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076233420	CHEMICAL CAD PRACTICAL	L	T	P	C
Practical		0	0	4	2

Syllabus contents

Part - I	**2D DRAWING**	
Introduction – Definition – Importance of CAD - Basic command - Practice to draw the Chemical Engineering Equipment with 2D using AutoCAD commends.		30
Ex.No	Name of the Experiment	
1	Batch Reactor.	
2	Shell and tube Heat exchanger.	
3	Long tube Evaporator.	
4	Ball mill.	
5	Simple piping layout with 2D.	
Part - II	**3D DRAWING**	
Introduction – Definition – Importance of 3D Drawing - Basic command - Practice to draw the Chemical Engineering Equipment with 3D using AutoCAD commends.		30
Ex.No	Name of the Experiment	
6	Spray Drier.	
7	Absorption column.	
8	Agitated batch crystallizer.	
9	Simple piping layout in isometric view.	
10	Set up Process Instrumentation Diagram (P & ID) of Distillation column.	
TOTAL HOURS		**60**

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim & Basic Command	10
B	Schematic Diagram	20
C	Procedure	20
D	Printout	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment / Facilities required	Quantity Required
1	Computer	Required Quantities
2	Printer	1 No.
3	CAD software (Open Source)	--

1076233520	TECHNICAL ANALYSIS PRACTICAL	L	T	P	C
Practical		0	0	4	2

Introduction:

Analysis of various chemical commodities is necessary for controlling the quality of product in industry. This can be achieved in handling various analysis in the laboratory. The students can be learned all these by doing experiments in the practical classes.

Course Objectives:

- To impart basic knowledge on the analysis of consumable chemicals.

Course Outcomes (CO):

On successful completion of this course, the student will be able to:

CO1: Analyze the basic characteristics of oils.

CO2: Analyze the basic characteristics of soap.

CO3: Analyze cement.

CO4: Determine the quality of bleaching powder.

CO5: Determine specific gravity of given sample using Hydrometer.

Pre-requisites:

Basic Chemistry practical.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	2	2
CO2	3	1	2	-	2	-	1
CO3	3	2	3	-	2	2	1
CO4	3	2	2	-	1	-	-
CO5	3	2	2	-	-	1	-

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

1076233520	TECHNICAL ANALYSIS PRACTICAL	L	T	P	C
Practical		0	0	4	2

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory-demonstrate-practice-activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

Assessment Methodology:

	Continuous Assessment (40 marks)				**End Semester Examination (60 marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1076233520	TECHNICAL ANALYSIS PRACTICAL	L	T	P	C
Practical		0	0	4	2

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

1076233520	TECHNICAL ANALYSIS PRACTICAL	L	T	P	C
Practical		0	0	4	2

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Syllabus contents

1. Estimation and comparison of TDS of water and waste water using conductivity meter 2. Estimation of Acid value of oil. 3. Estimation of Total Fatty Matter content of soap. 4. Estimation of calcium oxide content of cement. 5. Determination of available chlorine in Bleaching Powder. 6. Determination of specific gravity of a given sample using Hydrometer 7. Determine the moisture content of a given coal sample. 8. Determination of Flash and Fire point of the given oils by closed cup method 9. Determination of melting point of given sample 10. Determination of viscosity using SAYBOLT Viscometer	60
TOTAL HOURS	**60**

1076233520	TECHNICAL ANALYSIS PRACTICAL	L	T	P	C
Practical		0	0	4	2

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARK

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076233520	TECHNICAL ANALYSIS PRACTICAL	L	T	P	C
Practical		0	0	4	2

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment / Glasswares	Quantity Required
1	Burettes 50 ml	4 Nos.
2	Pipettes 25 ml, 20 ml, 10 ml	4 Nos.
3	Conical flask 500 ml, 250 ml, 100 ml	4 Nos.
4	Burette stand with clamp	4 Nos.
5	Hydrometer	1 Nos.
6	Silica Crucible with lid	1 Nos.
7	Closed cup Apparatus	1 Nos.
8	Funnels & Separating funnels	4 Nos.
9	Watch Glass 6",3",3"	3 Nos.
10	Wash bottles plastics	4 Nos.
11	Tripod stand & Wire gauge	1 No.
12	Muffle Furnace	1 No.
13	Buchner funnel	1 No.
14	Melting point Apparatus	1 Nos.
15	Sybolt Viscometer	1 No.
16	Aspirator bottles	4 Nos.
17	Refractometer	1 No.

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

Introduction:

The subject allows the students to gain knowledge in understanding the various mechanical properties of materials, steam generation systems, Boiler function and the important components of a boiler, steam turbines, refrigeration systems, Electrical Distribution systems and Electrical Transmissions.

Course Objectives:

- To develop an understanding about the various properties of materials and its strength
- To develop an understanding of boiler, turbine and electrical distribution systems.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Various Mechanical properties of the materials and types of stresses.

CO2: Understand the properties of steam and the function of Boiler.

CO3: Explain the basic principle of working of boiler and turbine.

CO4: Understand the various electrical distributions systems in chemical process industries.

CO5: Identifying the various parts of valves and centrifugal pump and understand how to dismantle and assemble the valves and centrifugal pump.

Pre-requisites:

None.

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	1	1	3
CO2	3	3	2	1	1	1	3
CO3	3	3	2	1	1	1	3
CO4	3	3	2	1	1	1	3
CO5	3	3	2	1	1	1	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations, and real-world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome - and employability-based.
- Do not let students work on an activity or an experiment with the expected outcome, rather allow students to be honest about whatever the results of the experiment are. If the results are different from the expectations, students should do an analysis where they could be the source of error, if any.

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises 50% Exercises	Cycle II Exercises	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical documents should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

The details of the documents to be prepared as per the instruction below.

Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	5
B	Formulas, Explanations, Tabular Column and Schematic Diagram	20
C	Calculations & Result	25
TOTAL		50
D	Practical Documents (As per the portions)	10
TOTAL MARKS		**60**

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		**Marks**	
Part – A	30 MCQ Questions.	30 x 1 Marks	30 Marks
Part – B	7 Questions to be answered out of 10 Questions.	7 x 10 Marks	70 Marks
TOTAL			100 Marks

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical Examination and End Semester Examination – Practical Exam

Part	Description	Marks
A	Aim & Apparatus Required	5
B	Formulas, Tabular Column and Schematic Diagram	20
C	Observations & Calculations	25
D	Result	10
E	Written Test (Theory Portions)	30
F	Viva voce	10
TOTAL MARKS		**100**

Syllabus Content

Unit I	BOILERS AND TURBINES	
I	Steam- Distinguish the wet steam, dry steam, saturated steam and supersaturated steam. Properties of steam- sensible heat, latent heat, total heat of steam, superheat and dryness fraction- Boiler- function of boiler- construction and working of a Simple Vertical Boiler – Fuels used in boiler- LNG and furnace oil - Definition of low pressure steam, medium pressure steam and high pressure steam. Steam turbine- purpose of steam turbine in process industries - Construction and working principle of steam turbine and gas turbine with simple sketch - Turbine efficiency- waste recovery in turbine.	8
Ex.No	**Name of the Experiment**	
1	Identify the parts of Gate valve, dismantle and assemble the parts of Gate valve.	30
2	Identify the parts of Globe valve, dismantle and assemble the parts of Globe valve.	

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

3	Identify the parts of centrifugal pump, dismantle and assemble the parts of Centrifugal pump.	
4	Compressor Test Rig	
Unit II	**ELECTRICITY AND ELECTRICAL DISTRIBUTION SYSTEM**	
II	Definition the following terms: Electricity- Voltage- Voltmeter- Ampere- Ammeter- watts - wattmeter- Statement of Ohm's Law- simple problems in Ohm's Law. Grounding and the purpose of grounding the motors and equipment - Types of current- AC Current & DC current- comparison of AC & DC current. Electrical Distribution systems: Transformers- Construction and working principle of Transformer - Motor Control Centers (MCC) - Fuses- Circuit breakers- Switch. (Functions of the above with brief description). Construction and working principle of D.C motor- Difference between motor and generator.	7
Ex.No	**Name of the Experiment**	
5	Determination of Unknown Resistance by Ohm's law.	30
6	Energy measurement in a single phase circuit using Lamp load.	
7	Load test on a single phase transformer.	
8	Verification of Series and parallel circuit.	
	TOTAL HOURS	**75**

Suggested List of Students Activity:

- Presentation/ Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course
- Micro project that shall be an extension of any practical lab exercise to real-world application.

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

Text and Reference Books:

1. Theory of Mechanics - R.S Khurmi - Eurasia Publishing House - 2017.
2. A text book of power plant engineering - R.K. Rajput - 5th Edition - Laxmi Publishers - 2016.
3. A text book of refrigeration and air conditioning - R.S. Khurmi - Chand Publishers - 2006.
4. Practical boiler operation engineering and power - Mallick Ranjan - PHI Publishers - 2015.
5. A text book of Electrical technology Vol.1 and Vol.2 - B.L. Theraja - S.Chand publishers – 2014.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610

https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

1076233640	GENERAL ENGINEERING	L	T	P	C
Practicum		1	0	4	3

DETAILED ALLOCATION OF MARK

Part	Description	Marks
A	Aim & Apparatus Required	5
B	Formulas, Tabular Column and Schematic Diagram	20
C	Observations & Calculations	25
D	Result	10
E	Written Test (Theory Portions)	30
F	Viva voce	10
TOTAL MARKS		**100**

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment / Accessories Required	Quantity Required
1	Gate Valve	1 No.
2	Globe Valve	1 No.
3	Centrifugal pump	1 No.
4	Compressor Test Rig	1 No.
5	Rheostat of various range	2 Nos.
6	RPS (0-12v, 0-30v)	2 Nos.
7	Ammeters (MC and MI) of various ranges	2 Nos.
8	Voltmeters (MC and MI) of various ranges	2 Nos.
9	Wattmeter (300v/5A - 2.5A/UPF)	2 Nos.

1076234110	PROCESS HEAT TRANSFER	L	T	P	C
Theory		3	1	0	4

Introduction:

Heat transfer is vital in chemical and petrochemical industries. Understanding mechanisms like conduction, convection, and radiation is essential for operations involving heat exchange. This subject teaches students to analyze performance and design equipment such as heat exchangers, boilers, and evaporators, which are crucial across industries.

Course Objective:

- Acquire sound knowledge of modes of heat transfer: conduction, convection, and radiation, as well as heat flow in fluids through heat transfer equipment such as heat exchangers. Understand the performance of evaporators and insulation properties.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: To comprehend the modes of heat transfer and their significance, grasp Fourier's Law of heat conduction for both steady state and unsteady state scenarios, understand the variation of thermal conductivity with temperature, and analyze heat conduction through composite walls and hollow cylinders, with the capability to solve associated problems.

CO2: To develop a comprehensive understanding of various heat transfer mechanisms such as convection, boiling, and radiation, along with their practical applications. To solve heat transfer problems encountered in various engineering and industrial applications.

CO3: To develop the necessary understanding of heat flow in fluids through heat exchanger equipment, along with the skills to analyze, design, and operate various types of heat exchangers encountered in engineering and industrial settings.

CO4: To empower the knowledge of principles of evaporation, boiling point elevation, and Duhring's rule, along with the skills necessary to analyse, design, and operate evaporators effectively in various industrial processes.

CO5: To develop the necessary knowledge and skills to effectively analyze, design, and operate multiple-effect evaporators and associated equipment in various industrial processes.

1076234110	PROCESS HEAT TRANSFER	L	T	P	C
Theory		3	1	0	4

Pre-requisites:

Knowledge of Thermodynamics.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076234110	PROCESS HEAT TRANSFER	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076234110	PROCESS HEAT TRANSFER	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	CONDUCTION	
Heat Transfer – Modes of Heat Transfer – Importance of heat transfer in process units- Fourier's Law of heat Conduction – Steady State & unsteady state heat conduction. Heat conduction through Composite Wall (two wall only) and Hollow Cylinder (with single insulation) - Simple problems in conduction Thermal Conductivity & its significance. Variation of thermal conductivity with temperature. Analogy between heat conduction & Electrical Current flow.		12
Unit II	**CONVECTION & RADIATION**	
Convection - Types of Convection – Free Convection & Forced Convection. Heat transfer coefficient & its Significance –Different modes of condensation – Drop wise Condensation & Film wise Condensation – Effect of non-condensable gases in condensable vapours - Condensation of superheated vapours. Boiling Mechanism in Heat Transfer – Nucleate boiling & Film boiling (principles only) Dimensionless Numbers & their Significance in Heat Transfer- Prandlt Number, and Nusselt Number (Brief description only). Radiation Heat transfer - Reflectivity, Absorptivity & Transmissivity – Emissive Power & Emissivity - Concept of Black body – Stephen Boltzmann Law (statement only) & Kirchhoff's Law (statement and derivation).		12

1076234110	PROCESS HEAT TRANSFER	L	T	P	C
Theory		3	1	0	4

Unit III	HEAT FLOW IN FLUIDS & HEAT EXCHANGERS	
Heat Exchangers - Counter current flow & Parallel flow in heat exchangers – Energy balance in heat exchangers – Heat Flux – overall heat transfer coefficient – Fouling factors & it's significance – Logarithmic mean temperature difference (LMTD) (derivation excluded). Simple problems in LMTD. Heat Exchangers: Types of Heat exchangers – Construction & Working Principle of Double pipe Heat Exchanger and Shell & Tube Heat exchanger - Functions of Baffles - Applications of Floating Head and U- Tube Heat Exchangers - Pitch -Triangular & Square Pitch – its advantages & disadvantages. Construction & Working Principle of Plate type heat exchanger- concept of spiral type heat exchanger (Principle only) - Heat Exchanger efficiency.		12
Unit IV	**EVAPORATION**	
Evaporation – Principles of Evaporation – Factors affecting rate of evaporation – Capacity & Economy – Boiling point elevation & Duhring's rule – Energy balance in single effect evaporator- Simple problems in single effect evaporator. Evaporators:- Types of evaporator – Calendria evaporator, Long tube vertical evaporator(Climbing Film) – Falling Film evaporator & Forced circulation evaporator – Construction , operation & applications of all types of evaporators.		12
Unit V	**MULTIPLE EFFECT EVAPORATION AND THERMAL INSULATION**	
Principle of Multiple effect Evaporation – Methods of feeding of multiple effect evaporator – Forward feed, backward feed, mixed feed and parallel feed–comparison of Forward feed and backward feed. Evaporator Accessories - Steam traps and its purpose - types of steam traps- brief description about inverted bucket steam trap - brief description about Barometric condenser – purpose of condensate pot. Thermal Insulation –Properties of Insulting materials –hot insulation and cold insulation– important types of insulating materials & their applications.		12
TOTAL HOURS		**60**

1076234110	PROCESS HEAT TRANSFER	L	T	P	C
Theory		3	1	0	4

Text and Reference Books:

1. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi – 1997.
3. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.
4. Introduction to chemical Engineering - Ghoshal, Sanyal and Dutta - 1st Edition - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610
- https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry
- https://archive.nptel.ac.in/courses/103/103/103103032/
- http://digimat.in/nptel/courses/video/103105140/L01.html
- https://nptel.ac.in/courses/112108149
- https://onlinecourses.nptel.ac.in/noc23_ch32/preview

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076234210	MECHANICAL OPERATIONS	L	T	P	C
Theory		3	1	0	4

Introduction:

It gives the student the knowledge of various mechanical operations and their significance in chemical industries. With this information student can control the operation of equipment in order to separate solid-solid, solid-liquid & gas-solid systems.

Course Objective:

- To impart thorough knowledge in mechanical operations used in chemical plants.
- To impart operational skills for chemical plant operations.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: To develop knowledge and skills in size reduction principles, laws of crushing along with calculation of the work index, methods, and equipment operation for effective industrial processes.

CO2: To acquire knowledge in solid particle characterization, screening techniques, and storage/conveying methods for solids.

CO3: To gain understanding in settling, centrifugation, and filtration processes, including their principles, construction, and working principles of relevant equipment.

CO4: To gain an understanding of the construction, operating principles, and applications of various separation equipment, special separation techniques, and gas-solid separators in process industries.

CO5: To empower knowledge on the distinction between mixing and agitation, the purpose and working principle of agitation vessels, the role of baffles and types of impellers, and their applications. Learn about swirling, vortex formation prevention, and the principle of operation and applications of industrial mixers.

Pre-requisites:

None

1076234210	MECHANICAL OPERATIONS	L	T	P	C
Theory		3	1	0	4

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	2	2	2	2	2
CO4	3	3	2	1	2	2	2
CO5	3	3	3	1	2	2	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076234210	MECHANICAL OPERATIONS	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Converted to	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076234210	MECHANICAL OPERATIONS	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	SIZE REDUCTION	
Objectives of Size Reduction – Methods of Size Reduction – Crushing Efficiency -Laws of Crushing - Rittinger's Law, Kick's Law & Bond's Law – Work Index – Simple problems in Laws of Crushing. Size Reduction Equipment – Classification of size reduction reductions - Construction, Principle of Working & application of the following Equipment – Blake Jaw Crusher, Smooth Double Roll Crusher – Ball Mill – Critical Speed of Ball mill & simple problems in critical Speed - Working principle of Fluid Energy Mill.		12
Unit II	**PROPERTIES OF SOLIDS, SCREENING & CONVEYING**	
Characterization of solid particles – Size & Shape – Sphericity - Definitions of the following terms - Volume shape factor & Surface shape factor, Average particle size, Sauter mean diameter, mass mean diameter and volume mean diameter, specific surface of the mixture & specific surface ratio. Screening – Tyler Standard screen series - Capacity & Effectiveness of screens- Screening Equipment - Working Principle of Trommel Screens & Vibrating Screens. Storage and Conveying of Solids – Hoppers, bins, silos (brief description) –Angle of repose - Working Principles & applications of Belt Conveyor, Screw Conveyor & Bucket Elevator.		12

1076234210	MECHANICAL OPERATIONS	L	T	P	C
Theory		3	1	0	4

Unit III	SEDIMENTATION, CENTRIFUGATION & FILTRATION	
Settling - Free settling & Hindered Settling – Terminal settling Velocity, Distinguish between Thickener & Clarifier – Construction and Working Principle of Dorr Thickener. Centrifugation- Principle of Centrifugation - Construction and Working Principle of Disc type Centrifuge. Filtration - Filter Medium & It's Requirements – Filter aids & It's function – Constant Pressure filtration and Constant rate filtration – Filter Medium Resistance & Filter Cake Resistance (definitions only) - Filtration Equipment - Construction, Principle of Operation & Applications of Rotary Drum Filter.		12
Unit IV	**SEPERATION OF SOLID PARTICLES**	
Construction, Principle of Operation & Applications of the following Equipment: Mechanical Classifier - Dorr Classifier - Special Separation Techniques- Elutriation and Jigging. Froth Flotation- Functions of Frothers and Collectors - Working principle of Floatation cell. Gas - Solid Separation- Cyclone Separator, Bag Filter & Electrostatic Precipitator.		12
Unit V	**MIXING AND AGITATION**	
Difference between Mixing and Agitation – Purpose of Agitation – Working Principle of Agitation Vessel – Function of Baffles. Impellers, Types of Impellers & Their applications - Propeller, Paddles & Turbines. Swirling & Vortex Formation in Mixing tanks and their prevention. Industrial Mixers - Principle of operation & applications of Banbury Mixer and Ribbon Blender.		12
TOTAL HOURS		**60**

1076234210	MECHANICAL OPERATIONS	L	T	P	C
Theory		3	1	0	4

Text and Reference Books:

1. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi – 1997.
3. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.
4. Introduction to chemical Engineering - Ghoshal, Sanyal and Dutta - 1st Edition - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610
- https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry
- https://onlinecourses.nptel.ac.in/noc20_ch27/preview
- https://www.udemy.com/topic/chemical-engineering/

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076234310	CHEMICAL TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Introduction:

It is necessary to provide information to Chemical Engineering students about new materials, chemicals involved and manufacturing process of some important and frequently used chemical products. Due to this basic knowledge, the students can develop their skill further in process industries.

Course Objective:

On completion of the units of the syllabus the students must be able to know about:

- To interpret the industrial processes for the manufacturing of inorganic chemicals.
- To interpret the industrial processes for the manufacturing of organic chemicals.

Course Outcomes:

After successful completion of this course, the students should be able:

CO1: Summarize various water treatment methods

CO2: Summarize chloro-alkali industries.

CO3: Summarize the manufacturing of fertilizers and industrial acids.

CO4: summarize the manufacturing of oil and soap

CO5: Summarize polymer industries.

Pre-requisites:

Basic knowledge of organic chemistry and chemical technology.

1076234310	CHEMICAL TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	1	2	2
CO2	3	3	2	1	1	2	2
CO3	3	3	2	1	1	2	2
CO4	3	3	2	1	1	2	2
CO5	3	2	2	1	1	2	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible)

1076234310	CHEMICAL TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076234310	CHEMICAL TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	**PROCESS WATER TREATMENT**
Sources of water - Hardness- Temporary hardness and Permanent hardness- disadvantages of hard water- caustic embrittlement. Water softening methods- Zeolite process and Ion Exchange process- Demineralization of water and its importance- difference between cooled water and chilled water and its applications- preparation of Boiler feed water- need for deareation- working principle of Deareator.	9
Unit II	**INORGANIC CHEMICALS AND ALLIED INDUSTRIES**
Raw materials, reactions involved, process description and applications for the following process: Manufacture of Soda ash by Solvay process - manufacture of caustic soda by membrane cell process. Manufacture of Oxygen from air by Liquefaction (Linde process) - Manufacture of Portland cement- setting of cement- Manufacture of paint- Manufacture of glass- various grades of glass.	9
Unit III	**FERTILIZER AND ACID INDUSTRIES**
Raw materials, reactions involved, process description and applications for the following process: Manufacture of Ammonia - Manufacture of Urea - Manufacture of Phosphoric acid – Manufacture of Sulphuric acid by DCDA process- Manufacture of Nitric acid. Brief description about NPK Fertilizer and Triple Superphosphate and its uses.	9

1076234310	CHEMICAL TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Unit IV	OIL, SOAP AND PAPER INDUSTRY	
Chemistry of oils and fats- classification of oils- Distinguish between oils and fats- Production of oil from plant seeds- Hydrogenation of vegetable oils- Manufacture of soap by full boiled process- recovery and purification of Glycerin. Manufacture of pulp by Kraft process- classification of pulping process - Manufacture of paper from pulp.		9
Unit V	**POLYMER AND PETROLEUM INDUSTRY**	
Polymer- classification of polymer- methods of polymerization- addition polymerization and condensation polymerization with examples. Manufacture of Polypropylene by Gas-phase process - Manufacture of polyurethane. Fractional distillation of crude oil – Brief notes on Cracking, Reforming, Alkylation, visbreaking and isomerization – preparation of Ethylene oxide by direct oxidation of ethylene.		9
TOTAL HOURS		**45**

Text and Reference Books:

1. Dryden's Outliness of Chemical Technology - M. Gopala Rao Marshall Sittig - 3rd Edition - Edited and Reprinted by East-West Press - 2016.
2. A Text on Petro Chemicals - Dr. B.K. Bhaskara Rao - 5th Edition - Khanna Publishers - 2004.
3. Shreve's Chemical Process Industries - Austin, G.T - 5th Edition - Tata Mc Graw Hill - 2017.
4. Encyclopedia of Chemical Technology - Kirk Othmer - 4th Edition - Wiley – Inter Science Publication - John Wiley & Sons - 1993.

Web-based/Online Resources:

- **https://nptel.ac.in/courses/103103029**
- **https://www.studocu.com/in/document/aligarh-muslim-university/applied-chemistry/nptel-chemical-chemical-technology-ii/31279098**

1076234310	CHEMICAL TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Introduction:

In Diploma level engineering heat transfer practical course, students learn hands-on about heat conduction, convection, and radiation. They conduct experiments, measure temperature and flow rates, and analyze data. Emphasis is on real-world applications like heat exchanger design and safety protocols. Effective communication and critical thinking skills are honed for future careers in heat transfer and related fields.

Course Objectives:

- To enable the students to apply heat transfer concepts in practical applications.

Course Outcomes (CO):

On successful completion of this course, the student will be able to:

CO1: Students will understand heat transfer principles, measure conductivity, assess heat loss, and apply knowledge to real-world scenarios.

CO2: Students will learn about heat exchangers, their types, design, applications, and the differences between co-current and counter-current flow in double pipe heat exchangers.

CO3: Students grasp convection heat transfer, its types, principles, applications, advantages, and disadvantages, along with practical applications.

CO4: Students grasp condensers, their types, construction, principles, applications, and determine heat transfer coefficients for vertical and horizontal setups.

CO5: Students grasp the concept, types, applications, advantages, and disadvantages of emissivity in chemical processes, while also verifying the Stefan-Boltzmann constant.

Pre-requisites:

Knowledge of Physics and Thermodynamics.

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	3	3	2	2
CO2	2	3	2	3	3	2	2
CO3	2	3	2	3	3	2	2
CO4	2	3	2	3	3	2	2
CO5	2	3	2	3	3	2	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory-demonstrate-practice-activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.
- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Syllabus contents

Chapter I	**Conduction**	
Introduction – Definition of Conduction – Types – Thermal Conductivity – Heat losses in various metals – Applications – Advantages – Disadvantages of conduction.		12
Ex. 1	Thermal Conductivity of Metal Bar.	
Ex. 2	Heat loss in pipe.	
Chapter II	**Heat Exchangers**	
Introduction – Definition of Heat Exchangers – Different Types of Heat Exchangers and its Design – Applications – Advantages – Disadvantages.		12
Ex. 3	Double Pipe Heat Exchanger by co-current Flow.	
Ex. 4	Double Pipe Heat Exchanger by Counter-current flow.	
Chapter III	**Convection**	
Introduction – Definition – Types – Construction and working principles – Applications – Advantages – Disadvantages.		12
Ex. 5	Natural Convection Heat Transfer.	
Ex. 6	Forced Convection Heat Transfer.	
Chapter IV	**Condenser**	
Introduction – Definition – Various Types of Condensers - Construction and working principles – Applications – Advantages – Disadvantages.		12
Ex. 7	Determination of Heat Transfer co-efficient in Vertical Condenser.	
Ex. 8	Determination of Heat Transfer co-efficient in Horizontal Condenser.	
Chapter V	**Radiation**	
Introduction – Definition - Types – Important Applications in chemical process Industries – Advantages – Disadvantages.		12
Ex. 9	Determination of Emissivity of a grey Body.	
Ex. 10	Verification of Stefan Boltzmann constant.	
	Total Hours	60

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076234420	HEAT TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment	Quantity Required
1	Thermal Conductivity of Metal Bar.	1 Nos.
2	Heat loss in pipes.	1 Nos.
3	Double Pipe Heat Exchanger by co-current Flow.	1 Nos.
4	Double Pipe Heat Exchanger by Counter-current flow.	1 Nos.
5	Natural Convection Heat Transfer.	1 Nos.
6	Forced Convection Heat Transfer.	1 Nos.
7	Vertical Condenser and Horizontal Condenser	1 Nos.
8	Emissivity apparatus.	1 Nos.
9	Stefan Boltzmann constant.	1 Nos.

1076234520	MECHANICAL OPERATIONS PRACTICAL	L	T	P	C
Practical		0	0	4	2

Introduction:

In mechanical operations practical, students learn about industrial processes like size reduction and separation. They engage in hands-on experiments with crushers, mills, and separators. Safety protocols are emphasized, preparing students for careers in chemical engineering and related fields.

Course Objectives:

- To provide hands on experience in analyzing the size reduction and separation of particles.

Course Outcomes (CO):

On successful completion of this course, the student will be able to:

CO1: Determine the Reduction ratio and specific surface area of newly generated solid particles using size reduction equipment such as Jaw crusher, roll crusher and ball mill.

CO2: Determine the screen efficiency of the given material by using sieve shaker.

CO3: Determine specific cake resistance and filter medium resistance of given slurry using Plate & Frame Filter press and also understand the principle of separation of solid particles using gas in a cyclone separator.

CO4: Determine the settling velocity of solid particle in different regions of settling particle.

CO5: Determine the settling velocity of solid particle in different regions of settling particle using a Cyclone Separator. Understand the settling characteristics of given slurry using Batch settling.

Pre-requisites:

None.

1076234520	MECHANICAL OPERATIONS PRACTICAL	L	T	P	C
Practical		0	0	4	2

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	3
CO2	3	1	2	2	1	-	3
CO3	3	3	2	-	1	3	2
CO4	3	2	2	3	2	2	-
CO5	3	2	1	3	3	1	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application - Based Learning: Employ a theory – demonstrate – practice – activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

1076234520	MECHANICAL OPERATIONS PRACTICAL	L	T	P	C
Practical		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

1076234520	MECHANICAL OPERATIONS PRACTICAL	L	T	P	C

Practical		0	0	4	2

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.
- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Practical		0	0	4	2

Syllabus contents

Chapter I	**Size Reduction**	
Introduction – Definition - Types – Importance of size reduction - Applications – Advantages – Disadvantages.		25
Ex. 1	Sieve Analysis.	
Ex. 2	Jaw Crusher.	
Ex. 3	Roller crusher.	
Ex. 4	Ball mill.	
Chapter II	**Separation of Solid-Liquid and Solid-Gas Mixture**	
Introduction – Definition of separation - Types – Applications – Advantages – Disadvantages.		20
Ex. 5	Filter press (Plate and Frame).	
Ex. 6	Leaf filter.	
Ex.7	Cyclone Separator.	
Chapter III	**Sedimentation, Filtration and Mixing**	
Introduction – Definition of Sedimentation, Filtration and Mixing – Types – Applications – Advantages – Disadvantages.		15
Ex.8	Stoke's Law of Settling.	
Ex. 9	Batch Settling.	
Ex. 10	Industrial Mixer.	
Total Hours		60

1076234520	MECHANICAL OPERATIONS PRACTICAL	L	T	P	C
Practical		0	0	4	2

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Practical		0	0	4	2

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment	Quantity Required
1	Long, wide glass tube	2 Nos.
2	Measuring Jar (1Litre)	2 Nos.
3	Mixing Tank with accessories	1No.
4	Leaf Filter with accessories such as Vacuum pump, manometer etc.	1No.
5	Set of sieves and sieve shaker machine	1No.
6	Jaw Crusher	1No.
7	Double Roller Crusher	1No.
8	Ball mill with different size of balls	1No.
9	Plate and Frame filter press with accessories	1No.
10	Cyclone separator	1No.

1076234640	PROCESS INSTRUMENTATION AND CONTROL	L	T	P	C
Practicum		1	0	4	3

Introduction:

This subject gives the knowledge of various instruments used to measure various processes parameters like temperature, pressure, level, flow etc. This course will impart knowledge on working principle, construction, and use of these instruments and will make the students knowledgeable in various types of measuring instruments used in chemical process industries.

Course Objectives:

- To impart the basic concepts of process control and instrumentation in process industries.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: To understand the application of various Industrial instruments & control.

CO2: To understand the working of various temperature measuring Instruments.

CO3: To understand the working of various pressure measuring Instruments.

CO4: To list out various Flow measuring Instruments.

CO5: To understand the significance of automatic control system.

Pre-requisites:

None.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	1	1	2
CO2	3	3	2	2	1	1	2
CO3	3	3	2	2	1	1	2
CO4	3	3	2	2	1	1	2
CO5	3	3	2	2	1	1	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

1076234640	PROCESS INSTRUMENTATION	L	T	P	C

Practicum	AND CONTROL	1	0	4	3

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations, and real-world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome - and employability-based.
- Do not let students work on an activity or an experiment with the expected outcome, rather allow students to be honest about whatever the results of the experiment are. If the results are different from the expectations, students should do an analysis where they could be the source of error, if any.

Assessment Methodology:

	Continuous Assessment (40 marks)				**End Semester Examination (60 marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises	Cycle II Exercises	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1076234640	PROCESS INSTRUMENTATION AND CONTROL	L	T	P	C
Practicum		1	0	4	3

Note:

- **CA1 and CA2:** All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical documents should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	5
B	Formulas, Explanations, Tabular Column and Schematic Diagram	20
C	Calculations & Result	25
TOTAL		50
D	Practical Documents (As per the portions)	10
TOTAL MARKS		**60**

-

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		Marks	
Part – A	30 MCQ Questions.	30 x 1 Marks	30 Marks
Part – B	7 Questions to be answered out of 10 Questions.	7 x 10 Marks	70 Marks
TOTAL			100 Marks

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical Examination and End Semester Examination – Practical Exam

Part	Description	Marks
A	Aim & Apparatus Required	5
B	Formulas, Tabular Column and Schematic Diagram	20
C	Observations & Calculations	25
D	Result	10
E	Written Test (Theory Portions)	30
F	Viva voce	10
TOTAL MARKS		**100**

Practicum	**AND CONTROL**	1	0	4	3

Syllabus Content

Unit I	**MEASUREMENT OF TEMPERATURE, PRESSURE,LEVEL AND FLOW**	
I	Temperature - Temperature measuring instruments - RTD - Thermocouples – Temperature Transmitter. Pressure- Units of Pressure - Pressure measuring instruments - Bourdon gauge - Bellow and Diaphragm pressure sensor – Pressure Transmitter. Flow rate - Flow rate measuring instruments –Coriolis flow meter- Electromagnetic flow meter - Ultrasonic flow meter- Vortex flow meter Level measurement – Radioactive level transmitter- Diaphragm level transmitter.	7
Ex.No	Name of the Experiment	
1	Measurement of Temperature by Thermocouple module.	30
2	Measurement of Temperature by of RTD module.	
3	Level measurement by using Differential Pressure (DP) Transmitter.	
4	Measurement of Pressure by Bourdon Pressure Transducer	
Unit II	**PROCESS CONTROL**	
II	Automatic control system –significance –Terminology used in control system: controlled variable, manipulated variable, set point - process control system: open loop system and closed loop system - Feedback control system and Feed forward control system - Ratio control system and Split range control system (Principles and Purposes only). Automatic controllers: controllers- classification; based on control action such as P, I, D, PI, PD, PID (pneumatic system) – Final control element: control valves- variable speed drives. Control application in Heat Exchanger - Application of Distributed Controlled System (DCS) and PLC in Distillation column.	8

1076234640	**PROCESS INSTRUMENTATION AND CONTROL**	L	T	P	C
Practicum		1	0	4	3

Ex.No	Name of the Experiment	
5	Study of ON- OFF controller using Temperature controller Trainer kit by monitoring the process in SCADA mode or Analog mode	30
6	Study of characteristics of control valve (Linear, Equal% and Quick opening).	
7	Study the linearity of P/I and I/P converter.	
8	Study of P, PI, PD and PID controller using Pressure controller Trainer kit by monitoring the process in SCADA mode or Analog mode	
TOTAL HOURS		**75**

Suggested List of Students Activity:

- Presentation / Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly / fortnightly based on the course.
- Micro project that shall be an extension of any practical lab exercise to real-world application.

Text and Reference Books:

- XI and XII standard Tamilnadu State Board Physics Text Book - 2023 Edition - Text book Corporation Tamil Nadu.
- Concepts of Physics Vol 1 & Vol 2 - H.C.Verma - 1st Edition - Bharathi Bhavan Publishers - 2021.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610
- https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry

1076234640	**PROCESS INSTRUMENTATION AND CONTROL**	L	T	P	C
Practicum		1	0	4	3

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARK

Part	Description	Marks
A	Aim & Apparatus Required	5
B	Formulas, Tabular Column and Schematic Diagram	20
C	Observations & Calculations	25
D	Result	10
E	Written Test (Theory Portions)	30
F	Viva voce	10
TOTAL MARKS		**100**

1076234640	**PROCESS INSTRUMENTATION AND CONTROL**	L	T	P	C
Practicum		1	0	4	3

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment	Quantity Required
1	Temperature sensors - Thermocouple.	1 Nos.
2	Temperature sensors – RTD.	1 Nos.
3	Differential Pressure Transmitter	1 Nos.
4	Bourdon Pressure Transducer	1 Nos.
5	Temperature control Trainer Kit with SCADA or Analog	1 Nos.
6	Pneumatic control valve (Linear, Equal % and Quick opening) set up	1 Nos.
7	P/I and I/P converter	1 Nos.
8	Pressure Control Trainer Kit with SCADA or Analog	1 Nos.

1076235110	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
Theory		3	1	0	4

Introduction:

This subject equips students with the necessary skills to analyze material and energy balances in chemical processes. In industries, raw materials are processed to create diverse products, with their composition and processing conditions determining product yield and resource efficiency. Understanding stoichiometry ratios and process conditions is vital for optimizing product formation and material recycling, making stoichiometry proficiency essential for chemical engineers.

Course Objective:

- This course aims to equip students with the skills necessary to analyse chemical processes through calculations essential for chemical processing operations.
- It introduces students to the application of laws and enables them to formulate and solve material and energy balances in processes, both with and without chemical reactions.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: To excel in chemical calculations, understand the mole concept, atomic weight, molecular weights, and compositions for solids & solutions. Also, grasp concentration units (molarity, molality, normality) and understand density & specific gravity.

CO2: To master the concepts related to ideal gases, including laws governing their behaviour, temperature scales, and pressure units. Understand the principles of gaseous mixtures, including Dalton's law and Amagat's law, and learn to calculate average molecular weight and density.

CO3: Understand methods for solving different types of material balance problems, definitions of key terms like tie substance and inert material, to solve material balance problems in various chemical processes, and grasp concepts related to bypass, recycle, and purging operations.

To master the stoichiometry concepts like coefficients, limiting reactants, and percentages.

CO4: Understand combustion principles, including calorific values, air requirements, and perform flue gas analysis.

CO5: Understand energy balance concepts, including heat capacity and enthalpy changes in chemical reactions.

1076235110	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
Theory		3	1	0	4

Pre-requisites:

Knowledge of mathematics and chemistry.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	1	2
CO2	3	3	3	2	2	1	2
CO3	3	3	3	2	2	1	2
CO4	3	3	2	3	2	1	2
CO5	3	3	2	2	3	1	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076235110	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076235110	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	BASIC CHEMICAL CALCULATIONS	
Basis of calculation - Mole concept - Atomic weight, Molecular weight- Methods of expressing the composition of solids and solutions- Weight percent & Volume percent- Mole percent and mole fraction- Concept of PPM (Parts Per Million)- Equivalent weight- Molarity, Molality and Normality - Density and Specific gravity.		12
Unit II	**BEHAVIOUR OF IDEAL GASES**	
Behaviour of Ideal gases- Ideal gas law- absolute pressure and gauge pressure- temperature - temperature scales- unit conversion of temperature and pressure. Gaseous mixtures-Dalton's law of partial pressure for gas mixtures- Amagat's law of partial volume - Average molecular weight and density of gaseous mixtures.		12
Unit III	**MATERIAL BALANCE WITHOUT CHEMICAL REACTION**	
Material balance - Methods of solving the three basic types of material balance problems- definitions of terms tie substance and inert material - simultaneous equation - Calculating quantities of acids required in mixed acid blending process. Material balance problems involving unit operation such as distillation, Evaporation and Leaching - Bypass operation- Recycle operation- Purging operation (Brief descriptions only).		12
Unit IV	**MATERIAL BALANCE WITH CHEMICAL REACTIONS**	
Definition of the following terms- Stoichiometric coefficient- Stoichiometric ratio- Limiting reactant - Excess reactant – Percentage of excess reactant – Percentage conversion – Percentage yield – Selectivity – Simple problems. Combustion – Gross calorific value and Net calorific value-Theoretical air requirement – percentage excess air — Orsat analysis of Flue gases - simple problems.		12

1076235110	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
Theory		3	1	0	4

Unit V	ENERGY BALANCE	
Energy balance - definition of terms heat capacity and specific heat capacity- sensible heat and Latent heat of pure liquid - amount of heat required to raise the temperature of process fluid using heat capacity data. Enthalpy changes accompanying chemical reaction – standard heat of formation-standard heat of combustion-heat of reaction.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Stoichiometry - Bhatt, B. I., Vora, S. M, - 4th Edition - Tata McGraw Hill Publishing Company Ltd., - 2004
2. Elementary Principles of Chemical Processes - Felder, R. M., Rousseau, R. W., - 3rd Edition - John Wiley & Sons - 2000.
3. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
4. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 1997.
5. Introduction to chemical Engineering - Ghoshal, Sanyal and Dutta - 1st Edition - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.
6. Basic Principles and Calculations in Chemical Engineering - Himmelblau, D. M., Riggs, J. B. - 8th Edition - Pearson India Education Services - 2015.
7. Chemical Process Principles, Part-I - Material & Energy Balances - Hougen, O. A., Watson, K. M., Ragatz, R. A. - 2nd Edition - CBS Publishers & Distributors - 2004.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610
- https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry

1076235110	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
Theory		3	1	0	4

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076235210	MASS TRANSFER - I	L	T	P	C
Theory		3	1	0	4

Introduction:

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipment's like distillation columns, absorption columns, which are used in industries for purification of products. This course explains the fundamentals of mass transfer and techniques involved in mass transfer operations of distillation, extraction and absorption. This subject intends to equip the students with the concept and principles of mass transfer operation, which are of prime importance in any chemical industry. Mass transfer equipment's are an integral part of any chemical plant. This subject will help the student's to operate and design various mass transfer equipment.

Course Objective:

- To enable the students to apply the principles of absorption, humidification, and distillation in process plant operations.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Interpret the mechanism of diffusion.

CO2: Summarize absorption and absorber.

CO3: Summarize cooling towers.

CO4: Interpret the concept of distillation.

CO5: Summarize the operation and design of distillation column.

Pre-requisites:

Fluid Mechanics, Mass Energy Balance, Chemical Engineering Thermodynamics

1076235210	MASS TRANSFER - I	L	T	P	C
Theory		3	1	0	4

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	2	1	3
CO2	3	3	-	1	3	1	2
CO3	3	-	3	1	-	2	2
CO4	3	-	1	1	-	2	3
CO5	3	-	-	1	-	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076235210	MASS TRANSFER - I	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076235210	MASS TRANSFER - I	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	PRINCIPLES OF MASS TRANSFER	
Diffusion and mass transfer operation- molecular diffusion and eddy diffusion - Fick's law of diffusion- Equimolal counter diffusion - Mass transfer coefficients – units of mass transfer coefficient - inter phase mass transfer Classification of mass transfer operations - methods of conducting mass transfer operations - unsteady state and steady state operations-stage wise and differential contact operation		12
Unit II	**ABSORPTION**	
Principles of Gas absorption and stripping - Henry's Law - choice of solvent for absorption - absorption factor - construction and principle of operation of packed bed absorption column- packing materials- random packing and regular packing - operating problems like channeling, loading, flooding, entrainment, priming, weeping and coning in absorption column – HTU, NTU and HETP concepts.		12
Unit III	**HUMIDIFICATION**	
Humidification operation - Terminology used in humidification operation such as Absolute humidity, Molal humidity, Dry bulb temperature, Wet bulb temperature, Relative humidity, Percentage saturation, Dew point, Humid heat and Humid volume - simple problems in Humidification Equipment for Humidification operations-construction and working principle of cooling towers - arrangements of cooling towers- natural draft, forced draft and induced draft –Cooling tower efficiency – Range and approach – blow down and cycle of concentration.		12

1076235210	MASS TRANSFER - I	L	T	P	C
Theory		3	1	0	4

Unit IV	FUNDAMETALS OF DISTILLATION	
Distillation- relative volatility- boiling point diagram and equilibrium diagram–- Raoult's law –azeotropic mixture- maximum and minimum boiling azeotropes – simple or differential distillation- Rayleigh's equation- flash distillation –vacuum distillation- continuous multistage rectification. Dimensionless numbers in mass transfer and its significance- Schmidt number, Lewis number, and Sherwood number (Brief description only).		12
Unit V	**DESIGN AND TECHNIQUES OF DISTILLATION COLUMN**	
Tray towers - calculation of number of trays - McCabe Thiele method - Assumptions in McCabe-Thiele method -Graphical procedure to determine the number of theoretical trays - total reflux - minimum reflux - optimum reflux- q line –values of q based on five different feed conditions-operating lines – feed tray location.- Types of distillation column trays- Types of plate efficiencies- Overall efficiency and Murphree plate efficiency - Azeotropic distillation and Steam distillation.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 1997.
3. Mass Transfer Operation - R.E. Treybal - 3rd Edition - Tata McGraw Hill - 2017.
4. Perry’s Chemical Engineers Hand book - Robert H. Perry and D.W. Green - 7th Edition - Tata McGraw Hill - 1997.

1076235210	MASS TRANSFER - I	L	T	P	C
Theory		3	1	0	4

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://pubs.acs.org/journal/iecred
- https://publica.fraunhofer.de/items/ffb7e060-d220-4e72-81f5-ae5e18224610
- https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry
- https://archive.nptel.ac.in/courses/103/103/103103145/
- https://onlinecourses.nptel.ac.in/noc21_ch06/preview
- https://www.youtube.com/watch?v=i_OI89Mz3gc

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076235311	INDUSTRIAL SAFETY AND POLLUTION CONTROL	L	T	P	C
Theory		3	0	0	3

Introduction:

This course provides students with fundamental principles of plant safety and safety measures in chemical plants. It covers occupational hazards, pollutants, emissions related to air and water, treatment methods, and analysis techniques. It also addresses chemical hazards, emphasizing the importance of industrial safety.

Course Objectives:

- To impart thorough knowledge on the safe operations in chemical plants.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Acquire in-depth knowledge of process safety principles, practices, and protocols to prevent accidents, protect personnel, and maintain environmental safety in process industries.

CO2: Gain thorough knowledge of fire safety principles, hazards, prevention strategies, and response techniques to effectively mitigate fire risks and protect lives and property.

CO3: Gain comprehensive understanding of industrial hazards, their causes, prevention strategies, and regulatory requirements to promote safety and mitigate risks in industrial environments.

CO4: Develop understanding of industrial safety protocols, equipment, and risk assessment to safeguard personnel and assets in industrial environments.

CO5: Empowered to tackle environmental challenges by understanding the complexities of air and water pollution, mastering essential monitoring techniques, and implementing proactive measures to safeguard the environment and human well-being.

Pre-requisites:

Preliminary knowledge on Environmental Pollution.

Basic Concepts of chemistry and environmental science.

1076235311	INDUSTRIAL SAFETY AND POLLUTION CONTROL	L	T	P	C
Theory		3	0	0	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	2	3
CO2	3	3	2	3	3	2	3
CO3	3	3	2	3	3	2	3
CO4	3	3	2	3	3	3	3
CO5	3	3	3	2	3	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076235311	INDUSTRIAL SAFETY AND POLLUTION CONTROL	L	T	P	C
Theory		3	0	0	3

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076235311	INDUSTRIAL SAFETY AND POLLUTION CONTROL	L	T	P	C
Theory		3	0	0	3

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	INDUSTRIAL ACCIDENT AND SAFETY	
Process Safety – causes of Accidents –unsafe acts and conditions– importance of safety in process industries – Responsibility of supervisor regarding safety – Material Safety Data Sheet (MSDS) and its importance- Evaluating workers exposure to volatile toxicants ,dusts and noise. Accident prevention- Differentiate Hazard and Risk - Case study of accidents in process industry: Bhopal gas tragedy and LG Polymers gas leak, Vizag.		9
Unit II	**FIRE AND ITS PREVENTION**	
Elements of fire and Fire triangle-different causes of fire- Distinction between fires and explosion- Flash point and Fire point- causes of initiation of fire - classification of fires - causes of electrical fire - Fire alarms and smoke detectors. Fires extinguish techniques - working of Carbon-dioxide fire extinguisher and Dry chemical fire extinguisher.		9
Unit III	**PROCESS PLANT HAZARDS**	
Hazard – classification of hazards- causes and prevention of Pressure vessel hazards- Static Electricity hazards and its control- Flammability and Toxicity- Lower Flammability Limit (LFL) and Upper Flammability Limit (UFL) - BLEVE- Runaway chemical reaction. MSDS(Material Safety Data Sheet) for the following chemicals : Acetone and Toluene.		9

1076235311	INDUSTRIAL SAFETY AND POLLUTION CONTROL	L	T	P	C
Theory		3	0	0	3

Unit IV	PREVENTIVE AND PROTECTIVE MEASURES	
Permit to work system- Hot work permit, Confined space vessel work permit, safety precautions while entry into confined spaces and Height work permit- -Lockout/ Tagout procedures. Functions of Pressure vacuum relief valve (PVR) - Breather vent for storage tanks- Function of Flame Arresters- Flare systems- Planning for Emergencies- Personnel protective Equipments and its importance.		9
Unit V	**POLLUTION CONTROL**	
Air pollution-sources and types of pollutants-Adverse effects- Air sampling and Monitoring- Ozone depletion – Green house effects- Acid rain and Global warming - Important aspects of Environment Protection Act, 1986. Water pollution- sources and types- constituents of waste water- - Important terms used in water treatment- BOD, COD, DO, TDS, and Biodegradability tests -Primary treatment - Coagulation and Flocculation- Secondary (Biological) treatment - Activated Sludge process - Important aspects of The Water (Prevention and control of Pollution) Act, 1974.		9
TOTAL HOURS		**45**

Text and Reference Books:

1. Learning Chemical Engineering for Process Industries - Nikhlesh Mathur - 1st Edition - Authors press - 2015.
2. Introduction to Chemical Engineering - Kenneth A. Solen - 1st Edition - Wiley Publications - 2014.
3. Introduction to Chemical Engineering - Pushpavanam.S - PHI Learning Pvt Ltd, New Delhi - 2012.
4. Environmental Pollution Control Engineering - C.S.Rao - 3rd Edition - New Age International Publishers, New Delhi - 2017.
5. Wastewater Engineering: Treatment & Reuse - Metcalf and Eddy - 4th Edition - McGraw Hill Publication - 2002.
6. Pollution control in process industries - S P Mahajan - Reprint Edition - Tata McGraw Hill Publishing Company, New Delhi - 2017.
7. Safety and Accident Management in the Chemical Process Industries Edition - H. Heinmann, M. Dekker - 2nd Edition - 2019.

8. Instrumental Methods of Analysis, 1/e Edition - B. K. Sharma - Krishna Prakashan Media (P) Ltd, - 2014.
9. HAZOP and HAZAN - Trevor Kletz - 4th Edition - Institution of Chemical Engineers, IChemE, UK. - 2014.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://onlinecourses.nptel.ac.in/noc20_mg43/preview

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076235312	PLANT UTILITIES	L	T	P	C
Theory		3	0	0	3

Introduction:

All oil refineries and other petroleum processing facilities need utilities in order to function. The subject is introduced to give the student a thorough knowledge of process utilities such as demineralization of water and its importance, refrigeration, steam generation, piping and its importance and pinch analysis, which is essentially for the processes, design, reliability and operation of these critical systems in petrochemical industries.

Course Objective:

To facilitate students' comprehension of process plant utilities and optimization techniques for enhancing various parameters in chemical industries.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Acquire a comprehensive understanding of various aspects related to water sources, parameters, treatment methods, and the requisites of industrial water usage.

CO2: Gain a comprehensive understanding of refrigeration principles, cycles, and systems, including both vapour compression and absorption cycles, as well as air refrigeration cycles.

CO3: Develop practical skills and theoretical knowledge necessary to effectively operate, maintain, and optimize steam systems in industrial settings.

CO4: Develop the knowledge and skills required to design, analyse, and manage piping systems effectively, contributing to the efficient and safe operation of industrial facilities across various sectors.

CO5: Gain a comprehensive understanding of Pinch Analysis and its applications in optimizing energy usage and heat exchanger network synthesis.

Pre-requisites:

Chemical Engineering Thermodynamics.

Chemical Technology, and Heat Transfer.

1076235312	PLANT UTILITIES	L	T	P	C
Theory		3	0	0	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076235312	PLANT UTILITIES	L	T	P	C
Theory		3	0	0	3

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076235312	PLANT UTILITIES	L	T	P	C
Theory		3	0	0	3

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	WATER AND ITS IMPORTANCE	
Sources of water- parameters like hardness, suspended solids (SS), turbidity and alkalinity etc., hard and soft water Requisites of industrial water and its uses-Methods of water treatment –flow diagram-coagulation by iron compounds like alum-sedimentation – filtration - chemical softening and demineralization (Ion Exchange Process) - Reverse osmosis and membrane separation - Effects of impure boiler feed water - scale and sludge formation, corrosion, priming and foaming, caustic embrittlement.		9
Unit II	**REFRIGERATION**	
Refrigeration - Definition, unit of refrigeration - coefficient of performance. Refrigeration cycles - Reversed Carnot cycle, representation on PV and TS diagram. Air refrigeration cycle - Bell Coleman air refrigeration cycle. Vapor compression and absorption cycle.		9
Unit III	**STEAM GENERATION**	
Properties of steam - Problems based on enthalpy calculation for wet steam ,dry saturated steam, superheated steam types of steam generators/boilers: water tube & fire tube, Solid fuel fired boiler, waste gas fired boiler, Waste heat boiler, Fluidized bed boiler. Scaling, trouble shooting, blow down preparing boiler for inspection Steam traps, pressure reducing valves (PRV), steam ejectors, boiler mountings and accessories: feed water pump, injector, economizer, air preheater, super heater, pressure gauge, water level indicator, safety valve etc.		9
Unit IV	**PIPING AND ITS IMPORTANCE**	
Piping: Role & scope of piping, line diagram, Process flow -Diagram and piping and instrumentation diagram-Piping networks for water, steam, condensate and air.		9

1076235312	PLANT UTILITIES	L	T	P	C
Theory		3	0	0	3

Unit V	PINCH ANALYSIS	
Pinch Analysis: Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram. Heat Exchanger Network Synthesis using Pinch technology.		9
TOTAL HOURS		45

Text and Reference Books:

1. Jack Broughton, Process Utility Systems: Introduction to Design, Operation and Maintenance, IChemE, 2004.
2. Thermal Engineering - Mahesh M Rathore - Tata McGraw Hill - 2010.
3. Chemical Process Design and Integration - Robin Smith - 2nd Edition - John Wiley & Sons Limited - 2010.
4. Water Treatment for industrial and other uses - Nordell Eskel - Reinhold Publishing Corporation, New York - 1961.
5. Plant Utilities - Dr. Mujawar - Kindle Edition - Nirali Prakashan Publication - 2017.
6. Plant Utilities - D.B. Dhone - 1st Edition - Nirali Prakashan Publication - 2018.
7. Thermal Engineering - P.L.Balleney - 9th Edition - Khanna Publisher New Delhi - 1978.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://onlinecourses.nptel.ac.in/noc22_ch24/preview

END SEMESTER QUESTION PATTERN - THEORY EXAM

- **Duration : 3 Hrs . Max. Marks : 100**
- **Note:** Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.
- **Instruction to the Question Setters:**
- Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076235313	RENEWABLE ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Introduction:

In this subject the basic concepts of various renewable energy sources and their production methods are discussed in detail. This subject will help the student's understand about renewable energy technologies and their storage techniques.

Course Objective:

- To impart the importance of renewable energy resources and their utilization.

Course Outcomes:

After successful completion of this course, the students should be able to

CO1: Summarize present and future energy scenario of the world.

CO2: Summarize various wind energy systems and solar energy harvesting methods.

CO3: Summarize the methods for Bio energy generation from Bio waste.

CO4: Summarize the tidal energy and hydrogen storage systems.

CO5: Summarize the energy storage technology.

Pre-requisites:

Knowledge of chemistry.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	1	2
CO2	3	3	2	3	2	1	2
CO3	3	3	3	2	2	1	2
CO4	3	3	1	3	2	1	2
CO5	3	3	2	2	3	1	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

1076235313	RENEWABLE ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

1076235313	RENEWABLE ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	**INTRODUCTION TO ENERGY ENGINEERING**	
World Energy Use- Reserves of Energy Resources Environmental Aspects of energy Utilization Renewable Energy Scenario in India and around the World- Potentials- Achievements Applications - Economics of renewable energy systems. Various methods of energy sources- Solar energy - wind energy- Bio-energy - Tidal power - fuel cells.		9
Unit II	**SOLAR ENERGY**	
Solar energy-Solar Radiation –solar constant- Measurements of Solar Radiation- Flat Plate and Concentrating Collectors- Solar direct Thermal Applications- Solar thermal Power Generation Fundamentals of Solar Photo Voltaic Conversion- Solar Cells- Solar PV Power Generation- Solar PV Applications.		9

1076235313	RENEWABLE ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Unit III	BIO ENERGY	
Bio-Energy- definition- Biomass – Physical and chemical composition – properties of biomass Biomass direct combustion. Biomass Gasifiers- site selection of Biogas plants-material requirement for construction of Bio gas Plant- utilization –economics Digesters - anaerobic and aerobic combustion - Ethanol production. Bio diesel-Cogeneration- utilization of Bio diesel – Technology for production of bio diesel - Transesterification – Process – Usage of Methanol – Glycerin – Storage and Characterization of biodiesel. Biomass Applications- Bio fuels-bio diesel- bio ethanol and value addition of byproducts.		9
Unit IV	**TIDAL, GEOTHERMAL AND GREEN HYDROGEN**	
Other renewable energy sources – Identify suitable energy sources for a location Introduction - Tidal energy- Wave Energy- Open and Closed OTEC Cycles. Illustrate Small Hydro-Geothermal Energy Hydrogen and Storage- Fuel Cell Systems- advantages, Hybrid Systems – Concept of Green hydrogen- production of green hydrogen.		9
Unit V	**ENERGY STORAGE TECHNOLOGY**	
Introduction, Need of Energy storage, Different modes of energy storage. Mechanical energy storage: Flywheels, compressed air, and pumped hydro Electrical and Magnetic Energy storage: Batteries Capacitors, electromagnets, and Chemical energy storage. Basics of Sensible heat storage, Stratified storage, Rock bed storage, Thermal storage in buildings, Earth storage and Aquifers storage. Basics of Latent heat storage, Phase change materials (PCM).		9
TOTAL HOURS		**45**

1076235313	RENEWABLE ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Text and Reference Books:

1. Energy Systems and Sustainability: Power for a Sustainable Future - Bob Everett & Godfrey Boyle - Oxford University Press – 2012.
2. Wind Energy Explained: Theory, Design and Application - James F. Manwell, Jon G. McGowan – Wiley – 2002.
3. Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems - Olindo Isabella - UIT Cambridge Ltd – 2014.
4. Biomass and Bioenergy: Applications - Khalid Rehman Hakeem – Springer – 2014.
5. Tidal Energy Systems: Design, Optimization and Control - Vikas Khare & Savita Nema – Elsevier – 2016.

Web-based/Online Resources

- https://onlinecourses.nptel.ac.in/noc23_mm24/preview
- https://www.youtube.com/watch?v=wjm5k6Kf-RU

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Introduction:

In chemical engineering mass transfer practicals, students explore distillation, absorption, and extraction through hands-on experiments. They learn to operate equipment like columns and towers while prioritizing safety. These sessions prepare students for careers in petrochemicals, pharmaceuticals, and environmental engineering.

Course Objectives:

- To enable the students in interpreting the concepts of mass transfer
- To provide hands-on experience in mass transfer operations.

Course Outcomes (CO):

On successful completion of this course, the student will be able to

CO1: To understand Verification of Rayleigh equation and vapor liquid equilibrium by using simple distillation and also determine the vaporization efficiency of steam distillation.

CO2: To understand the concept of decolorization by adsorption and also measurement of diffusivity of given acetone sample.

CO3: Determine the extraction efficiency of Liquid-Liquid Extraction system and also estimate the percentage recovery of oil from oilseed by leaching.

CO4: Determine the rate of drying using batch dryer and also measuring the humidity of air using wet and dry bulb thermometers.

CO5: Determine yield of crystallization.

Pre-requisites:

Knowledge of Chemistry.

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	1	2	2	1	1
CO2	2	3	1	2	2	1	1
CO3	2	3	1	2	2	1	1
CO4	2	3	1	2	2	1	1
CO5	2	3	1	2	2	1	1

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory – demonstrate – practice - activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.
- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Syllabus contents

Chapter I	**DISTILLATION**	
Distillation – Principle – Types of distillation – Simple Distillation principle – vapour liquid equilibrium – Raleigh equation – Application – Steam Distillation principle – Relative Volatility - Application – Advantage and disadvantages.		18
Ex. 1	Verify Rayleigh's equation and material balance for simple distillation.	
Ex. 2	Plot the vapor - liquid equilibrium curve for simple distillation of ethanol-water system of given composition by using conventional method or Virtual method.	
Ex. 3	Estimate the vaporization efficiency for steam distillation.	
Chapter II	**DIFFUSION & ADSORPTION**	
Diffusion – Principle – Types of Diffusion – Diffusivity – Measurement of Diffusivity. Adsorption – Principle – Adsorbents – Types of Adsorbents – Decolorization by Adsorption – Application.		12
Ex. 4	Determine the diffusivity of given acetone sample by using conventional method or Virtual method.	
Ex. 5	Decolorization by Adsorption.	
Chapter III	**EXTRACTION & LEACHING**	
Extraction – Principle – Types of Extraction – Liquid-Liquid Extraction – Triangular Chart and its uses – Applications. Solid-Liquid Extraction – Principle – Adsorbent - % recovery of oil in seed – Application.		12
Ex. 6	Determine the extraction efficiency of Liquid-Liquid Extraction system.	
Ex.7	Estimate the percentage recovery of oil from oilseed by single stage leaching.	
Chapter IV	**DRYING & HUMIDIFICATION**	
Drying – Principle – Mechanism – Moisture content – Wet basis and Dry basis – Drying characteristics – Application – Advantages and Disadvantages. Humidification – Principle – Wet Bulb Temperature – Dry Bulb Temperature – Application - Advantages and Disadvantages.		12

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

Ex.8	Estimate the rate of drying for the given sample using batch dryer.	
Ex. 9	Estimate the humidity of air using wet and dry bulb thermometers.	
Chapter IV	**CRYSTALLIZATION**	
Crystallization – Principle – Mechanism of crystallization – Types of crystallization – Purity – Yield – Calculation of Yield – Application – Advantages and Disadvantages.		6
Ex. 10	To determine the yield of crystals of crystallization process.	
Total Hours		60

Note : Out of 10 experiments, the above mentioned two experiments (Ex. 2 & 4) may be done by conventional method or by using virtual lab simulator developed by Initiative of Ministry of Education under the National Mission on Education using the below link.

http://www.vlab.co.in/ba-nptel-labs-chemical-engineering.

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

1076235420	MASS TRANSFER PRACTICAL	L	T	P	C
Practical		0	0	4	2

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment	Quantity Required
1	Simple Distillation Apparatus	1 Nos.
2	Steam Distillation Apparatus	1 Nos.
3	Diffusivity Measurements Apparatus	1 Nos.
4	Decolourization by Adsorption Equipment	1 Nos.
5	Liquid-Liquid Extraction Apparatus	1 Nos.
6	Soxhlet Extractor	1 Nos.
7	Drier	1 Nos.
8	wet and dry bulb thermometers	1 Nos.
9	Crystallization Apparatus	1 Nos.

1076235521	CHEMICAL PROCESS SIMULATION LAB	L	T	P	C
Practical		0	0	4	2

Introduction:

In chemical process calculation for diploma chemical engineering, students learn fundamental calculations for chemical processes. Topics include material and energy balances, and stoichiometry. Practical exercises apply these concepts to real-world scenarios, preparing students for careers in various industries.

Course Objectives:

- Equip students with the ability to operate a variety of unit operations and plants under different process variable conditions using simulators.
- Emphasize the importance of simulators and explore their applications in distributed control systems.
- Provide hands-on experience to students in monitoring and controlling industrial processes through dynamic graphics such as mimics, bar graphs, trends, and alarms.

Course Outcomes (CO):

On successful completion of this course, the student will be able to

CO1:	Master adjustments, analyze changes, identify malfunctions, and conduct experiments using simulators for Batch Reactor and Continuous Stirred Tank Reactor modules.
CO2:	Understand the principles of heat transfer in double pipe heat exchangers through simulation, including temperature profiles, heat transfer coefficients, and overall heat transfer rates.
CO3:	Master simulation techniques for size reduction with ball mills, rotary driers for solids drying, and fractionation columns for distillation of binary mixtures.
CO4:	Gain expertise in simulating level and flow control in vessels of varying sizes, analyzing flow through pipes, and understanding the operation of centrifugal pumps through simulation.
CO5:	Master the simulation of fluidized bed and packed bed columns, including their operational principles, performance characteristics, and optimization techniques.

Pre-requisites:

Knowledge of Chemical Process.

1076235521	CHEMICAL PROCESS SIMULATION LAB	L	T	P	C
Practical		0	0	4	2

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	3	1	1	2
CO2	3	2	2	3	1	1	2
CO3	3	2	3	3	1	1	2
CO4	3	3	3	3	1	1	2
CO5	3	3	3	3	1	1	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory – demonstrate – practice - activity strategy throughout the course to ensure outcome-driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

1076235521	CHEMICAL PROCESS SIMULATION LAB	L	T	P	C
Practical		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Basic Command	10
B	Procedure	20
C	Printout & Result	20
TOTAL MARKS		**50**

1076235521	CHEMICAL PROCESS SIMULATION LAB	L	T	P	C
Practical		0	0	4	2

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.
- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim	10
B	Procedure	20
C	Execution	20
D	Printout	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076235521	CHEMICAL PROCESS SIMULATION LAB	L	T	P	C
Practical		0	0	4	2

Syllabus contents

Chapter I	REACTOR KINECTICS	
Change the P,I,D values and process parameters and observe the change in trend, bar graph and mimics. Attend the malfunction occurring in the plant then restoring to its design conditions. Perform the experiments using the simulator by varying the process variables and tabulate the results. Practice the above exercise on the following modules given below using process simulator.		12
Ex. 1	Batch Reactor / Reaction kinetic studies in Batch Reactor.	
Ex. 2	Continuous Stirred Tank Reactor.	
Chapter II	**HEAT EXCHANGER EQUIPMENT**	
Ex. 3	Double pipe Heat exchanger.	6
Chapter III	**DRYING, DISTILLATION AND SIZE REDUCTION**	
Ex. 4	Size reduction using Ball mill / Drying characteristics of solids using Rotary Drier.	12
Ex. 5	Fractionation column for the distillation of binary mixture.	
Chapter IV	**LEVEL , FLOW CONTROL AND PUMP**	
Ex. 6	Level and flow control in different sizes of vessel.	18
Ex. 7	Flow through pipes.	
Ex. 8	Centrifugal pump.	
Chapter V	**FLUIDIZED AND PACKED COLUMN**	
Ex. 9	Fluidized bed column.	12
Ex. 10	Packed bed column.	
Total Hours		60

1076235521	CHEMICAL PROCESS SIMULATION LAB	L	T	P	C
Practical		0	0	4	2

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim	10
B	Procedure	20
C	Execution	20
D	Printout	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment / Facilities required	Quantity Required
1	Computer	Required Quantities
2	Printer	1 No.
3	Simulation Software / Virtual Lab	--

1076235522	PETROLEUM TESTING LAB	L	T	P	C
Practical		0	0	4	2

Introduction:

Analysis of various chemical commodities is necessary for controlling the quality of product in industry. This can be achieved in handling various analyses in the laboratory. The students can be learned all these by doing experiments in the practical classes.

Course Objectives:

To train the students on basic principles involved in estimation and Characterization of industrially important materials like Water, Oils and Fat, Soap, Cement, Bleaching powder, Glycerol, and Sucrose.

Course Outcomes (CO):

On successful completion of this course, the student will be able to

CO1: Reid Vapor pressure determination test.

CO2: ASTM distillation to find the quality of the petroleum product.

CO3: Carbon residue determination by Conradson method.

CO4: Carbon residue determination by Rams bottom method.

CO5: Determination of Sediments and water in crude by centrifuging.

Pre-requisites:

Knowledge of Basic of Petroleum Refining.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	2	1	2
CO2	3	3	2	3	2	1	2
CO3	3	3	2	3	2	1	2
CO4	3	3	2	3	2	1	2
CO5	3	3	2	3	2	1	2

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

1076235522	PETROLEUM TESTING LAB	L	T	P	C
Practical		0	0	4	2

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application - Based Learning: Employ a theory – demonstrate – practice – activity strategy throughout the course to ensure outcome - driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1076235522	PETROLEUM TESTING LAB	L	T	P	C
Practical		0	0	4	2

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

1076235522	PETROLEUM TESTING LAB	L	T	P	C
Practical		0	0	4	2

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Syllabus contents

Unit I	**ANALYSIS OF THE VOLATILITY OF THE HYDROCARBON IN THE PETROLEUM SAMPLE**	
Volatility of petroleum products – methods of assessment of volatility of petroleum products – distillation by ASTM – Reid vapor pressure.		10
Ex. 1	ASTM Distillation of Petroleum Products.	
Ex. 2	Determination of Reid vapor Pressure.	
Unit II	**EVALUATION OF COMBUSTION PROPERTIES OF PETROLEUM PRODUCTS**	
Combustion – introduction – methods of assessment of combustion properties in petroleum products –ignition quality of petroleum product by aniline point – burning quality by smoke point.		10
Ex. 3	Determination of aromatics using aniline point.	
Ex. 4	Smoke point of Petroleum Products.	

1076235522	PETROLEUM TESTING LAB	L	T	P	C
Practical		0	0	4	2

Unit III	DETERMINATION OF ACIDITY AND BROMINE NUMBER	
Definition of Acidity – Types – Importance – Application. Definition of bromine number – Estimation procedure – Application.		10
Ex. 5	Total Acidity Test	
Ex. 6	Bromine Number test to determine the % of olefin in the Distillate.	
Unit IV	**CORROSION**	
Corrosion – Reasons for corrosion of petroleum products – methods of measurements of corrosion potentiality – Experiment for measurement of corrosion in petroleum products by Copper corrosion test.		10
Ex. 7	Copper Corrosion test.	
Unit V	**ESTIMATE THE MISCELLANEOUS PROPERTIES OF PETROLEUM PROPERTIES**	
Miscellaneous properties of Petroleum products – Introduction – Measurement of Refractive index by refract meter – Carbon residue in crude – methods of measurement of carbon residue – Carbon residue by Conradson method and Rams bottom method.		20
Ex. 8	Carbon residue by Conradson method.	
Ex. 9	Carbon residue by Rams bottom method.	
Ex. 10	Determination of Sediments and water in crude by centrifuging.	
Total Hours		60

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

1076235522	PETROLEUM TESTING LAB	L	T	P	C
Practical		0	0	4	2

DETAILED ALLOCATION OF MARK

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment	Quantity Required
1	ASTM Distillation Apparatus.	1 No.
2	Reid vapor Pressure Apparatus.	1 No.
3	Aniline point Apparatus.	1 No.
4	Smoke point Apparatus.	1 No.
5	Total Acidity Apparatus	1 No.
6	Bromine Number Apparatus	1 No.
7	Corrosion Test Apparatus	1 No.
8	Conradson method Apparatus.	1 No.
9	Rams bottom method Apparatus.	1 No.
10	Centrifuging Apparatus.	1 No.
12		1 No.

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

Introduction:

In Diploma level engineering education to skill development especially working with instruments and Equipment's play a vital role. These can be achieved by experience in handling various equipment. This is accomplished by doing various experiments in practical classes.

Course Objectives:

- To enhance the analytical ability of students considering health, safety and environment

Course Outcomes (CO):

On successful completion of this course, the student will be able to:

CO1: Understand the principles and methods for estimating and improving removal efficiency of both temporary and permanent water hardness.

CO2: Demonstrate proficiency in assessing water quality through the estimation of dissolved oxygen levels, biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

CO3: Analyze and interpret data to determine the effectiveness of water treatment processes by calculating percentage removal of BOD and COD.

CO4: Gain practical skills in heavy metal analysis, including the estimation of hexavalent chromium content and assessing the percentage removal of chromium.

CO5: Apply knowledge of adsorption processes to evaluate and enhance color removal efficiency in effluent water treatment.

Pre-requisites:

Knowledge of Chemistry.

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	3	2	3
CO2	3	3	2	3	3	2	3
CO3	3	3	3	3	3	2	3
CO4	3	3	2	3	3	2	2
CO5	3	3	2	2	3	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- Engage and Motivate: Instructors should actively engage students to boost their learning confidence.
- Real-World Relevance: Incorporate relatable, real-life examples and engineering applications to help students understand and appreciate course concepts.
- Interactive Learning: Utilize demonstrations and plan interactive student activities for an engaging learning experience.
- Application-Based Learning: Employ a theory - demonstrate – practice – activity strategy throughout the course to ensure outcome - driven learning and employability.
- Simulation and Real-World Practice: Conduct demonstrations and hands-on activities in a simulated environment, transitioning to real-world scenarios when possible.
- Encourage Critical Analysis: Foster an environment where students can honestly assess experiment outcomes and analyze potential sources of error in case of discrepancies.

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	Each Practical 10 Marks	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  First Cycle : 1,2,3,4 & 5.

  Second Cycle : 6,7,8,9 & 10.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim, Apparatus Required, Formulas	10
B	Tabular Column & Observations	20
C	Calculations & Result	20
TOTAL MARKS		**50**

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

- **CA 3:** Practical document should be maintained for every exercise / experiment immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise observation and calculations should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or printed manual or file. The reading and calculations and graph should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.
- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

Syllabus contents

Chapter I	WATER HARDNESS ASSESSMENT	
Introduction to water hardness and its types - Methods for estimating removal efficiency of temporary hardness - Techniques for estimating removal efficiency of permanent hardness - Practical applications and case studies.		12
Ex. 1	Estimate the removal efficiency of temporary hardness.	
Ex. 2	Estimate the removal efficiency of permanent hardness.	
Chapter II	**WATER QUALITY ANALYSIS**	
Understanding dissolved oxygen and its importance - Estimation methods for dissolved oxygen levels - Introduction to biochemical oxygen demand (BOD) and its significance - BOD estimation techniques - Overview of chemical oxygen demand (COD) and its measurement - COD estimation methods – Applications.		18
Ex. 3	Estimate the amount of dissolved oxygen in a given effluent sample.	
Ex. 4	Estimate the BOD of a given effluent sample.	
Ex. 5	Estimate the COD of a given effluent sample.	
Chapter III	**REMOVAL EFFICIENCY ANALYSIS**	
Principles of percentage removal analysis - Calculation methods for percentage removal of BOD - Calculation methods for percentage removal of COD - Case studies and real-world applications		12
Ex. 6	Estimate the percentage removal of BOD.	
Ex. 7	Estimate the percentage removal of COD.	
Chapter IV	**HEAVY METAL ANALYSIS**	
Introduction to heavy metal contamination in water - Estimation methods for hexavalent chromium content - Techniques for assessing percentage removal of chromium - Safety precautions and laboratory practices.		12

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

Ex. 8	Estimate the amount of hexavalent chromium in a given sample.	
Ex. 9	Estimate the percentage removal of chromium from a given sample.	
Chapter V	**ADSORPTION PROCESS**	
Fundamentals of adsorption in water treatment - Adsorption mechanisms and factors affecting efficiency - Estimation methods for color removal efficiency - Hands-on experimentation and analysis - Future trends and advancements in adsorption technology.		6
Ex. 10	Estimate the color removal of a given effluent water by adsorption.	
	Total Hours	60

END SEMESTER EXAMINATION – PRACTICAL EXAM.

Note:

- The Practical document prepared by the student should be submitted with a Bonafide Certificate.
- All the exercises have to completed, any one exercise will be given for examination.
- Practical observation note book is sufficient and no need of separate practical record note book. Submission of Practical observation note book to model practical exam and end semester practical exam is mandatory.
- All the exercises should be given in the question paper. The student is allowed to select by lot or question paper issued by the DOTE Exam section shall be used.

1076235523	ENVIRONMENTAL ENGINEERINGB LAB	L	T	P	C
Practical		0	0	4	2

DETAILED ALLOCATION OF MARKS

Part	Description	Marks
A	Aim & Apparatus Required	10
B	Formulas, Explanations, Tabular Column	20
C	Observations & Reading Taken	20
D	Calculations	20
E	Result	20
F	Viva voce	10
TOTAL MARKS		**100**

Equipment / Facilities required to conduct the Practical Portions:

S.No.	Name of the Equipment / Facilities required	Quantity Required
1	Burette 50 mL	10 Nos.
2	Pipette 20 mL	10 Nos.
3	Conical flask 250 mL	10 Nos.
4	Burette Stand with clamp	10 Nos.
5	Round bottom flask	2 Nos.
6	Funnel	5 Nos.
7	Measuring Jar	5 Nos.

1076236111	CHEMICAL ENGINEERING THERMODYNAMICS AND REACTION ENGINEERING	L	T	P	C
Theory		3	0	0	3

Introduction:

This subject equips students with a strong understanding of various thermodynamic systems and the application of the First and Second Laws of Thermodynamics in different processes. In process industries, raw materials undergo processing to produce various products. The components in raw materials combine in definite proportions. Understanding the chemical kinetics of reactions and the working principles of industrial reactors is crucial. Thus, knowledge of reaction engineering and thermodynamics is essential for the success of a chemical engineer.

Course Objective:

- To develop an understanding of thermodynamic systems.
- To enable the students to use thermodynamics concepts in chemical engineering applications.
- To provide an overview of chemical reaction engineering.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Understand thermodynamic terminologies, processes, properties, and the First Law of Thermodynamics to solve simple problems and apply them in chemical engineering contexts.

CO2: Master the concepts of thermodynamic laws, cycles, efficiencies, and properties, crucial for analyzing and solving problems in chemical engineering processes.

CO3: Gain proficiency in chemical reaction fundamentals, including rates, equilibrium, and factors impacting reaction kinetics, essential for chemical engineering practice.

CO4: Understand the significance, classification, and operation of chemical reactors, with a focus on CSTR, PFTR, and fluidized bed reactors, and apply concepts like space time and space velocity for analysis and comparison.

CO5: Grasp the significance of catalysts in chemical reactions, understand their types, characteristics, deactivation mechanisms, and regeneration methods, essential for chemical engineering practice.

Pre-requisites

Knowledge of basic chemistry.

1076236111	CHEMICAL ENGINEERING THERMODYNAMICS AND REACTION ENGINEERING	L	T	P	C
Theory		3	0	0	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	1	2	2
CO2	3	3	2	1	1	1	2
CO3	3	3	2	2	2	1	3
CO4	3	3	2	2	2	2	3
CO5	3	3	2	2	2	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076236111	CHEMICAL ENGINEERING THERMODYNAMICS AND REACTION ENGINEERING	L	T	P	C
Theory		3	0	0	3

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076236111	CHEMICAL ENGINEERING THERMODYNAMICS AND REACTION ENGINEERING	L	T	P	C
Theory		3	0	0	3

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	PROPERTIES OF SYSTEM AND FIRST LAW OF THERMODYNAMICS	
Terminologies in Thermodynamics- System and surroundings- open system, closed system, and isolated system - Thermodynamic process- Isothermal process, Isobaric process, Isochoric process, adiabatic process and cyclic process (definitions only). Properties of a system-Extensive properties and Intensive properties with examples-state function and path function-comparison between reversible process and irreversible process-Internal energy and Enthalpy - First law of Thermodynamics – Simple problems in First law of Thermodynamics.		9
Unit II	**SECOND LAW OF THERMODYNAMICS &THERMODYNAMIC PROPETIES**	
Limitations of First law of Thermodynamics-Heat engine & Thermal efficiency- Heat pump & Thermal efficiency- Statement of Second Law of Thermodynamics- Carnot cycle and steps involved in Carnot cycle- Efficiency of Carnot cycle- simple problems on Carnot cycle efficiency -concept of Entropy. Third law of Thermodynamics - Helmotz Free energy (A), Gibb's Free energy and its significance. Joule- Thomson effect and significance of Joule- Thomson co-efficient. Fugacity & Fugacity co-efficient- Activity and Activity co-efficient- Chemical potential and its significance.		9

1076236111	CHEMICAL ENGINEERING THERMODYNAMICS AND REACTION ENGINEERING	L	T	P	C
Theory		3	0	0	3

Unit III	CHEMICAL KINETICS	
Chemical reaction- classification of chemical reactions- Definitions of reaction rate- elementary and non-elementary reactions- Molecularity and order of a reaction - Rate law, rate constant and units of rate constant – Fractional conversion. Effect of temperature on reaction rate- Activation energy- Arrhenius equation- simple problem in Arrhenius equation –Determination of the rate Chemical equilibrium and equilibrium constant- importance of thermodynamics in chemical reactions- Feasibility of a chemical reaction– Factors influencing the rate of reactions- ratio of reactants, presence of inert gas, pressure and temperature.		9
Unit IV	**CHEMICAL REACTORS**	
Importance of chemical reactors in chemical industry- classification of chemical reactors- construction, operation and application of Continuous Stirred Tank Reactor (CSTR) and Plug Flow Tubular Reactor (PFTR) and Fluidized bed reactors. Concept of Space time and space velocity- simple problems- comparison of reactors		9
Unit V	**SOLID CATALYST**	
Catalyst- Homogenous and heterogeneous catalyst – Role of catalyst in chemical reactions- List the important catalysts used in various industrial process. Brief description about inhibitors, poisons and promoters. Specific characteristics of solid catalysts- Activity, Kindling point, Solid density, specificity, Surface area and Porosity. Catalyst deactivation- Deactivation by thermal degradation and sintering-Deactivation by poisoning- methods of catalyst regeneration.		9
TOTAL HOURS		**45**

1076236111	CHEMICAL ENGINEERING THERMODYNAMICS AND REACTION ENGINEERING	L	T	P	C
Theory		3	0	0	3

Text and Reference Books:

1. Unit Operations of Chemical Engineering - W.L. McCabe and J.C. Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L. Badger and J.T. Banchero - Tata McGraw Hill Publishing Co. Ltd. New Delhi - 1997.
3. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.
4. Ghoshal, Sanyal and Dutta - Introduction to chemical Engineering - 1st Edition - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.

Web-based/Online Resources

- https://www.essentialchemicalindustry.org
- https://learncheme.com/
- https://learncheme.com/screencasts/thermodynamics/
- https://onlinecourses.nptel.ac.in/noc22_ch22/
- https://www.classcentral.com/course/swayam-chemical-engineering-thermodynamics-12898

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076236112	FERTILIZER TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Introduction:

The agriculture sector plays a crucial role in the Indian economy, and chemical fertilizers are indispensable for ensuring good crop yields. Understanding the intricate link between chemistry and the chemical fertilizer industry is vital for chemical engineers. Therefore, it is essential to provide students with a comprehensive and balanced understanding of this relationship.

Course Objective:

- Introduction to chemical fertilizers, including classification and applications.
- Production methods and characteristics of nitrogen-based fertilizers.
- Manufacturing processes and types of complex fertilizers, including NPK blends and biofertilizers.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: A comprehensive overview of the knowledge and skills that students will gain from studying fertilizers and their production, with a focus on both theoretical understanding and practical application in agricultural contexts.

CO2: To overview of the knowledge and skills that students will gain from studying fertilizers and their production, with a focus on both theoretical understanding and practical application in agricultural contexts.

CO3: Understanding phosphatic fertilizers, their production methods, characteristics, and application in agricultural practices, emphasizing both theoretical knowledge and practical skills essential for sustainable agriculture.

CO4: A comprehensive understanding of potash fertilizers, their production methods, characteristics, and application in agricultural practices, focusing on theoretical knowledge and practical skills essential for sustainable agriculture.

CO5: Provide a comprehensive understanding of advanced fertilizers, including complex fertilizers and biofertilizers, focusing on theoretical knowledge and practical skills essential for sustainable agricultural practices.

Pre-requisites:

Knowledge of basic Chemistry.

1076236112	FERTILIZER TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076236112	FERTILIZER TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Assessment Methodology:

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076236112	FERTILIZER TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	OVERVIEW OF FERTILIZERS	
Chemical Fertilizers, Classification of Fertilizers, Role of essential elements in plant growth, Macro nutrients elements and Micro nutrients elements, Applications of fertilizers considering nutrients. Feed stock and raw materials for Nitrogenous, Phosphatic and Potassic fertilizers, Acid used for production of Fertilizer – Manufacture methods – Product characteristics and application of Nitric acid, Sulphuric acid and Phosphoric acid.		9
Unit II	**NITROGENOUS FERTILIZERS**	
Nitrogen sources - Manufacture, Characteristics and Application of Ammonia, Methods of Production, Characteristics and storage and handling specifications of various Nitrogen fertilizer such as Urea, Ammonium Sulphate, Ammonium Nitrate, Ammonium Chloride.		9
Unit III	**PHOSPHATIC FERTILIZERS**	
Phosphatic fertilizers, Raw materials, Classification of Phosphatic Fertilizer, Methods of Production, Characteristics and storage and handling specifications of Various Phosphatic fertilizer - Single super Phosphate, Triple super Phosphate, Mano Ammonium Phosphate, Diammonium Phosphate, Ammounium Poly Phosphate.		9
Unit IV	**POTASH FERTILIZERS**	
Introduction of Potash fertilizers, Raw material for Potash fertilizer, Muriate of Potash – raw materials – Various methods of production and product characteristics of Muriate Potash, Potassium sulphate – Raw materials – Various methods of production and Product characteristics, Potassium Nitrate – Raw materials - Methods of Production, Specification, Characteristics.		9

1076236112	FERTILIZER TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Unit V	COMPLEX, MIXED AND BIO FERTILIZERS
Introduction of Complex Fertilizers – Raw materials – Various types of Complex fertilizers – Ammonium Phosphate Sulphate – Raw materials – Methods of production – Product characteristics – Urea Ammonium Phosphate – Raw materials – Manufacture method – Specification – NPK – Raw materials – Methods of production. Introduction of Mixed Fertilizers - Manufacture methods. Biofertilizers, Types of Biofertilizers, Nitrogen fixing, Biofertilizers Phosphate solubilizing Biofertilizers, Preparation of a Biofertilizers.	9
TOTAL HOURS	**45**

Text and Reference Books:

1. Hand book of Fertilizer Association of India, New Delhi - 1998.
2. Hand book of Fertilizer Technology - Fertilizer Association of India, New Delhi - 1977.
3. Chemistry and Technology of Fertilizers - Slack A.V - Interscience, New York - 1967.
4. Dryden's Outliness of Chemical Technology - M. Gopala Rao Marshall Sittig - 3rd Edition - Edited and Reprinted by East-West Press - 2016.
5. Shreve's Chemical Process Industries - Austin, G.T - 5th Edition - Tata Mc Graw Hill - 2017.
6. Chemical Technology, Volume I & II - Pandey & Shukla - 2nd Edition - Vanis Books Company - 2018.
7. Bio fertilizers in Agriculture - Subba Rai N.S - Oxford & IBH Publishing Company - 1982.
8. Commercial Fertilizers - Collings G H - 5th Edition - McGraw Hill, New York - 1955.
9. Chemistry and Technology of Fertilizers - Slacks A V - Interscience, New York - 1966.
10. Fertilizer Technology and Management - Brahma Mishra - IK International Publishing House Private Limited, New Delhi, India.

1076236112	FERTILIZER TECHNOLOGY	L	T	P	C
Theory		3	0	0	3

Web-based/Online Resources

- https://www.essentialchemicalindustry.org
- https://onlinecourses.nptel.ac.in/noc22_ag14/preview
- https://www.itecgoi.in/uploadfolder/1510883541753_Annexure_C_Certificate_Course_in_Fertilizer_Technology.pdf
- https://fertiliser-society.org/training-and-other-resources/
- https://www.fertilizer.org/
- https://archive.nptel.ac.in/courses/103/107/103107086/
- http://acl.digimat.in/nptel/courses/video/126104006/L42.html

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076236113	PETROLOEUM AND ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Introduction:

Every Petrochemical engineering technologist gets acquainted with knowledge of petrochemical technology to operate a plant efficiency, safety and economically. Proper selection of equipment and process improves efficiency of the plant. By learning this subject they can measure performance of various refinery products and select relevant process with safe handling of equipment to obtain desired petrochemicals such as C1 to C4 and also aromatics Compounds. The various chapters of Petrochemical technology likes C1, C2, C3, C4fractions, aromatics and plastic derivatives etc., provide the complete sketch about the processes in all petrochemical complexes also provides the processing of raw materials for various commercial products based on crude petroleum.

Course Objective:

On completion of the units of the syllabus the students must be able:

- To enable the students gain knowledge about various petrochemicals and their manufacturing methods and the importance of conservation of energy in chemical process industries.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: The manufacturing process, Physical properties and uses from C1 compounds like Methanol, Chloromethane.

CO2: The manufacturing process, Physical properties and uses from C2 compounds like Ethylene, Acetylene.

CO3: The manufacturing process, Physical properties and uses from C3 compounds like Isopropanol, acetone. C4Compounds - Butadiene manufacturing from various chemicals and its physical properties.

CO4: The manufacturing process, Physical properties and uses of Aromatic Compounds.

CO5: Properties, Classification, manufacturing and industrial applications of Plastics.

Pre-requisites:

Knowledge of Petroleum Engineering.

1076236113	PETROLOEUM AND ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	3
CO2	3	3	2	2	3	2	3
CO3	3	3	3	2	3	2	3
CO4	3	3	2	3	3	2	3
CO5	3	3	2	3	3	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (maybe followed by a real environment as far as possible).

1076236113	PETROLOEUM AND ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076236113	PETROLOEUM AND ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	CRUDE PETROLEUM AND LUBE OIL	
Petroleum- origin of petroleum- classification of crude petroleum- composition of petroleum- Different oil refineries of India and their capacities –Fractional distillation of crude oil – petroleum products from crude oil refining and their boiling ranges. Different tests of crude oil and its significance- Reid vapour pressure, Octane number, Cetane number, Calorific value, and Viscosity Index.		9
Unit II	**CRACKING AND CHEMICAL TREATMENT OF PETROLEUM**	
Manufacturing process of Lube oil- treatment of lube oil- various additives added to lube oil- Manufacturing process of wax- Grades of wax – uses of wax. Cracking- types of cracking- thermal cracking and catalytic cracking- Fluidised catalytic cracking and their products- sweetening of petroleum-chemical treatment for upgrading liquid fuel- Hydrocracking, Reforming, Alkylation, Visbreaking and isomerisation.		9
Unit III	**MANUFACTURE OF PETROCHEMICALS-I**	
Process description, flow diagram, reactions involved and uses of for the following process - Ethylene oxide by direct oxidation of ethylene- Butanol production by Oxo process – Nitrobenzene from benzene. Process description, flow diagram, reactions involved and uses for the following process- Phenol and acetone by isopropyl benzene oxidation- Dehydrogenation of ethyl benzene to styrene- production of synthesis gas from Naphtha. .		9

1076236113	PETROLOEUM AND ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

Unit IV	MANUFATURE OF PETROCHEMICALS- II	
Process description, flow diagram and uses for the following process- Butadiene from dehydrogenation of Butane- cyclohexane from Benzene- Pthalic anhydride from O-Xylene- Maleic anhydride from Benzene. Process description, flow diagram and uses for the following process-Propylene oxide- Formaldehyde from methanol- Manufacture of LAB.		9
Unit V	**ENERGY ENGINEERING**	
Needs of energy Conservation in process Industry – Energy conservation methods- Estimation of energy consumption - Specific Energy consumption (SEC) - simple problem in SEC- Energy optimization- Energy Audit in existing plant- Forecasting energy requirement. Waste heat recovery from stack gas and Boilers - Use of Refractory and insulating materials for energy savings - Energy efficient Motors and pumps-Energy efficiency in thermal utilities - cooling tower, Heat exchangers, Distillation column.		9
TOTAL HOURS		**45**

Text and Reference Books:

1. Dryden's Outliness of Chemical Technology - M. Gopala Rao Marshall Sittig - 3rd Edition - Edited and Reprinted by East-West Press - 2016.
2. A Text on Petro Chemicals - Dr. B.K. Bhaskara Rao - 5th Edition - Khanna Publishers - 2004.
3. Shreve's Chemical Process Industries - Austin, G.T - 5th Edition - Tata Mc Graw Hill - 2017.
4. Encyclopedia of Chemical Technology - Kirk Othmer - 4th Edition - Wiley – Inter Science Publication - John Wiley & Sons - 1993.
5. Introduction to Petrochemicals - Sukumar M - Oxford and IBH publishing Co., - 1992.
6. Petrochemical Process - Chauvels A. and Lefebvre G - Vol. 4., - 2001.

Web-based/Online Resources

- http://www.sciencedirect.ru
- https://archive.nptel.ac.in/content/syllabus_pdf/103102022.pdf

1076236113	PETROLOEUM AND ENERGY ENGINEERING	L	T	P	C
Theory		3	0	0	3

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076236211	MASS TRANSFER -II	L	T	P	C
Theory		3	1	0	4

Introduction:

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipment's like crystallizers and driers which are used in industries for purification of products

This course explains the fundamentals of mass transfer and techniques involved in mass transfer operations of extraction, drying and adsorption.

This subject intends to equip the students with the concept and principles of mass transfer operation, which are of prime importance in any chemical industry. Mass transfer equipment's are an integral part of any chemical plant. This subject will help the students to operate and design various mass transfer equipment.

Course Objective:

On completion of the units of the syllabus the students must be able to:.

- To enable the students to apply the principles of drying, crystallization and extraction in process plant operations.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1:	Understands the different types of dryers used in industries
CO2:	Understands the various type of crystallizers used in industries.
CO3:	Understands the various types of extraction equipment.
CO4:	Understand the operation of various leaching equipment
CO5:	Understand the various adsorption equipment used in industries.

Pre-requisites:

Knowledge of Chemical Processes.

1076236211	MASS TRANSFER -II	L	T	P	C
Theory		3	1	0	4

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	1	1	-	1
CO2	3	1	3	1	1	-	1
CO3	3	1	2	1	1	1	1
CO4	2	2	3	2	1	1	1
CO5	3	2	3	2	1	1	1

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076236211	MASS TRANSFER -II	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076236211	MASS TRANSFER -II	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	DRYING	
Principles of Drying - moisture content on dry basis and wet basis - terminology used in drying operation such as equilibrium moisture , free moisture, bound & unbound moisture , constant rate drying period , falling rate drying period and critical moisture content (Definitions only). Concept and application of Tray drier and Rotary drier. Description and operation of Rotary drier, Spray drier, Fluidized bed drier and Agitated thin film dryer.		12
Unit II	**CRYSTALLIZATION**	
Crystallization- differentiate between evaporation and crystallization- origin of crystals in crystallizer- yield and purity of crystals- super saturation- unit of super saturation - methods of creating super saturation- Nucleation- primary and secondary nucleation - crystal growth- Ostwald ripening- caking and effect of humidity on storage. Crystallization equipment- Forced circulation evaporator crystallizer- Oslo evaporative crystallizer- Draft tube baffle crystallizer - Description and operation of the above equipment.		12
Unit III	**LIQUID - LIQUID EXTRACTION**	
Liquid-liquid extraction – importance of extraction – raffinate and extract- triangular chart and its use (brief description only) – Distribution coefficient and selectivity – choice of solvent for extraction - applications of extraction. Extraction equipment - Mixer settler - Sieve plate columns – Rotating disk contactors (RDC) - Description and operation of the above equipment.		12

1076236211	MASS TRANSFER -II	L	T	P	C
Theory		3	1	0	4

Unit IV	LEACHING	
Principles of Leaching – difference between leaching and extraction–industrial applications of leaching- Factors affecting the rate of leaching- particle size, temperature, solvent and agitation. Equipment for Leaching: Bollmann Extractor - Rotocel extractor - Bonotto extractor – Description and operation of the above equipment.		12
Unit V	**ADSORPTION**	
Adsorption- comparison of physical and chemical adsorption- industrial applications of adsorption- Industrial adsorbents and their uses- Activated carbon, Silica Gel, Activated Alumina, Zeolites and Fuller's Earth. Adsorption equipment- Agitated vessel, Fixed bed adsorber and moving bed adsorber- Description and operation of the above equipment.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 1997.
3. Mass Transfer Operation - R.E. Treybal - 3rd Edition - Tata McGraw Hill - 2017.
4. Perry's Chemical Engineers Hand book - Robert H. Perry and D.W. Green - 7th Edition - Tata McGraw Hill - 1997.
5. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.
6. Ghoshal, Sanyal and Dutta - Introduction to chemical Engineering - 1st Edition - Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.

1076236211	MASS TRANSFER -II	L	T	P	C
Theory		3	1	0	4

Web-based/Online Resources

- https://www.essentialchemicalindustry.org
- https://nptel.ac.in/courses/103/106/103106108/
- https://nptel.ac.in/courses/103/107/103107082/
- https://learncheme.com/
- https://link.springer.com/10.1007%2F0-387-23816-6_27
- https://onlinecourses.nptel.ac.in/noc21_ch49/preview
- https://archive.nptel.ac.in/courses/103/106/105106205/

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076236212	NATURAL GAS ENGINEERING	L	T	P	C
Theory		3	1	0	4

Introduction:

Natural gas engineering, a subset of chemical and petrochemical engineering, involves exploring, extracting, processing, and using natural gas resources efficiently. It combines principles from chemical, petroleum, and mechanical engineering to optimize production and distribution. Students learn drilling, completion, and stimulation techniques, along with gas treatment methods for removing impurities and extracting valuable components. Environmental sustainability is emphasized for responsible resource management.

Course Objective:

On completion of the units of the syllabus the students must be able to:

- Attain proficiency in natural gas exploration, extraction, processing, transportation, storage, and utilization.
- Develop skills in various aspects of natural gas engineering to contribute effectively to the gas industry.
- Gain comprehensive knowledge of natural gas engineering principles and practices.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Upon course completion, students will grasp the origin, composition, sources, classification, impurities, processing, combustion characteristics, heating value, Wobbe number, and properties, as well as applications of natural gas.

CO2: Understanding various equipment types (vertical, horizontal, spherical separators, gravity separators) and gas cleaning methods (impingement, filters, scrubbers, electric precipitators) along with their advantages and disadvantages.

CO3: Mastering acid gas treating methods and sulphur recovery processes, with detailed descriptions and flow diagrams for metal oxide, slurry, amine, carbonate washing, methanol-based, and other processes.

1076236212	NATURAL GAS ENGINEERING	L	T	P	C
Theory		3	1	0	4

CO4: Understanding natural gas dehydration methods, including glycol, solid desiccant, acid gas dehydration, adsorption, and membrane processes, along with water content determination and factors affecting dehydrator performance.

CO5: Mastering NGL recovery and fractionation processes, including mechanical refrigeration, cryogenic refrigeration, lean oil absorption, solid bed adsorption, membrane separation, and NGL fractionation techniques.

Pre-requisites:

Knowledge of Petroleum Refining.

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	3	2	3
CO2	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076236212	NATURAL GAS ENGINEERING	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076236212	NATURAL GAS ENGINEERING	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	PROPERTIES AND COMPOSITION OF NATURAL GAS	
Natural gas origin - Composition of natural gas - Sources of Natural gas –Classification of natural gas – Impurities in Natural gas – Natural gas processing and products – Combustion charactertics of Natural gas – Heating value – Wobbe Number - Properties of natural gas, Specific gravity, Pseudo critical Properties, viscosity - Compressibility factor and chart for natural gas - Application of Natural gas.		12
Unit II	**GAS LIQUID SEPARATION**	
Gas – Liquid Separation – Introduction – Separation equipment – types of separators – Description of vertical separator , Advantages and Disadvantages – Description of Horizontal separator, Advantages and Disadvantages – Description of spherical separator – Advantages and Disadvantages – Description of gravity separators- – Factors affecting the separation – Gas cleaning methods – Impingement – Filters - Scrubbers – Electric Precipitators.		12
Unit III	**ACID GAS TREATING OF NATURAL GAS**	
Acid gas removal process description with neat flow diagram: Metal oxide process- Iron oxide proces , Zinc oxide process - Slurry process - Chem Sweet process, sulfa check process - Amine process, Carbonate Washing and Water Washing -Methanol based process - Other process – potassium phosphate process, alkazid process, hot potassium carbonate process - Sulphur recovery process - Claus process - sulphur production by redox process.		12
Unit IV	**NATURAL GAS DEHYDRATION**	
Natural Gas Dehydration: Introduction - Water Content Determination - Process Description of Glycol dehydration - Solid desiccant dehydration - Process Description – Acid Gas Dehydration - Other Factors that Affect Glycol Dehydrator Performance - Adsorption process - Properties of Industrial Adsorbents for Dehydration – Process description of Two bed adsorption Dehydration - Nonregenerable Desiccant Processes - membrane process.		12

1076236212	NATURAL GAS ENGINEERING	L	T	P	C
Theory		3	1	0	4

Unit V	NGL RECOVERY AND FRACTIONATION	
NGL Recovery: Introduction - NGL Recovery Processes - mechanical refrigeration process - Choice of Refrigerant - self-refrigeration system - Cryogenic Refrigeration process - Ortloff gas subcooled process - Lean Oil Absorption process - solid bed adsorption process - Membrane Separation Process - NGL fractionation.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Hand Book of Natural Gas Engineering - Katz and Lee - Tata McGraw Hill - 1990.
2. Standard Handbook of Petroleum and Natural Gas Engineering Vol. 2 - Lyons, W.C - Gulf Professional Publishing, Elsevier Inc - 2004.
3. Natural Gas Industry-A Review of World Resources and Industrial Applications - Katz D.L. and Lee, R.L - Butterworth.
4. The Natural Gas Industry-A Review of World Resources and Industrial Applications - During, M.M - Butterworth.
5. Hand book of Natural Gas Transmission and Processing - Saied Mokhatab, William A. Poe, and James G.Speight - 2nd Edition - Gulf Professional Publishing, Elsevier Inc - 2012.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://petrowiki.spe.org
- https://www.youtube.com/user/DrStanko/videos
- https://onlinecourses.nptel.ac.in/noc22_ch57/preview
- https://onlinecourses.nptel.ac.in/noc19_ch24/preview

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

1076236213	ELECTROCHEMICAL ENGINEERING	L	T	P	C
Theory		3	1	0	4

Introduction:

Electrochemical engineering integrates electrochemistry with engineering principles, focusing on electron transfer reactions, cells, and systems for energy and chemical processing. It encompasses design, optimization, and operation of electrochemical technologies in diverse fields like energy storage, corrosion prevention, and water treatment. This multidisciplinary subject is pivotal for sustainable energy solutions and technological advancements across industries.

Course Objective:

On completion of the units of the syllabus the students must be able to:

- Provide a comprehensive understanding of electrochemical principles and processes.
- Explore various applications of electrochemical engineering in different industrial sectors.
- Emphasize the importance of safety and environmental considerations in electrochemical engineering practices.

Course Outcomes:

After successful completion of this course, the students should be able to:

CO1: Acquire comprehension of drying polarization and overpotential phenomena in electrochemical processes for various applications.

CO2: Develop understanding of colloidal electrochemistry, including electrochemical properties of colloids, coagulation phenomena, electrokinetic processes, and applications in various fields.

CO3: Attain proficiency in electroactive layers and modified electrodes, encompassing various types of modifications, characterization techniques, and understanding of electrochemical behavior at modified interfaces.

CO4: Acquire expertise in chemically modifying electrodes and understanding their properties, facilitating advanced electrochemical applications.

CO5: Develop comprehensive understanding of electrolytic production of inorganic chemicals, including principles, reaction mechanisms, and industrial cell design for various compounds.

Pre-requisites:

Knowledge of basic chemistry and Physics.

1076236213	ELECTROCHEMICAL ENGINEERING	L	T	P	C
Theory		3	1	0	4

CO/PO Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	2	2	3
CO2	3	3	3	3	3	2	3
CO3	3	3	3	3	2	2	3
CO4	3	3	3	3	2	2	3
CO5	3	3	3	3	3	2	3

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Instructional Strategy:

- It is advised that teachers take steps to pique pupils' attention and boost their learning confidence.
- To help students learn and appreciate numerous concepts and principles in each area, teachers should provide examples from daily life, realistic situations and real- world engineering and technological applications.
- The demonstration can make the subject exciting and foster in the students a scientific mindset. Student activities should be planned on all the topics.
- Throughout the course, a theory-demonstrate-practice-activity strategy may be used to ensure that learning is outcome-based and employability-based.
- All demonstrations/Hand-on practices are under a simulated environment (may be followed by a real environment as far as possible).

1076236213	ELECTROCHEMICAL ENGINEERING	L	T	P	C
Theory		3	1	0	4

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Written Test (Unit I & II)	Written Test (Unit III & IV)	Quiz MCQ (Online / Offline)	Model Examination	Written Examination
Duration	2 Periods	2 Periods	1 Hour	3 Hours	3 Hours
Exam Marks	50	50	60	100	100
Convertedto	15	15	5	20	60
Marks	15		5	20	60
Tentative Schedule	6th Week	12th Week	13-14th Week	16th Week	

Note:

CA1 and CA2: Assessment written test should be conducted for 50 Marks for two units. The marks scored will be converted to 15 Marks. Best of one will be considered for the internal assessment of 15 Marks.

CA1and CA2, Assessment test should be conducted for two units as below.

Answer five questions (5 X 10 Marks = 50 Marks).

Eight questions will be asked; students should write five questions. Each unit four questions can be asked. Each question may have subdivisions. Maximum two subdivisions shall be permitted.

CA3: 60 MCQ can be asked by covering the entire portion. It may be conducted by Online / Offline. The answer scripts of every students (Online/Offline) for this assessment should be kept for records and future verification. The marks scored should be converted to 5 marks for the internal assessment.

CA4: Model examination should be conducted as per the end semester question pattern. The marks should be converted to 20 marks for the internal assessment.

1076236213	ELECTROCHEMICAL ENGINEERING	L	T	P	C
Theory		3	1	0	4

Question Pattern:

Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.

Syllabus contents

Unit I	DRYING POLARISATION AND OVER POTENTIAL	
Electrolytic polarization, Dissolution and Decomposition potential, Overvoltage – hydrogenand oxygen overvoltage, applications, Polarography – principles, diffusion layer, limiting current density, polarographic circuit, dropping mercury electrode, merits & demerits, supporting electrolyte, current maxima, polarograms, half wave potential, diffusion current, applications.		12
Unit II	**COLLOIDAL ELECTROCHEMISTRTY**	
Electrochemical properties of colloids – Charge on colloidal particles, Electrical Double Layer, Coagulation of colloidal sols, Electro kinetic phenomena - Electro-Osmosis – Determination of zeta potential, Electrophoresis – sedimentation potential (Dorn effect), Determination of colloidal particle size, Surfactant, Emulsion, Emulsifiers, gels - Applications		12
Unit III	**ELECTROACTIVE LAYERS AND MODIFIED ELECTRODES**	
Chemically modified electrodes, Types and methods of modification – chemisorption, covalent bond formation, polymer film coatings, inorganic materials, Langmuir-Blodgett (LB) methods, properties of the modified electrodes, electrochemistry at monolayer and multilayer modified electrodes, characterization of modified electrodes.		12

1076236213	ELECTROCHEMICAL ENGINEERING	L	T	P	C
Theory		3	1	0	4

Unit IV	ELECTROCHEMICAL TECHNIQUES	
Ion selective electrodes – Principles of potentiometry and amperometry- determination of dissolved oxygen - effect of sweep rate-analysis of cyclic voltammograms. Potential step method (chronoamperometry) under diffusion control derivation of Cottrell equation for a planar and spherical electrode- significance of spherical diffusion- principles of scanning probe techniques-STM-AFM and SECM – working principles of electrochemistry		12
Unit V	**ELECTROLYTIC PRODUCTION OF IN-ORGANIC CHEMICALS**	
Electrolytic production of sodium hypochlorite, sodium and potassium chlorates, bromates and iodates. Sodium, Potassium, and ammonium persulphates, hydrogen peroxide, potassium permanganate, cuprous oxide and manganese dioxide – Basic principles, reaction mechanisms, effect of operating variables, cell design and operating characteristics of industrial cells.		12
TOTAL HOURS		**60**

Text and Reference Books:

1. Electrochemical methods - Fundamentals and applications - Bard and Faulkner - 2nd Edition - John Wiley & Sons publications - 2000.
2. Electrochemical reaction engineering - Scott - Academic Press Inc - 2006.

Web-based/Online Resources:

- https://www.essentialchemicalindustry.org
- https://www.cecri.res.in/
- https://chemistry-europe.onlinelibrary.wiley.com/journal/2196040X
- https://www.electrochem.org/

1076236213	ELECTROCHEMICAL ENGINEERING	L	T	P	C
Theory		3	1	0	4

END SEMESTER QUESTION PATTERN - THEORY EXAM

Duration : 3 Hrs . Max. Marks : 100

Note: Answer ten questions by selecting two questions from each unit. Each question carries 10 marks each.

Instruction to the Question Setters:

Four questions will be asked from every unit, students should write any two questions. The question may have two subdivisions only.