NEP-2020 Aligned Curriculum for

Three Year (Six Semesters) Diploma Programme in

CHEMICAL ENGINEERING (PETRO CHEMICAL)

(3rd to 4th Semester)

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Semester System

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(Effective From Session 2025 - 26)

Prepared By:
Institute Of Research, Development & Training, U.P., Kanpur

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

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PREFACE

An important issue generally debated amongst the planners and educators world over is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization has created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and opens economy in the last few decades. In order to cope with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources, in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by the State Board of Technical Education, UP to revise the existing curricula of 42 diploma programmes as per the needs of the industry and making them NEP-2020/AICTE compliant, are laudable.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programmes. The curricula for diploma programmes have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma programme.

The real success of the diploma programme depends upon its effective implementation. However best the curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected of the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much needed dynamism in the system.

Director
Institute of Research Development & Training

ACKNOWLEDGEMENTS

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1. Sh. Narendra Bhooshan, IAS, Additional Chief Secretary, Department of Technical Education, Govt. of UP, for his exemplary vision & approach.

2. Sh. Avinash Krishna Singh, IAS, Secretary, Directorate General, Department of Technical Education, Govt. of U.P.

3. Sh. F.R. Khan, Director, I.R.D.T. Kanpur for continually motivating, guiding and taking keen interest in the review of curriculum..

4. All the participants from industries, Polytechnics and other technical institutions for their professional inputs during curriculum workshops.

5. CDC Officer and other concerning staff of IRDT for their support and assistance in conducting curriculum workshops.

6. In the last but not least would like to thanks management of the industries who spare not only their precious time but also allowed the visit of their industries to the team making the curriculum

(Monit Kumar)
Research Assistant
Curriculum In-charge
I.R.D.T. Kanpur

(Shyam Lal)
CDC Officer/Course Co-ordinator
IRDT Kanpur

1. SALIENT FEATURES

1)	Name of the Programme	:	Diploma in Chemical Engineering (Petro-chemical)
2)	Duration of the Programme	:	Three years (Six Semesters)
3)	Entry Qualification	:	Matriculation or equivalent NEP2020/NSQF Level as Prescribed by State Board of Technical Education, U.P.
4)	Pattern of the Programme	:	Semester Pattern
5)	NSQF Level	:	Level - 5
6)	Ratio between theory and Practical	:	40: 60 (Approx.)

7) **Industrial Training**

Four and six weeks of industrial training is made mandatory after the II and IV semesters during summer vacation.Total marks allotted to industrial training will be respectively 50 & 100.

In the last (6^{th} Semester) we have made the one semester Industrial training/Internship as optional along with usual classroom training.

8) **Ecology and Environment**

As per Govt. of India directives a subject on Environmental Science has been incorporated in the curriculum.

9) **Entrepreneurship and Start-ups**

A full subject Entrepreneurship & Start-ups has been incorporated in the curriculum.

10) **Student Centered Activities**

A provision of 4-8 hrs per week has been made for organizing Student Centered Activities for overall personality development of students. Such activities will comprise of co–curricular activities such as expert lectures, self-study, games, hobby classes like photography, painting, singing etc. seminars, declamation contests, educational field visits, NCC, NSS, library and other cultural activities.

11) **Project work**

A project work has been included in the curriculum to enable the student get familiarize with the practices and procedures being followed in the industries and provide an opportunity to work on some live projects in the industry.

2- PROGRAM OUTCOMES (POs)

PO1: Basics and Discipline specific Knowledge
Assimilate knowledge of basic mathematics, science, engineering fundamentals.

PO2: Problem's Analysis and solution
Identify, analyse and solve problems using standard methods and established techniques.

PO3: Design and Development
Design solutions for technical problems.
Assist in designing components, systems, or processes to meet specific requirements.

PO4: Engineering Tools, Experimentation, and Testing
Use modern engineering tools and appropriate techniques to conduct experiments as per BIS standard.

PO5: Socio/ Economic /Environmental impact assessment/remedy.

Apply relevant technologies while considering societal needs, environmental impact keeping in view sustainable and ethical responsibilities.

PO6: Project Management and Communication
Apply engineering management principles, work effectively as an individual or in a team, and communicate clearly on activities.

PO7: Lifelong Learning
Recognize the importance of continuous learning and actively pursue self-improvement to keep pace with technological developments

3- **Employment Opportunities -**

i) Chemical and Allied Industries like

- Fertilizer industry
- Petroleum refinery and petrochemical industry
- Oil and natural gas corporation
- Cement plant
- Cosmetic industry
- Sugar industry
- Mineral industry
- Pulp and Paper industry
- Polymer industry
- Food industry
- Agro industry
- Pharmaceutical industry
- Distilleries
- Paint and dye industry
- Rubber industry
- Soap & detergent industry
- Textile industry etc.
- Pesticide industry
- General processing industries
- Glass industry
- Ceramics industry
- Automobile industry (paint shop and electroplating shop)
- Test Equipment: Manufacturing and repairing

In various functional areas like erection and commissioning of plant, plant operation, energy conservation, plant utilities, production, water treatment, maintenance and safety, quality control, inspection and testing, marketing and sales, consultancy services and areas concerning environmental protection.

(ii) Research Organizations like CSIR laboratories, Defence laboratories, Atomic energy establishments etc.

(iii) Boards and Corporations.

(iv) Entrepreneurs to small/tiny units especially food, agro and chemical industries such as paints, soap, detergents, equipment repairing etc.

v) Academic Institutions (as technicians/instructors at all levels)

4. LEARNING OUTCOMES

Sr.	Learning Outcomes
After undergoing this programme, students will be able to:	
1	Prepare and interpret drawings of engineering components and plants
2	Read and interpret drawings related to plant layout, process equipment and components, process flow sheets and product manufacturing.
3	Apply concepts of mechanics to solve chemical engineering problems
4	Apply basic principles of mathematics, science and engineering to solve chemical engineering problems
5	Select various materials used in chemical processes, their properties and specifications
6	Understand various unit operations, unit processes and process instrumentation in process industry
7	Calculate the quantity of raw materials, energy inputs, manpower requirement and output from the process
8	Control the process and quality of the products commensurating with laid specifications
9	Recognise the need for and have the ability to engage in life long learning
10	Conduct experiments, analyse, interpret data and synthesise valid conclusions
11	Operate conventional machine for machining of components as per specifications as an aid to function effectively in the process industry.
12	Use electrical and electronic instruments to measure various engineering parameters
13	Use various measuring and gauging instruments
14	Select material as per desired application
15	Understand the general design of process equipments and testing
16	Operate different utility plants
17	Understand different renewable sources of energy and their applications.
18	Understand different plants utilities and their generation and maintenance
19	Use various software tools for automation and process development.
20	Interpret factory acts, laws and taxes
21	Develop communication and interpersonal skills for effective functioning in the world of work.
22	Communicate effectively in English and local language in oral and written form with others
23	Manage resources effectively at work place
24	Plan and execute given task/project as a team member or leader
25	Prepare detailed project proposal and report.

26	Use computer and IT tools for creating documents, making spread sheet and making presentation
27	Solve real life problems by application of acquired knowledge and skills
28	Use energy conservation methods to manage energy efficiency
29	Use appropriate practices for conservation and prevention of environment pollution and safety in process industries.

5- ABSTRACT OF CURRICULUM AREAS

HUMANITIES & SOCIAL SCIENCES COURSES [HS]	
	• Communication Skills in English
	• Sports and Yoga
	• Entrepreneurship and Start-ups
BASIC SCIENCES COURSE [BS]	
	• Mathematics
	• Applied Physics
	• Applied Chemistry
ENGINEERING SCIENCE COURSES [ES]	
	• Engineering Graphics
	• Engineering Workshop Practice
	• Introduction to IT Systems
	• Fundamentals of Electrical & Electronics Engineering
	• Engineering Mechanics
PROGRAM CORE COURSES [PC]	
	• Fluid Flow Operations
	• Fluid Flow Operations (Lab)
	• Chemical Process Calculations
	• Chemical Engineering Thermodynamics
	• Chemical Technology
	• Mechanical Operations & Solid Handling
	• Mechanical Operations & Solid Handling (Lab)
	• Process Heat Transfer
	• Process Heat Transfer (Lab)
	• Chemical Reaction • Engineering
	• Natural and Bio Gas Engineering
	• Mass Transfer Operations-I

PROGRAM ELECTIVE COURSES [PE]	
	Program Elective -1 • Petroleum Engineering • Energy Engineering **Program Elective-2** • Plant Utilities • Waste Management
OPEN ELECTIVE COURSES [OE]	
	Open Elective -1 ● Renewable Energy Technologies ● Internet Of Things ● Disaster Management

PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY OR ELSEWHERE

- Summer Internship – I (3-4 weeks) after IInd Sem
- Summer Internship – II (4-6 weeks) after IVth Sem
- Major Project(In-House) / Internship / Industrial Training

AUDIT COURSES [AU]

- Environmental Science
- Essence of Indian Knowledge and Tradition
- Indian Constitution

6-STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING (PETRO CHEMICAL)

NOTE: I & II Sem. is common to all Engineering & Technology branches and implemented from the session 2024-2025

THIRD SEMESTER

SR. NO.	SUBJECTS	COURSE TYPE AND CATEGORY	STUDY SCHEME PERIODS/WEEK			CREDITS	MARKS IN EVALUATION SCHEME								TOTAL MARKS OF INTERNAL & EXTERNAL
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		TH	PR	TOT	TH	HRS	PR	HRS	TOT	
3.1	Fluid Flow Operations	Program Core (Theory)	2	-	-	2+0=2	40		**40**	60	3	-	-	**60**	**100**
3.2	Fluid Flow Operations (Lab)	Program Core (Practical)	-	-	4	0+2=2	-	60	**60**	-	-	40	3	**40**	**100**
3.3	Chemical Process Calculations	Program Core (Theory)	3	-	-	3+0=3	40	-	**40**	60	3	-	-	**60**	**100**
3.4	Chemical Engineering Thermodynamics	Program Core (Theory)	3	-	-	3+0=3	40	-	**40**	60	3	-	-	**60**	**100**
3.5	Chemical Technology	Program Core (Practicum)	2	-	4	2+2=4	40	-	**40**	60	3	-	-	**60**	**100**
3.6	Mechanical Operations & Solid Handling	Program Core (Theory)	2	-	-	2+0=2	40	-	**40**	60	3	-	-	**60**	**100**
3.7	Mechanical Operations & Solid Handling (Lab)	Program Core (Practical)		-	4	0+2=2	-	60	**60**	-	-	40	3	**40**	**100**
3.8	Summer Internship **(4 Weeks)		-	-	-	0+2=2	-	50	**50**	-	-	-	-	**-**	**50**
#Student Centered Activities			-	-	12	-	-	50	**50**	-	-	-	-	**-**	**50**
TOTAL			**12**	**-**	**24**	**20**	**200**	**220**	**420**	**300**		**80**		**380**	**800**

** Students will present a seminar on their summer internship along with certificate, project and report.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. Photography etc., Seminars, Declamation Contests, voluntary contribution in physical activities, Educational Field Visits, NCC, NSS, Cultural Activities and Self-Study etc.

Note- 1) Each period will be 60 minutes duration.
2) Each session will be of 16 weeks.
3) Effective teaching will be at least 14 weeks.

STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING (PETRO CHEMICAL)
FOURTH SEMESTER

SR. NO.	SUBJECTS	COURSE TYPE AND CATEGORY	STUDY SCHEME PERIODS/WEEK			CREDITS	MARKS IN EVALUATION SCHEME								TOTAL MARKS OF INTERNAL & EXTERNAL
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		TH	PR	TOT	TH	HRS	PR	HRS	TOT	
4.1	Process Heat Transfer	Program Core (Theory)	2	-	-	2+0=2	40	-	40	60	3	-	-	60	100
4.2	Process Heat Transfer (Lab)	Program Core (Practical)	-	-	4	0+2=2	-	60	60	-	-	40	3	40	100
4.3	Chemical Reaction Engineering	Program Core (Practicum)	2	-	4	2+2=4	40	-	40	60	3	-	-	60	100
4.4	Natural and Bio Gas Engineering	Program Core (Theory)	3	-	-	3+0=3	40	-	40	60	3	-	-	60	100
4.5	Mass Transfer Operations-I	Program Core (Practicum)	2	-	2	2+1=3	40	-	40	60	3	-	-	60	100
4.6	Program Elective -1	Program Core (Theory)	2	-	-	2+0=2	40	-	40	60	3	-	-	60	100
4.7	Program Elective-2	Program Core (Theory)	2	-	-	2+0=2	40	-	40	60	3	-	-	60	100
4.8	(Q) Open Elective-1	Open Elective	2	-	-	2	50*	-	-	-	-	-	-	-	-
	Advance Skill Certification	Certification Course	-	-	-		-	-	-	-	-	-	-	-	-
4.9	(Q) Essence Of Indian Knowledge And Tradition	Audit Course	2	-	-	-	50	-	-	-	-	-	-	-	-
# STUDENT CENTERED ACTIVITIES			-	-	9	-	-	50	50	-	-	-	-	-	50
TOTAL			**17**	**-**	**19**	**20**	**240**	**110**	**350**	**360**			**-**	**400**	**750**

*Students will submit the certificate.
(Q) This Course is Qualifying only, Exam marks will not be added in obtained marks.
Advance Skill Development:
To fulfill the requirements for Advanced Skill Development, a minimum of 20 hours of skill certification is necessary. This certification must be obtained from a recognized national or international agency or institute. The assessment and certification process will be conducted by the respective agency or institute. Students must present their certificate to earn 02 credits for this subject.
Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. Photography etc., Seminars, Declamation Contests, voluntary contribution in physical activities, Educational Field Visits, NCC, NSS, Cultural Activities and Self-Study etc.
-Industrial Training (Summer Internship-II) of 4-6 Weeks after 4th Semester, Evaluation will be in 5th Semester.

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

PROGRAM ELECTIVE-1

SR. NO.	SUBJECT NAME
1	Petroleum Engineering
2	Energy Engineering

PROGRAM ELECTIVE-2

SR. NO.	SUBJECT NAME
1	Plant Utilities
2	Waste Management

OPEN ELECTIVE-1

SR. NO.	SUBJECT NAME
1	Renewable Energy Technologies
2	Internet Of Things (Syllabus provided by TATA)
3	Disaster Management

OR

OPEN ELECTIVE-1

SR.NO.	CERTIFICATE COURSES
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc)
2.	COURSES CONDUCTED BY INFOSYS PRINGBOARD
3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY NEILIT

DETAILED CONTENTS OF VARIOUS SUBJECTS

THEORY	3.1 FLUID FLOW OPERATIONS	L	T	P
		2	-	-

COURSE OBJECTIVES

This course provides knowledge of the measurement of fluid flow and various fluid transportation machinery. The knowledge gained in this subject is directly applied in different subjects of Chemical Engineering. This subject helps students understand the installation, working, and application of different fluid flow and transportation machinery used in industry.

COURSE OUTCOMES (CO):
After studying this course, the students will be able to:

CO1 : Distinguish between different types of fluids and explain their properties and flow characteristics.

CO2 : Explain pressure concepts and calculate pressure using manometers and pressure measuring devices.

CO3 : Analyze incompressible fluid flow and calculate flow rates using continuity equation, Bernoulli's theorem, and flow meters.

CO4 : Identify types of pipes, fittings, and valves and explain their construction and applications in fluid flow systems.

CO5 : Explain the principles, working, and performance of pumps used for transportation of fluids and calculate pumping requirements

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	2	–	3	–	–	1	*	*
CO3	2	3	1	3	–	–	1	*	*
CO4	2	1	2	1	–	1	–	*	*
CO5	2	3	2	–	1	1	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit-1: Introduction to fluids (06 Periods)

1. Properties of fluids- Density and viscosity, Vapor pressure and surface tension, cohesion and adhesion, Hydrostatic Pressure.
2. Types of Fluids- Ideal and Real fluids, Compressible and Incompressible Fluids (liquid), Newtonian and Non-Newtonian fluids and Newton's Law of Viscosity.
3. Types of Fluid flow: Stream line flow, steady and unsteady state flow, uniform and non- uniform flow, rotational and irrotational flow, Laminar flow and turbulent flow.

Unit-2: Pressure Measurements (02 Periods)

1. Pressure: Types of Pressure, Atmospheric, Gauge & Absolute Pressure, Barometric Leg
2. List of Pressure measuring devices: U-Tube Manometer –computation of Pressure difference using U-Tube manometer - Inclined Manometer –Simple Problems in U-Tube manometer.

Unit-3: Flow of Incompressible Fluids (08 Periods)

1. Equation of continuity, Mass flow rate, volumetric flow rate, average velocity and mass velocity.
2. Introduction to Bernoulli's Theorem and its applications (derivation excluded).
3. Concept of Boundary layer, Form friction and skin friction.
4. Hagen-Poiseuille equation (derivation excluded).
5. Construction and Comparative Application of Venturi meter, Orifice meter, Rota meter, Pitot tube.

Unit-4: Pipe, fitting and valves (04 Periods)

1. Type of Pipes, Standard sizes of pipes on the basis of Wall thickness, Schedule number, BWG Number, Difference between Tube and Pipe.
2. Joints and fittings, Gate valve, Globe valve, Ball valve, Needle valve, Non return value, Butterfly valve, Diaphragm valve, Control Valves, Solenoid Operating Valves.

Unit-5: Transportation of Fluids (08 Periods)

1. Pumps- Classification of Pumps, Centrifugal Pump: Parts of centrifugal pump, working of Centrifugal pump, Installation of Centrifugal Pump (Strainer, valves, NRV's explanation), priming, Cavitation, Net Positive Suction Head (NPSH).
2. Positive displacement Pump: Reciprocating pumps based on Fluid Handling and based on action of piston/plunger, Construction & working of Gear pump, Rotary Pump, Diaphragm pump, Screw pump.

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

RECOMMENDED BOOKS

1. Unit Operations of Chemical Engineering by McCabe, Smith; McGraw Hill
2. Introduction to Chemical Engineering by Badger & Banchero; McGraw Hill
3. Chemical Engineering Volume-1 by Richardson & Coulson; Pergamon Press

WEBSITES FOR REFERENCE:

1. http://swayam.gov.in

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	6	20
2	2	10
3	8	30
4	4	10
5	8	30
Total	28	100

PRACTICAL	3.2 FLUID FLOW OPERATIONS (Lab)	L	T	P
		-	-	4

COURSE OBJECTIVE:

The objectives of this course are to:

1. Provide hands-on experience in measuring fluid properties such as density, viscosity, pressure, and flow rate.
2. Develop skills to operate and interpret readings from common fluid flow measuring devices and instruments.
3. Enable students to analyze fluid flow behavior through experiments based on Bernoulli's theorem and Reynolds number.
4. Train students to compute frictional losses in pipes and fittings under practical conditions.
5. Familiarize students with the working, construction, and application of pumps, valves, and fluid handling equipment used in industry.

COURSE OUTCOMES (CO):

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

CO1: Measure density and viscosity of liquids using standard laboratory instruments.
CO2: Measure pressure using manometers and related devices.
CO3: Verify Bernoulli's theorem and determine Reynolds number for different flow regimes.
CO4: Measure flow rate and determine coefficients of discharge using flow measuring devices.
CO5: Calculate major and minor frictional losses in pipes and fittings.
CO6: Demonstrate the working and applications of pumps, valves, and fluid handling components.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	2	2	–	3	–	–	_	*	*
CO2	2	2	–	3	–	–	1	*	*
CO3	2	3	1	3	1	1	1	*	*
CO4	2	2	1	3	–	–	_	*	*
CO5	2	3	1	3	1	–	_	*	*
CO6	2	1	2	3	1	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit 1: Measurements of Density, Viscosity **(**04 Periods)

Ex1. Determination of Density using Density Bottle and Hydrometer.
Ex2. To measure the viscosity of different liquids (Ostwald's Viscometer or Redwood Viscometer or latest Digital Viscometers)

Unit 2: Measurement of Pressure **(0**6 Periods)

Ex3. Study Sketch and Demonstration of U-Tube Manometer.
Ex4. Use of U-Tube Manometer to measure vacuum generated by vacuum pump.

Unit 3: Bernoulli's Theorem, Reynold's Number, Pipe Friction (10 Periods)

Ex5. To perform experiment on Bernoulli's Theorem and prove that the summation of pressure head, kinetic head and potential head is constant.
Ex6. To perform Reynolds Experiment and determine Reynolds number at the end of laminar region and beginning of turbulent region

Unit 4: Measurement of Flow (12 Periods)

Ex7. Determination of coefficient of discharge of venturi meter
Ex8. Determination of coefficient of discharge of orifice meter
Ex9. Measurement of Flow using rotameter for different liquids
Ex.10. Study Sketch of Pressure Transducers (Mass Flow Meters)

Unit 5: Losses in Pipe Flow (12 Periods)

Friction in pipe, Fanning's friction factor, Friction losses due to sudden expansion/reduction of pipe and in pipe fittings, Definition equivalent of length of pipe fittings,
Ex.11 Determination of equivalent length of pipe fittings
Ex.12 To measure the major and minor loses in pipes.

Unit 6: Study-Sketch or Demonstration, Working and Internals of Valves and Pumps (12 Periods)

Gate valve, Globe valve, Ball valve, Needle valve, Non return value, Butterfly valve, Diaphragm valve, Control Valves and Centrifugal Pump, Reciprocating Pumps, Strainers, Solenoid Operating Valves, two way & three way Valves, Pieces of Different types of pipes like A, B, C Class, Seamless & ERW.

INSTRUCTIONAL STRATEGY

Give industrial based simple practical problems for measurement of pressure and mass flow rate. Brief description about the related equipment.

RECOMMENDED BOOKS AND RESOURCES

1. Unit Operations of Chemical Engineering by McCabe, Smith; McGraw Hill
2. Introduction to Chemical Engineering by Badger & Banchero; McGraw Hill
3. Chemical Engineering Volume-1 by Richardson & Coulson; Pergamon Press
4. Fluid Mechanics and Hydraulic Machines by R. K. Bansal; Laxmi Publications.
5. Animated/Real videos of related experiments/equipment's.

WEBSITES FOR REFERENCE:

http://swayam.gov.in

THEORY	3.3 CHEMICAL PROCESS CALCULATIONS	L	T	P
		3	-	-

COURSE OBJECTIVES

The objectives of this course are to:

1. Provide students with fundamental concepts of material and energy balance used in chemical industries.
2. Develop the ability to perform unit conversions and apply engineering units consistently in calculations.
3. Enable students to analyze gas mixtures and solution concentrations used in industrial processes.
4. Train students to perform material balance calculations for unit operations with and without chemical reactions.
5. Familiarize students with energy balance concepts, including heat of reaction, combustion calculations, and calorific values used in process industries.

COURSE OUTCOMES(CO):

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

CO1 : Understand the scope and importance of material and energy balance in chemical industries and perform unit conversions using appropriate systems of units.
CO2 : Calculate properties and concentrations of solutions and gas mixtures used in chemical industries.
CO3 : Determine material input and output for unit operations without chemical reaction, including recycle, bypass, and purge systems.
CO4 : Perform material balance calculations involving chemical reactions, including excess and limiting reactants.
CO5 : Perform energy balance calculations involving heat of reaction, combustion, calorific value, and adiabatic processes and combustion problems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	–	–	–	1	*	*
CO2	3	2	–	–	–	–	–	*	*
CO3	2	3	1	–	–	1	1	*	*
CO4	2	3	2	–	1	2	1	*	*
CO5	2	3	2	–	1	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

UNIT-1: INTRODUCTION (04 Periods)

1. Introduction to material and energy balance in chemical industries
2. Unit conversion, S.I. system, M.K.S. system, C.G.S. system.

UNIT-2: GASES AND GAS MIXTURE (08 Periods)

1. Boyle's law, Charle's law, Ideal Gas law, value of universal gas constant, Amagat's Law
2. Average molecular weight, density and composition (by weight and by mole) of gas mixture.
3. Various units of concentration: PPM (parts per million), PPB (parts per billion) molarity, molality, normality.

UNIT-3: MATERIAL BALANCE WITHOUT CHEMICAL REACTION (08 Periods)

1.Steps for solving simple material balance problems.
2.Solving simple problems on various unit operations like drying, evaporation, crystallization, distillation, mixing and absorption.
3. Concept of: By-pass streams.

UNIT-4: MATERIAL BALANCE WITH CHEMICAL REACTION (06 Periods)

1. Limiting component, excess component, percent excess, yield, conversion, and selectivity recycle, and purge related simple problems.

UNIT-5: ENERGY BALANCE & COMBUSTION (16 Periods)

1. Definitions of Specific heat (Cp & Cv)/sensible heat, latent heat.
2. Hess's law and associated basic problems.
3. Concept of Heat of reaction, heat of combustion & heat of formation.
4. Adiabatic reaction and adiabatic flame temperature
5. Calorific Value: Net and gross and its basic numerical problems.
6. Combustion: proximate and ultimate analysis, air fuel ratio in Boiler/Furnaces, Theoretical oxygen/air required.
7. Problems of fuel analysis.
8. Oxidation of sulphur and its compounds.

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

RECOMMENDED BOOKS

1. Stoichiometry by B. I. Bhatt &S. M. Vora; McGraw Hill Publication
2. Chemical Process Principles Part-1 by O.A. Hougen and K.M. Watson.
3. Chemical Process Principles Part-1 by R.A. Rastogi
4. Solved Examples in Chemical Engineering by G.K. Ray

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

RECOMMENDED BOOKS

5. Stoichiometry by B. I. Bhatt &S. M. Vora; McGraw Hill Publication
6. Chemical Process Principles Part-1 by O.A. Hougen and K.M. Watson.
7. Chemical Process Principles Part-1 by R.A. Rastogi
8. Solved Examples in Chemical Engineering by G.K. Ray
9.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	15
2.	08	20
3.	08	20
4.	06	15
5.	16	30
Total	42	100

THEORY	3.4 CHEMICAL ENGINEERING THERMODYNAMICS	L	T	P
		3	-	-

COURSE OBJECTIVES:

It is a core subject of Chemical Engineering and is essential for understanding basic concepts, thermodynamic properties of fluid and performance of thermal systems used in industry.

COURSE OUTCOMES:

CO1: Explain thermodynamic systems, properties, state and path functions, and fundamental laws including zeroth law and gas laws.
CO2: Apply the first law of thermodynamics to open and closed systems and solve problems using property relations and steam tables.
CO3: Explain the second and third laws of thermodynamics, entropy concept, and performance of Carnot cycle, heat engines, heat pumps, and refrigerators.
CO4: Analyze thermodynamic cycles and equipment such as refrigeration systems and compressors based on second-law applications.
CO5: Explain phase and chemical reaction equilibrium, VLE behavior, and thermodynamic property relations used in industrial systems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	1	1	2	*	*
CO2	3	3	1	2	1	–	2	*	*
CO3	3	2	1	–	2	–	2	*	*
CO4	3	3	2	1	2	1	2	*	*
CO5	3	2	2	1	2	–	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit-1: Introduction and Basic Concepts (06 Periods)

Thermodynamic systems: closed, open, isolated, homogeneous, heterogeneous and surroundings, Thermodynamic properties: intensive, and extensive properties, State and path functions. Concept of internal energy, enthalpy, entropy, free energy and equilibrium, Ideal gas law, Amagat's law, Dalton's law, Zeroth law of thermodynamics

Unit-2: First Law of Thermodynamics for Open and Closed System (10 Periods)

Statement of first law of thermodynamics, expression and application of first law of thermodynamics for isothermal, isobaric, isochoric, adiabatic and polytropic processes. Properties of pure substances, phase change process of pure substance, property diagram for phase change processes- T-V, P-V and P-T diagrams, property tables- use of steam tables.

Unit-3: Second Law of Thermodynamics (06 Periods)

Statement of second law of thermodynamics: Kelvin Plank and Clausius, Heat engine, Heat Pump and Refrigerators- coefficient of performance and efficiency, Reversible and irreversible process, Carnot cycle and its efficiency. Concept of entropy and Statement of third law of thermodynamics

Unit-4: Applications of Second law of Thermodynamics (10 Periods)

Concept of refrigeration, Thermodynamic cycles: vapor compression and absorption refrigeration and air refrigeration. Compressors- Piston, Rotary Screw, Centrifugal and Reciprocating. Liquefaction process, Properties and applications of refrigerants and their naming.

Unit-5: Chemical Reaction Equilibrium and Vapor Liquid Equilibrium (10 Periods)

Composition of Gas Mixtures- Mass and Mole fraction, Concept of chemical potential, Henry's law, Raoult's law, Gibb's phase rule, vapor liquid equilibrium (VLE); P-v-T behavior. Dew point and bubble point, fugacity, fugacity coefficient, activity and activity coefficient.
Introduction to Applications of Thermodynamics in Industries: Power Generation-Steam Turbine & Gas Turbine, Refrigeration and Air Conditioning.

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the students related to subject and transfer industrial knowledge to students.

LIST OF RECOMMENDED BOOKS

1. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness; McGraw Hill.
2. Chemical Engineering Thermodynamics by K.V. Narayanan; Prentice Hall India.
3. Chemical Engineering Thermodynamics by Dodge; McGraw Hill.
4. Chemical Engineering Thermodynamics by YVC Rao
5. Engineering Thermodynamics by PK Nag
6. Thermal Engineering by Ballaney
7. Chemical Engineering Thermodynamics by K.A. Gavhane, Nirali Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	06	10
2.	10	20
3.	06	20
4.	10	25
6.	10	25
Total	42	100

PRACTICUM	3.5 CHEMICAL TECHNOLOGY	L	T	P
		2	-	4

COURSE OBJECTIVES:

A comprehensive knowledge of various chemical industries involving process technology, availability of raw materials, production trend, preparation of flow sheet, engineering problems involving material of construction and uses, is required for diploma holders in Chemical Engineering.

COURSE OUTCOMES (CO):

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

CO1: Explain the manufacturing processes and uses of major industrial gases (O_2, H_2, N_2).
CO2: Explain manufacturing processes and engineering aspects of sugar and fermentation industries.
CO3: Describe manufacturing processes of soaps and detergents and related process issues.
CO4: Explain pulping methods and paper manufacturing processes.
CO5: Describe polymerization processes and manufacture of polymers, paints, varnishes, and dyes.
CO6: Explain manufacturing processes in chlor-alkali industry (caustic soda, soda ash, HCl).
CO7: Explain sulphuric acid and oleum manufacturing using DCDA process**.**

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	2	1	1	1	–	1	*	*
CO3	3	2	1	2	1	–	1	*	*
CO4	2	1	1	1	1	–	1	*	*
CO5	3	2	2	1	1	–	1	*	*
CO6	3	2	1	2	2	–	1	*	*
CO7	3	2	1	2	2	–	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSE CONTENTS

Unit-1: Industrial Gases (02 Periods)

1. Manufacturing and uses of Oxygen, Hydrogen, and Nitrogen

Unit-2: Sugar Industry & Fermentation Industry (04 Periods)

1. Manufacturing of crystal sugar using cane sugar.
2. Introduction of fermentation industry and classification of fermentation processes
3. Production of ethyl alcohol by fermentation
4. Various engineering problems encountered in fermentation industry

Experiment:
Ex1. To measure the concentration of sugar solution by Refractometer.
Ex2. Preparation of vinegar using sugarcane juice etc.

Unit-3: Soaps and Detergent Industry (06 Periods)

1. Manufacturing of soap and glycerin as by products from soap.
2. Manufacturing of detergents (including raw material and manufacturing process)
3. Various engineering problems encountered in soaps and detergent industry.

Experiments:
Ex.3 Preparation of Soap by Coconut Oil
Ex.4 Preparation of Soap by mustard oil
Ex.5 Preparation of Detergent/liquid detergent.

Unit-4: Pulp and Paper Industry (02 Periods)

1. Different pulping process
2. Manufacturing of paper by Craft and Sulphite Process

Experiment:
Ex.6 Recycling of Paper waste

Unit-5: Polymer and Paint Industry (06 Periods)

1) Types of polymer, polymerization process, manufacture of polyethylene, styrene, nylon 6, Nylon 66, rayon. Manufacture of rubber.
2) Introduction to Paint, Varnishes and dyes.

Experiments:
Ex.7 Preparation of phenyl formaldehyde Resin.
Ex.8 Preparation of Urea formaldehyde Resin

Unit-6: Chlor-alkali Industry (04 Periods)

1. Manufacturing process of Caustic Soda
2. Manufacturing process of Soda ash.
3. Manufacturing process of Hydrochloric acid.

Experiments:
Ex.9 To find percentage purity of commercial hydrochloric acid.
Ex.10 To Determine the Density of Caustic Soda.

Unit-7: Sulphuric Acid Industry (04 Periods)

1. Manufacturing process of Sulphuric Acid by Double Contact Double Absorption Method.
2. Manufacturing of oleum

Experiments:
Ex.11 To Determine the Density of Sulphuric Acid
Ex.12 To Determine the Percentage Purity of Sulphuric Acid**.**

INSTRUCTIONAL STRATEGY

Teacher should explain each process industry and use of each and every equipment used. An industrial visit can be organized in various chemical and process industries. Audio-visuals should be used to teach.

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	02	8
2.	04	15
3.	06	20
4.	02	7
5.	06	20
6.	04	15
7.	04	15
Total	**28**	**100**

THEORY	3.6 MECHANICAL OPERATIONS AND SOLID HANDLING	L	T	P
		2	-	-

COURSE OBJECTIVES

The subject gives the students the knowledge of working of individual mechanical operations and handling of solids and their significance in chemical industries. With this information, students will be able to control the operation of equipment and regulate production.

COURSE OUTCOMES

After completing this course, students will be able to:

CO1 : Explain the concept and role of unit operations in process industries.
CO2 : Analyze characteristics of solid particles and methods of size analysis.
CO3 : Select and explain size-reduction equipment and crushing laws.
CO4 : Apply principles of screening and mechanical separation equipment.
CO5 : Explain filtration, sedimentation and associated separation equipment.
CO6 : Describe and select conveying equipment for solid particles.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	2	1	1	1	–	1	*	*
CO3	3	2	1	2	1	–	1	*	*
CO4	2	1	1	1	1	–	1	*	*
CO5	3	2	2	1	1	–	1	*	*
CO6	3	2	1	2	2	–	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSE CONTENTS

Unit-1: Concepts and role of unit operation in process industries (02 periods)

Unit-2: Characterization of Solid Particles (04 periods)

Spherecity, Particle shape, particle size, mixed particle sizes and size analysis, expressions for specific surface of mixture, average particle size (expression and meaning of terms only, no derivation)

Unit-3: Size Reduction (08 periods)

1. Crushing laws: Rittinger's law, Bond's law and Kick's law, Crushing efficiency.
2. Size Reduction Equipment: Classification and types; study of machines including Gyratory Crusher, Jaw Crusher, Grinding Rolls, Single Roll Toothed Crusher, Impact or Attrition Mill, and Ball Mill, Ultra-fine grinders such as Fluid Energy Mills.

Unit-4: Mechanical Separation (05 periods)

1. Screening, Screen analysis, Tyler standard screen series, screen effectiveness, Types of screening equipment i.e. gyrating screens, stationary screens and vibrating screens, Screen efficiency, Screen capacity.

Unit-5: Filtrations: (05 periods)

1- Classification of filtrations, filter media, filter aids, mechanisms of filtrations, plate and frame filter press, Continuous: Vacuum filters, Rotary drum filters.
2- Separation based on the motion of particles through fluids, Gravity classifiers, clarifiers and thickeners, Batch sedimentation, centrifugal settling process, Cyclone Separators.

Unit-6: Conveying of Solid Particles: (04 periods)

1. Classification of conveying **e**quipment, Belt conveyor, Screw conveyor, Chain conveyor and it's applications

Instructional Strategy

Mechanical operations have significant importance in the area of chemical engineering. Adequate competency needs to be developed by giving sufficient practical knowledge to mechanical operation (characterization of solid particles, size reduction, energy requirement and mechanical separation). A field visit may be conducted to expose the working of various conveyers and filtration equipment in industries.

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.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	02	5
2.	04	15
3.	08	30
4.	05	20
5.	05	15
6.	04	15
Total	**28**	**100**

PRACTICAL	3.7 MECHANICAL OPERATIONS AND SOLID HANDLING (Lab)	L	T	P
		-	-	4

COURSE OBJECTIVES:

The subject gives the students the knowledge of working of individual mechanical operations and handling of solids and their significance in chemical industries. With this information, students will be able to control the operation of equipment and regulate production.

COURSE OUTCOMES

After completion of the course, students will be able to:

CO1: Perform experiment on jaw crusher and determine crushing efficiency.
CO2: Determine crushing efficiency using roll crusher.
CO3: Determine crushing efficiency of ball mill.
CO4: Conduct sieve analysis using sieve shaker.
CO5: Determine rate of filtration using filter press.
CO6: Determine rate of filtration using rotary vacuum filter.
CO7: Evaluate performance of cyclone separator.
CO8: Evaluate performance of centrifuge.
CO9: Determine mixing rate/time using ribbon mixer.
CO10: Determine mixing rate/time using slurry mixer.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	3	–	3	–	1	1	*	*
CO2	3	3	–	3	–	1	1	*	*
CO3	3	3	–	3	–	1	1	*	*
CO4	3	2	–	3	–	1	1	*	*
CO5	3	3	–	3	1	1	1	*	*
CO6	3	3	–	3	1	1	1	*	*
CO7	3	2	–	3	1	1	1	*	*
CO8	3	2	–	3	1	1	1	*	*
CO9	3	2	1	3	–	2	1	*	*
CO10	3	2	1	3	–	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSE CONTENTS

Experiments:

Ex. 1 To perform on experiment on Jaw crusher and find its crushing efficiency.

Ex. 2 To determine the crushing efficiency by a roll crusher using a sample of solid particles.

Ex. 3 To determine the crushing efficiency of ball-mill using a sample of solid particles.

Ex. 4 To find the sieve analysis of a given sample of solid particles by sieve shaker
Ex. 5 To find the rate of filtration with the help of filter press.
Ex. 6 To perform an experiment on rotary vacuum filter and find rate of filtration.
Ex. 7 To perform an experiment on cyclone separator.
Ex. 8 To perform an experiment on centrifuge.
Ex.9: To perform an experiment on ribbon mixer for solid-liquid mixing and find rate/time of mixing.
Ex.10: To perform an experiment on industrial slurry mixer for solid-liquid mixing rate/time of mixing.

INSTRUCTIONAL STRATEGY

Mechanical operations have significant importance in the area of chemical engineering. Adequate competency needs to be developed by giving sufficient practical knowledge to mechanical operation, A field visit may be conducted to expose the working of various conveyers and filtration equipment in industries.

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.

THEORY	4.1 PROCESS HEAT TRANSFER	L	T	P
		2	-	-

COURSE OBJECTIVES:

Most of the Chemical Engineering operations will involve either heat addition or heat removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat transfer mechanisms. This subject enables the students to apply this knowledge for understanding the performances of various heat transfer equipment such as heat exchangers, condensers, evaporators etc. used in almost all chemical and related industries.

COURSE OUTCOMES:

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

CO1: Understand different modes of heat transfer and steady/unsteady heat transfer concepts.
CO2: Analyze steady heat conduction problems in simple geometries.
CO3: Explain convective heat transfer and analyze heat transfer coefficients for natural and forced convection.
CO4: Understand radiation heat transfer and its governing laws.
CO5: Analyze heat exchanger performance using LMTD for parallel and counter flow and recognize types and geometries of heat exchangers.
CO6: Understand boiling and condensation heat transfer processes.
CO7: Analyze evaporator performance, capacity, and economy.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	3	1	2	–	–	–	*	*
CO3	3	3	1	2	–	–	–	*	*
CO4	2	2	–	–	–	–	–	*	*
CO5	3	3	2	2	1	–	–	*	*
CO6	2	2	1	1	–	–	–	*	*
CO7	3	3	2	2	1	–	–	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSE CONTENTS

Unit-1: Modes of Heat Transfer: (02Periods)
Conduction, Convection, Radiation. Concept of steady state and unsteady state heat transfer

Unit-2: Conduction (04Periods)

1. Fourier's law of heat conduction, thermal conductivity of materials – solids, liquids and gases and effect of temperature on thermal conductivity. One dimensional steady state heat conduction through a plane wall, composite wall and cylinder, multi-layer cylinder.
2. Insulation and insulating materials, critical thickness of insulation, physical properties of insulating materials

Unit-3: Convection (04 Periods)

1. Natural and forced convection, Dimensionless numbers: Reynold, Prandtl, Nusselt and Grashoff, empirical correlations for free and forced convection (Significance Only & Derivation Excluded).
2. Simple numerical problems using Fourier's law of heat conduction, Significance of Dittus-Boelter and Sieder-Tate Equation, Convective heat transfer coefficient (Derivation Excluded).

Unit-4: Radiation (06 Periods)
Reflection, absorption and transmission of thermal radiation, Definitions of: Transmissivity, reflectivity and absorptivity. Emissive power, Wein's displacement law, Stefan Boltzmann Law, Planck's law, Kirchhoff's law, Concept of black body, Grey body, solar radiation

Unit-5: Heat Exchanger (06 Periods)
Introduction and classification: Local/individual and overall heat transfer coefficient, fouling factor, roughness of surfaces and their effect, LMTD for parallel and counter current heat exchangers. Construction and description of:- Concentric double pipe, Shell and tube (1-1heat exchanger and 1-2 heat exchanger), Compact heat exchanger-Plate type heat exchanger, Extended surface equipment-finned tube heat exchanger.

Unit-6: Boiling and condensation (02 Periods)
Introduction to Boiling and Boiling Curves; Condensation – Drop wise and Film wise

Unit-7: Evaporators (04 Periods)
Evaporation, Capacity &Economy of Evaporators, construction and description of open pan, long type vertical evaporator, falling film evaporator and agitated thin film evaporator, Multiple effect evaporator,

INSTRUCTIONAL STRATEGY

A field visit may be conducted to expose the students to various types of heat transfer equipment. Practical should be conducted to give an idea about modes of heat transfer, effect of insulation on heat transfer.

RECOMMENDED BOOKS

1. Heat Transfer by Chapman, MacMillan Publication.
2. Heat Transfer by KA Gavahane, NiraliPublications.

3. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York
4. Heat Transfer 7th Ed. By Holman JP; McGraw Hill, New York
5. Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India.
6. Unit Operation of Chemical Engineering by McCabe and Smith.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1.	02	05
2.	04	15
3.	04	15
4.	06	25
5.	06	25
6.	02	05
7.	04	10
Total	**28**	**100**

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

PRACTICAL	4.2 PROCESS HEAT TRANSFER (Lab)	L	T	P
		-	-	4

COURSE OBJECTIVES:

To develop practical competency in measuring thermal properties and evaluating heat transfer performance in conduction, convection, heat exchangers, and evaporation systems through laboratory experimentation and analysis.

COURSE OUTCOMES:

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

CO1: Determine thermal conductivity of a metal rod at different temperatures.
CO2: Calculate rate of heat loss through a composite wall.
CO3: Determine thermal conductivity (k-value) of insulating powder.
CO4: Evaluate heat transfer coefficient for natural convection.
CO5: Evaluate heat transfer coefficient for forced convection.
CO6: Determine heat transfer coefficient in a double pipe heat exchanger (parallel and counter flow).
CO7: Determine heat transfer coefficient in a shell and tube heat exchanger.
CO8: Determine heat transfer rate in a finned tube heat exchanger.
CO9: Determine overall heat transfer coefficient for an open pan evaporator.
CO10: Determine rate of evaporation in a jacketed bottle/open pan evaporator.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	3	–	3	–	1	1	*	*
CO2	3	3	–	3	–	1	1	*	*
CO3	3	3	–	3	–	1	1	*	*
CO4	3	3	–	3	–	1	1	*	*
CO5	3	3	–	3	–	1	1	*	*
CO6	3	3	1	3	1	1	1	*	*
CO7	3	3	1	3	1	1	1	*	*
CO8	3	3	1	3	1	1	1	*	*
CO9	3	3	1	3	1	1	1	*	*
CO10	3	3	1	3	1	1	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSE CONTENT

Experiments:

Ex.1 To find the thermal conductivity of (material at different temperature) metal rod.
Ex.2 To calculate the rate of heat loss through composite wall.
Ex.3 To determine experimentally the k value of insulating powder
Ex.4 To calculate the heat transfer co-efficient for natural convection.
Ex.5 To calculate the heat transfer co-efficient for forced convection.
Ex.6 To determine the heat transfer coefficient with the help of double pipe heat exchanger using parallel and

counter flow.

Ex.7 To determine heat transfer coefficient in shell and tube heat exchanger using parallel and counter flow.

Ex.8 To determine heat transfer rate in finned tube heat exchanger.

Ex.9 To determine overall heat transfer co-efficient for an open pan evaporator.

Ex.10 To determine the rate of evaporation in a jacketed bottle (open pan evaporation).

INSTRUCTIONAL STRATEGY

Give industrial based simple practical problems for measurement of pressure and mass flow rate. Brief description about the related equipment.

REFERENCE BOOKS

1. Lab Manual
2. W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", McGraw Hill, International Edn.,
3. G Chandrasekhar, Laboratory Experiments in Chemical and Allied Engineering:, Penram Inter- national Publishing (India) Pvt. Ltd.,

WEBSITES FOR REFERENCE:

http://swayam.gov.in

PRACTICUM	4.3 CHEMICAL REACTION ENGINEERING	L	T	P
		2	-	4

COURSE OBJECTIVES:

This subject outlines the basic principles of Kinetics. These principles are useful in developing new concept and operating the plant. It enables the students to have an idea about the different types of rectors and its design also gives knowledge about the importance of catalyst in various chemical processes in the industries.

COURSE OUTCOMES:

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

CO1: Explain reaction rate concepts and kinetic theories including Arrhenius and collision theory.
CO2: Interpret batch and semi-batch reactor data to determine reaction order and rate parameters.
CO3: Analyze performance and design concepts of batch, CSTR and PFR reactors.
CO4 : Explain heterogeneous reacting systems and non-ideal flow behavior.
CO5 : Describe catalyst types, preparation, properties and industrial applications.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	1	–	–	1	*	*
CO2	3	3	1	2	–	1	1	*	*
CO3	3	3	2	2	1	1	1	*	*
CO4	2	3	1	1	1	–	1	*	*
CO5	2	2	1	2	2	–	1	*	*

COURSE CONTENTS

Unit-1: Introduction to Chemical Kinetics (04 Periods)

1. Concept of rate of reaction, rate equation, rate constant, order of reaction, Molecularity of reaction.
2. Elementary and non-elementary reaction.
3. Activation Energy, Theories of reaction rates constant- Arrhenius law, Collision theory & Transition state theory.

Unit-2: Interpretation of batch reactor data. (06 Periods)

1. Concept of batch reactor, semi batch reactor, constant and variable volume reactions.
2. Integral and Differential method of analysis of batch reactor data.
3. Integral method of analysis of irreversible unimolecular first order reaction, bimolecular second order reaction, nth order, zero order and auto catalytic reaction.
4. Half-life concept for the overall order of irreversible reactions.

Unit-3: Introduction to Reactor Design (06 Periods)

1. Type of Reactors: Batch reactor & Continuous reactor (Plug flow reactor, Mixed flow reactor)
2. Concept of space-time, space velocity and holding time.
3. Performance equation for ideal batch reactor, mixed flow reactor and plug flow reactor for constant volume irreversible first order reaction.
4. Size comparison of the Reactor-PFR vs CSTR (For first order irreversible reactions).

Experiments:

Ex.1 Study, Sketch and Demonstration of Batch Reactor
Ex.2 Study, Sketch and Demonstration of CSTR
Ex.3 Study, Sketch and Demonstration of PFR
Ex. 4 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through a batch reactor.
Ex. 5 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through a CSTR.
Ex. 6 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through a PFR
Ex.7 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through CSTR's in Series.

Unit 4. Introduction to Heterogeneous Reacting System (06 Periods)

1. Rate Equation for Heterogeneous Reaction
2. Contacting pattern for two phase system
3. Factor affecting heterogeneous reaction
4. Basic of non-ideal flow
5. E, the age distribution of fluid

Unit-5: Catalysis (06 Periods)

1. Definition, types and classification of catalyst
2. Preparation of catalyst, ingredients (Promoter, inhibitor, accelerator)
3. Catalyst Poisoning & Regeneration.
4. Desired properties of catalyst.

Experiments:

Ex.1 Demonstration of heterogeneous Catalytic reaction

INSTRUCTIONAL STRATEGY

Stress should be given on interpretation and designing of the different reactors. Industrial visit during the semester should be planned and audio-visual aids should be used for making student understand. This will make subject interesting and improve student's performance in the subject.

RECOMMENDED BOOKS

1. Chemical Reaction Engineering by Octave Levenspiel; Wiley Eastern Ltd.
2. Chemical Engineering Kinetics by J.M Smith; McGraw Hill Publication
3. Chemical Engineering Thermodynamics by J.M Smith, H.C. Vanness; McGraw Hill
4. Thermodynamics for Chemists by Samuel Glasstone; Krieger Publication Company.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	15
2.	06	20
3.	06	25
4.	06	20
5	06	20
Total	**28**	**100**

THEORY	4.4 NATURAL AND BIO GAS ENGINEERING	L	T	P
		3	-	-

COURSE OBJECTIVES:

The field of Natural and Biogas Engineering is very much important for Petrochemical Students this subject outline the basic and essential concepts of Natural and Biogas Industries. The subject gives ideas about Natural Gas Production Processing and Transportation. This course will also provide the knowledge to students to understand the basic concepts and principles of biogas including its applications and utilization in various fields.

COURSE OUTCOMES:
After successful completion of the course, students will be able to:

CO1 : Explain the basic concepts, characteristics and importance of natural gas and biogas.
CO2 : Describe properties and reservoir parameters of natural gas.
CO3 : Explain natural gas production systems and separation equipment.
CO4: Describe dehydration, sweetening, compression and transportation of natural gas.
CO5 : Explain biogas production processes and biogas plant systems.
CO6: Describe applications, utilization, safety and future scope of biogas.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	2	–	1	*	*
CO2	3	2	–	–	–	–	1	*	*
CO3	3	2	1	2	–	–	1	*	*
CO4	3	3	2	1	1	–	1	*	*
CO5	2	2	1	1	2	–	1	*	*
CO6	2	1	–	–	3	1	1	*	*

DETAILED CONTENTS

UNIT:1 INTRODUCTION AND BASIC CONCEPTS (06 Periods)

Introduction to Natural Gas, properties of Natural Gas. Introduction to Biogas, Characteristics of Biogas and necessary condition for its formation, Benefits and potential of Biogas.

UNIT:2 PROPERTIES OF NATURAL GAS (04 Periods)

Formation volume factor, Gas Reservoir, Deliverability, Skin Factor, Productivity Index.

UNIT:3 NATURAL GAS PRODUCTION (08 Periods)

Gas Production, Upstream, Downstream, Surface Facilities, Principle of Separator, Working & Application of Separator: Vertical, Horizontal, Two Phase Separation and Three Phase Separation.

UNIT:4 DEHYDRATION OF NATURAL GAS (08 Periods)

Basic Concept of dehydration, Design of dehydration, Sweetening Process, Compressor Design and Energy Calculation, Transportation and Measurement.

UNIT:5 BIOGAS AND BIOGAS SYSTEM (08 Periods)

Production of Biogas: Composition, application, Anaerobic Digestion, Applications, Power Generation, Grid Injection, Aerobic Digestion, Comparison of Anaerobic and Aerobic Digestion, Components of Biogas.

UNIT:6 APPLICATION AND UTILIZATION OF BIOGAS (08 Periods)

Biogas as Transportation fuel, Biogas Vehicles, Biogas Problems and Safety Measures, Benefits of Biogas, Utilization in Social Research, Future Research and Development of Biogas field.

RECOMMENDED BOOKS

1. Natural Gas Engineering Handbook by Ali Ghalambor and Boyun Guo
2. Natural Gas Production Engineering by Mohan Kelkar
3. The Biogas Handbook By Wellinger Jerry Murphy David Baxter
4. Biogas from Waste and Renewable Resources: An Introduction Hardcover – Illustrated By Dieter Deublein, Angelika Steinhauser

REFERENCE WEBSITES

1. https://bue.libguides.com
2. https://www.oilandgaseng.com
3. https://biogaseng.com
4. https://biogasengineering.it/en/

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	06	10
2.	04	10
3.	08	20
4.	08	20
5.	08	20
6.	08	20
Total	**42**	**100**

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RACTICUM	4.5 MASS TRANSFER OPERATIONS- I	L	T	P
		2	-	2

COURSE OBJECTIVES:

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipment like distillation columns, gas absorption columns, dryers, cooling towers and extraction columns etc. which are used in industries for purification of products

COURSE OUTCOMES:

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

CO1 : Explain fundamentals and classification of mass transfer operations used in process industries.
CO2 : Estimate diffusivity and evaluate overall mass transfer coefficients for gas–liquid systems.
CO3 : Explain gas absorption and desorption processes and column design concepts.
CO4 : Analyze humidification and dehumidification processes and associated equipment.
CO5 : Explain drying mechanisms and select suitable drying equipment.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	3	–	3	–	–	1	*	*
CO3	3	2	2	2	1	–	1	*	*
CO4	2	2	2	2	2	–	1	*	*
CO5	2	2	2	3	1	–	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSE CONTENTS

Unit-1: Introduction and Classification of Mass Transfer Operations (01 Periods)

Unit-2: Diffusion (06 periods)

1. Definition of diffusion and its classification: Molecular & Eddy diffusion, Knudsen diffusion, Role of diffusion in mass transfer
2. Molar Flux, Fick's law of Diffusion, Diffusion in Gas phase: equimolar counter diffusion, diffusion through stationary gas.
3. Mass transfer coefficient, Interface mass transfer, relation between film and overall mass transfer coefficient,

Experiments:

Exp.1 To study the working of wetted wall-column
Exp.2 To find out diffusion coefficient in liquid phase

Exp.3 To find out diffusion coefficient in Gas phase
Exp.4 To find out overall mass transfer coefficient using a wetted wall-column.

Unit-3: Gas Absorption and Desorption (07 periods)

1. Absorption and Desorption, absorption material balance and design equation of operating line (for Dilute system only), choice of solvent, Raoult's law and Henry's law, Absorption factor.
2. Concept of HTU and NTU, HETP for packed column of distillation (Derivation excluded)
3. Introduction to Packed Column and Tray Column (differences and applications), their internals, Random and Structured packings, properties of tower packings, flooding, channeling, weeping and loading.

Experiments:

Exp.5 To study absorption using packed bed absorption tower

Unit-4: Humidification and Dehumidification (07 periods)

1. Definition: Saturated and Unsaturated gas, Dry bulb and wet bulb Temperature, dew point, Adiabatic saturation temperature, Humidity, relative humidity, percentage humidity, humid heat, humid volume, use of humidity chart.
2. Gas liquid contact operation (Description, construction, Working, advantage and disadvantage): Cooling towers- natural, Induced and Forced draft, humidifier and dehumidifier, spray chambers, spray ponds.

Experiments:
Exp.6 To determine the humidity using Hygrometer.
Exp.7 To determine temperature using wet bulb thermometer.

Unit-5: Drying (07 periods)

1. Definition: moisture content (wet and dry basis), equilibrium moisture content, bound moisture content, unbound moisture content, free and critical moisture content, constant and falling rate periods, rate of drying curve, time of drying (Derivation excluded).
2. Drying equipment (Description, construction, Working, advantage and disadvantage) – tray dryer, rotary dryer, spray dryer, fluidized bed dryer and application.

Experiments:
Exp.8 To study drying operation and calculate time of drying using tray-dryer
Exp.9 Study Sketch of Tray Dryer, Rotary Dryer, Spray Dryer.

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray) and different types of packing's/trays used in the column. This will also make the students aware of auxiliary equipment/models/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Treybal, Kogakusha Publication
2. Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication
3. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
4. Mass Transfer by Sherwood Pigford and Wilke, McGraw Hill Publication
5. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication
6. Mass Transfer Operations by Kiran D. Patil, Nirali Publication.

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SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	01	5
2	06	20
3	07	25
4	07	25
5	07	25
Total	28	100

Program Elective -1

THEORY	4.6 (a) PETROLEUM ENGINEERING (POE 1)	L	T	P
		2	-	-

COURSE OBJECTIVES

To provide an overview of petroleum industry. Petroleum exploration and exploitation techniques, oil and gas reserve identification and evaluation. Drilling and production of oil and gas. Disposal of effluents.

COURSE OUTCOMES:

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

CO1 : Explain earth science concepts, reservoir rocks, traps, reserves classification and reservoir mechanisms.

CO2 : Describe drilling of oil and gas wells, drilling rigs, fluids and cementing operations.

CO3 : Explain logging techniques, formation parameters and well completion practices.

CO4 : Analyze petroleum exploration, well testing, production performance and recovery methods.

CO5 : Explain surface processing, transportation, effluent treatment and petroleum economics..

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	2	1	2	–	–	1	*	*
CO3	3	2	1	3	–	–	1	*	*
CO4	2	3	2	2	1	–	1	*	*
CO5	2	2	1	1	3	1	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

COURSECONTENT

UNIT-I **(05 periods)**

Earth science - occurrence of petroleum Rocks and traps. Reservoir rocks and properties. Classification of oil and gas reserves Reservoir mechanics and drive mechanism.

UNIT-II **(05 periods)**

Drilling – introduction to drilling of oil and gas wells. Drilling rigs and equipments. Drilling fluids and cementing.

UNIT-III **(06 periods)**

Logging techniques. Various types of logs. Formation parameters. Log applications. Formation evaluation. Well completion.

UNIT-IV **(06 periods)**

Petroleum exploration – well testing, production potential and well performances. Materialbalance, Artificial lift, Improved recovery methods.

UNIT-V **(06 periods)**

Surface equipments, processing of oil and gas. Transportation of oil and gas. Effluent treatment. Petroleum economics. Supply and demand trends.

REFERENCE BOOKS

1. Geology of Petroleum by Leverson A.L.- 2nd edition The AAPG foundation.
2. Principles of oil production by T.E.W Nind- 2nd edition Mc Graw-Hill.
3. Introduction to Petroleum Engineering by Geltin
4. Vikas Mahto, Objective Questions & Answers in Petroleum Engineering, Khanna Publishing House,New Delhi.
5. Wellsite Geological Techniques for petroleum exploration, Oxford and IBH publishing Company.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	05	20
2	05	20
3	06	20
4	06	20
5	06	20
Total	28	100

OR

Program Elective -1

THEORY	4.6 (b) . ENERGY ENGINEERING (POE 1)	L	T	P
		2	-	-

COURSE OBJECTIVES:

1. To identify different types of fuel sources for energy production.
2. To appreciate the advantages of energy production from renewable energy resources.

COURSE OUTCOMES:

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

CO1: Explain classification, properties, testing and energy production from solid fuels and biomass resources.

CO2 : Describe energy generation from liquid fuels including petroleum, synthetic and blended fuels.

CO3 : Explain types, production and applications of gaseous fuels.

CO4 : Apply combustion principles and determine air requirements and combustion equipment selection.

CO5 : Explain renewable energy technologies and evaluate their advantages for energy production.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	1	–	1	*	*
CO2	3	2	1	1	1	–	1	*	*
CO3	3	1	–	–	1	–	1	*	*
CO4	2	3	2	1	1	–	1	*	*
CO5	2	2	1	–	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

UNIT-I **(05 periods)**

Fuels - Classification, Properties, tests and analysis. Solid Fuels - Coal, origin, classification, storage and handling, carbonization, gasification and briquetting - gasification of biomass.

UNIT-II **(05 periods)**

Liquid fuels - Petroleum based fuels, synthetic fuels, alcohol and blended fuels, storageand handling.

UNIT-III **(06 periods)**

Gaseous fuels - Water gas, Carbureted water gas, producer gas, coal gas and natural gas.

UNIT-IV **(06 periods)**

Combustion - Air requirement for solid, liquid and gaseous fuels, Combustion equipment

UNIT-V **(06 periods)**

Introduction to Solar energy, Wind energy, Tidal energy, Hydro power, Geothermal energy, Nuclear energy.

REFERENCE BOOKS

1. Gupta, "Energy Technology", Khanna Publishing House, New Delhi
2. G.D.Rai, "Non-conventional energy sources", Khanna Publishers, IV edition, New Delhi,

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	05	20
2	05	20
3	06	20
4	06	20
5	06	20
Total	**28**	**100**

Program Elective -2

THEORY	4.7(a) PLANT UTILITIES (POE 2)	L	T	P
		2	-	-

COURSE OBJECTIVE

The objectives of this course are to:

- Provide a comprehensive understanding of the current and future global energy scenario.
- Introduce students to renewable and non-conventional energy sources as alternatives to fossil fuels.
- Enable understanding of solar, wind, and bio-energy systems and their working principles.
- Develop the ability to evaluate suitable renewable energy options for a given location.
- Familiarize students with economic, environmental, and sustainability aspects of renewable energy technologies.

COURSE OUTCOMES(CO) :

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

CO1: Explain the foundational structures of the Indian Knowledge System, including the Vedas, Upavedas, Vedangas, and Upangas, and discuss their historical significance.

CO2: Relate ancient Indian scientific and technological achievements to modern science and analyze the convergence of science and spirituality.

CO3: Describe the basic principles of Yoga and Holistic Healthcare and evaluate their benefits and potential for integration with modern medicine.

CO4: Analyze case studies to demonstrate the contemporary relevance and practical application of Indian Knowledge Systems in solving modern problems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	1	-	-	-	3	-	2	*	*
CO2	2	2	-	-	2	-	2	*	*
CO3	-	-	-	-	3	2	3	*	*
CO4	1	2	2	-	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

OR Program Elective -2

THEORY	4.7 (b) WASTE MANAGEMENT (POE 2)	L	T	P
		2	-	-

COURSEOBJECTIVES:

1. To recognize and learn about waste management, waste treatment and recycling
2. To understand the impacts on our environment.
3. To learn about pollution, pollutants, waste disposal processes

COURSE OUTCOMES:
After successful completion of the course, students will be able to:

CO1: Classify solid and hazardous wastes, explain their sources, characteristics, generation rates, and the need for waste management systems.

CO2: Explain waste sampling, source reduction, recycling, reuse, segregation, storage, collection, transfer, transport, and safe handling of municipal and hazardous wastes.

CO3: Compare and select appropriate waste processing and treatment technologies including biological, chemical, thermal conversion, energy recovery, and biomedical waste treatment methods.

CO4: Analyze landfill disposal methods and design considerations including site selection, sanitary and secure landfills, leachate and gas management, closure, and remediation.

CO5: Interpret waste management legislation and apply principles of integrated waste management for municipal, hazardous, and biomedical wastes.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	1	2	–	1	*	*
CO2	3	2	1	2	2	1	1	*	*
CO3	3	3	2	2	2	1	1	*	*
CO4	3	3	3	2	3	1	1	*	*
CO5	2	2	1	1	3	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSECONTENT

UNIT- I **(05 Periods)**

Types and Sources of Solid and Hazardous Wastes - Need for Solid and Hazardous Waste Management, Waste Generation Rates Composition Hazardous Characteristics,

UNIT-II **(06 Periods)**

Waste Sampling - Source Reduction of Wastes - Recycling and Reuse - Handling and Segregation of Wastes at Source-Storage and Collection of Municipal Solid Wastes-Analysis of Collection Systems Need for Transfer and Transport- Transfer Stations-Labeling and Handling of Hazardous Wastes.

UNIT-III **(06 Periods)**

Waste Processing- Processing Technologies-Biological and Chemical Conversion Technologies – Composting –Thermal Conversion Technologies –Energy Recovery-Incineration –Solidification and Stabilization of Hazardous Wastes-Treatment of Biomedical Wastes-

UNIT-IV **(06 Periods)**

Disposal in Landfills - Site Selection - Design and Operation of Sanitary Landfills – Secure Landfills and Landfill Bioreactors - Leachate and Landfill Gas Management - Landfill Closure and Environmental Monitoring -Closure of Landfills-Landfill Remediation

UNIT-V **(05 Periods)**

Legislations on Management and Handling of Municipal Solid Wastes, Hazardous Wastes, and Biomedical Wastes-Elements of Integrated Waste Management.

REFERENCEBOOKS:

1. O.P.Gupta,"Elements of Solid Waste Hazardous Management",Khanna Publishing House, New Delhi,2018
2. George Tchobanoglous, Hilary Theisen and SamuelA, Vigil, Integrated Solid Waste Management, McGraw- Hill, New York,19932.
3. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, NewDelhi.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	05	20
2.	06	20
3.	06	20
4.	06	20
5.	05	20
Total	28	100

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OPEN ELECTIVE 1

THEORY	4.8 (a) RENEWABLE ENERGY TECHNOLOGIES	L	T	P
		2	0	0

COURSE OBJECTIVE

The objectives of this course are to:

- Provide a comprehensive understanding of the **current and future global energy scenario**.
- Introduce students to **renewable and non-conventional energy sources** as alternatives to fossil fuels.
- Enable understanding of **solar, wind, and bio-energy systems** and their working principles.
- Develop the ability to **evaluate suitable renewable energy options** for a given location.
- Familiarize students with **economic, environmental, and sustainability aspects** of renewable energy technologies.

COURSE OUTCOMES (CO):

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

CO1: Explain the global energy scenario, energy resources, and the need for renewable energy with economic and environmental perspectives.
CO2: Describe principles, components, and applications of solar energy systems including solar thermal and solar PV technologies.
CO3: Explain wind energy fundamentals, types of wind energy systems, site selection, and performance aspects.
CO4: Evaluate bio-energy generation methods such as biomass combustion, biogas, biofuels, and cogeneration systems.
CO5: Identify and compare alternative renewable energy sources such as tidal, wave, hydro, geothermal, hydrogen, fuel cells, and hybrid systems for suitable applications.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	2	–	2	*	*
CO2	3	2	2	1	1	1	1	*	*
CO3	2	2	2	–	1	1	1	*	*
CO4	2	2	1	1	2	1	1	*	*
CO5	2	3	1	1	3	1	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENT

Unit-1: (6 Periods)

Introduction: 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.

Unit-2: (6 Periods)

Solar energy: Solar Radiation; 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.

Unit-3: (5 Periods)

Wind Energy: Wind Data and Energy Estimation; Types of Wind Energy Systems; Performance. Site Selection; Details of Wind Turbine Generator; Safety and Environmental Aspects.

Unit-4: (5 Periods)

Bioenergy: Biomass direct combustion; Biomass gasifiers; Biogas plants; Digesters; Ethanol production; Bio diesel; Cogeneration; Biomass Applications.

Unit-5: (6 Periods)

Other Renewable Energy Sources: Tidal energy; Wave Energy; Open and Closed OTEC Cycles; Small Hydro-Geothermal Energy; Hydrogen and Storage; Fuel Cell Systems; Hybrid Systems.

INSTRUCTIONAL STRATEGY

1. Teacher should focus on conceptual clarity.
2. An industrial visit can be organized in relevant industries. Audio-visuals aids should be used to teach.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Seminar, Presentation, Viva-voce.

RECOMMENDED BOOKS:

1. O.P. Gupta, Energy Technology, Khanna Publishing House, Delhi (ed. 2018)
2. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN Spon Ltd., UK, 2006.
3. Solar Energy, Sukhatme. S.P., Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
4. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, U.K., 1996.
5. Fundamental of Renewable Energy Sources, GN Tiwari and MK Ghoshal, Narosa, New Delhi, 2007.
6. Renewable Energy and Environment-A Policy Analysis for India, NH Ravindranath, UK Rao, B Natarajan, P Monga, Tata McGraw Hill.
7. Energy and The Environment, RA Ristinen and J J Kraushaar, Second Edition, John Willey & Sons, New York, 2006.
8. Renewable Energy Resources, JW Twidell and AD Weir, ELBS, 2006.

OR

OPEN ELECTIVE -1

Open Elective	4.8 (b) Internet of Things	L	T	P
		2	-	-

CO1 : Explain the concept of Internet of Things, enabling technological trends, and its societal impact.

CO2 : Describe embedded system components, their interaction with the physical world, and core IoT hardware elements.

CO3 : Explain IoT device interfacing, software–hardware interaction, and basic networking structure and hardware.

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	–	3	1	2	*	*
CO2	3	2	2	2	1	–	1	*	*
CO3	3	3	2	3	1	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENT

Unit I - Introduction to Internet of Things

- Define the term “Internet of Things”
- State the technological trends which have led to IoT.
- Describe the impact of IoT on society.

Unit II - Design consideration of IoT

- Enumerate and describe the components of an embedded system.
- Describe the interactions of embedded systems with the physical world.
- Name the core hardware components most commonly used in IoT devices.

Unit III-Interfacing by IoT devices

- Describe the interaction between software and hardware in an IoT device.

- Explain the use of networking and basic networking hardware.
- Describe the structure of the Internet.

SUGGESTED SOFTWARE/LEARNING WEBSITES:

1. https://www.raspberrypi.org/blog/getting-started-with-iot/
2. https://www.arduino.cc/en/IoT/HomePage
3. https://www.microchip.com/design-centers/internet-of-things
4. https://learn.adafruit.com/category/internet-of-things-iot
5. http://esp32.net/

SUGGESTED LEARNING RESOURCES

1- Internet of Things by Raj Kamal, McGraw Hill Education; First edition (10March 2017)

2- internet of Things: AHands-On Approach by Arsheep Bahge andVijay Madisetti, Orient Blackswan Private Limited - New Del-hi; First edition (2015) ISBN : 978-8173719547

OR

OPEN ELECTIVE -1

Open Elective	4.8 (c) Disaster Management	L	T	P
		2	-	-

COURSE OBJECTIVES:

Following are the objectives of this course:

- To learn about various types of natural and man-made disasters.
- To know pre- and post-disaster management for some of the disasters.
- To know about various information and organisations in disaster management in India.
- To get exposed to technological tools and their role in disaster management.

COURSE OUTCOMES:

After competing this course, student will be:

CO1: Acquainted with fundamental concepts of disaster, hazard, vulnerability, risk, and capacity, and explain their inter-relationships.

CO2 : Classify various types of disasters (Geological, Hydro-meteorological, Biological, Man-made) and analyze their causes, trends, and consequences.

CO3 : Apply the Disaster Management Cycle (Pre, During, Post) and global frameworks (Hyogo, IDNDR) to plan for risk assessment and mitigation.

CO4 : Familiarised with institutional and legal mechanism of Disaster Management in India, including the DM Act 2005 and the role of various agencies.

CO5: Able to select scientific tools (GIS, RS, GPS) and engineering practices (structural/non-structural mitigation) for disaster preparedness and safe construction.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PS O 1	PSO 2
CO1	2	-	-	-	3	-	1	*	*
CO2	3	2	-	-	3	-	2	*	*
CO3	1	2	1	-	3	2	2	*	*
CO4	2	-	-	-	3	1	2	*	*
CO5	3	2	1	2	3	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENT:

Unit – I: Understanding Disaster

Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.

Unit – II: Types, Trends, Causes, Consequences and Control of Disasters

Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire);

Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – ClimateChange and Urban Disasters.

Unit- III: Disaster Management Cycle and Framework

Disaster Management Cycle – Paradigm Shift in Disaster Management.

Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity De- velopment; Awareness.

During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation –

Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Stretegy, Hyogo Frame- work of Action.

Unit– IV: Disaster Management in India

Disaster Profile of India – Mega Disasters of India and Lessons Learnt.

Disaster Management Act 2005 – Institutional and Financial Mechanism,

National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter Governmental Agencies

Unit– V: Applications of Science and Technology for Disaster Management

Geo-informatics in Disaster Management (RS, GIS, GPS and RS).

Disaster Communication System (Early Warning and Its Dissemination).

Land Use Planning and Development Regulations, Disaster Safe Designs and Constructions,Structural and Non Structural Mitigation of Disasters

S&T Institutions for Disaster Management in India

RECOMMENDED BOOKS

1. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
2. Bhandani, R. K., An overview on natural & man-made disasters and their reduction, CSIR,New Delhi
3. Srivastava, H. N., and Gupta G. D., Management of Natural Disasters in developing countries,Daya Publishers, Delhi
4. Alexander, David, Natural Disasters, Kluwer Academic London

5. Ghosh, G. K., Disaster Management, A P H Publishing Corporation
6. Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	06	19
2.	06	24
3.	05	19
4.	05	19
5.	06	19
Total	28	100

AUDIT COURSE	4.8 (Q) ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	L	T	P
		2	-	-

COURSE OBJECTIVES:

Understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

COURSE OBJECTIVES:
Understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

COURSE OUTCOMES(CO) :
At the end of the course, the student will be able to:
CO1: Explain the foundational structures of the Indian Knowledge System, including the Vedas, Upavedas, Vedangas, and Upangas, and discuss their historical significance.
CO2: Relate ancient Indian scientific and technological achievements to modern science and analyze the convergence of science and spirituality.
CO3: Describe the basic principles of Yoga and Holistic Healthcare and evaluate their benefits and potential for integration with modern medicine.
CO4: Analyze case studies to demonstrate the contemporary relevance and practical application of Indian Knowledge Systems in solving modern problems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	1	-	-	-	3	-	2	*	*
CO2	2	2	-	-	2	-	2	*	*
CO3	-	-	-	-	3	2	3	*	*
CO4	1	2	2	-	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit 1: Introduction to Indian Knowledge System **(16 Periods)**

Overview of Indian Knowledge System

Importance and relevance

1. Introduction to the Vedas
2. Upavedas
3. Vedangas
4. Upangas

Unit 2: Modern Science and Indian Knowledge System **(06 Periods)**

1. Relevance of Science and Spirituality,
2. Science and Technology in Ancient India,

Unit 3: Yoga and Holistic Healthcare **(04 Periods)**

1. Basic principles of Yoga
2. Benefits of holistic healthcare practices
3. Integration with modern healthcare

Unit 4: Case Studies / Assignment **(02 Periods)**

Practical Applications / Case studies demonstrating the relevance of Indian Knowledge System in modern times

MEANS OF ASSESSMENT

Viva -Voce Exam

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

8- GUIDELINES FOR ASSESSMENT OF STUDENT-CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 50 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows-

I. 15 Marks for general behaviour and discipline
(by HODs in consultation with all the teachers of the department)

II. 10 Marks for attendance as per following:
(by HODs in consultation with all the teachers of the department)

a) 75 - 80% 06 Marks
b) 80 - 85% 08 Marks
c) Above 85% 10 Marks

III. Even Semester:

25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSS activities as per following: (by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) State/National Level participation
b) Participation in two of above activities
c) Inter-Polytechnic level participation

****Odd Semester:**

25 Marks maximum

a) Language Lab Practices / foreign language practices
b) Group Discussion and Personality Development
c) Industrial Visits/Industrial Talks
d) Power Point Presentations and Resume Making
e) Development of Aptitude and Reasoning Skills
f) Participation in the technical Exhibitions, Symposiums, Seminars, Workshops at the Institute /District/State/National Level.

9- Instruments List

3.2 FLUID FLOW OPERATIONS LABORATORY			
S. N.	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Density Bottles (5 ml)	6	600
2	Density Bottles (10 ml)	6	800
3	Density Bottles (100 ml)	6	1000
4	Hydrometer	1	790
5	Ostwald Viscometer /Digital Viscometer	1	10000
6	Redwood Viscometer /Digital Viscometer	1	17584
7	U-Tube manometer (For Demonstration Purposes)	1	1,580
8	Reynolds Experiment set-up	1	50000
9	Bernoulli's Theorem Experiment Set-up	1	30000
10	Venturi Meter & Orifice Meter Experiment Set-up	1	35000
11	Vacuum pump with experiment set-up	1	20000
12	Determination of Frictional losses through pipe	1	55000
13	Centrifugal pumps and reciprocating pump(For Demonstration Purposes)	1 Each	30000
14	Rota-meter, Venturi meter, Orifice meter, pitot tube	1	80000
15	Globe valve, check valves, Butterfly valve, Needle valve, Gate Valve, Diaphragm Valve	1 Each	18000
16	Experiments related raw materials	Misc.	50000

3.5 CHEMICAL TECHNOLOGY LABORATORY			
S. N.	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Open pan evaporator	1	57000
2	Fermentor (Bioreactor)- Aerobic and Anaerobic	1 each	1000000
3	Fractional Distillation apparatus sieves and plate type	1	150000
4	Distillation flask with side arm	1	20000
5	Heating Mantle with regulator	2	15000
6	Beakers (100 ml)	5	90
7	Beakers (200 ml,)	5	150
8	Beakers (500 ml)	05 each	200
9	Round bottom flasks	5	1500
10	Experiments related raw materials.	Misc.	20000

3.6 MECHANICAL OPERATIONS AND SOLID HANDLING LABORATORY			
S. N.	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Ball Mill	1	75000
2	Jaw Crusher	1	70000
3	Sieve shaker with sieves	1	30000
4	Roller mill/Roll crusher	1	50000
5	Cyclone Separator	1	40000
5	Plate and frame filter press	1	80000
6	Mixer: Liquid-Liquid Mixer	1	40000
7	Solid-Liquid Mixer	1	40000
8	Centrifuge experimental set-up	1	50000
9	Ribbon Mixer	1	35000
10	Laboratory slurry mixture	1	80000
11	Experiments related raw materials.	Misc.	50000

4.1 PROCESS HEAT TRANSFER LABORATORY			
S. N.	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Equipment to measure thermal conductivity of metal rod.	1	57550
2	Heat transfer through compound wall equipment.	1	57200
3	Thermal conductivity (Insulating powder) Apparatus	1	58600
4	Forced convection apparatus	1	57800
5	Natural convection apparatus	1	54100
6	Open pen evaporator	1	56800
7	Drop and film wise condensation apparatus	2	65200
8	Parallel and counter flow apparatus for heat exchanger	1	60100
9	Shell and tube heat exchanger	1	63690
10	Double pipe heat exchanger for heat transfer coefficient	1	63686
11	Single effect evaporator	1	125339
12	Finned tube heat exchanger	1	113432
13	Experiments related raw materials.	Misc.	15000

4.2 CHEMICAL REACTION ENGINEERING			
S. N.	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Batch Reactor with 5 litter tank capacity, SS material	1	120000
2	Isothermal Plug Flow Reactor	1	120000
3	Isothermal Mixed Flow Reactor/Continuous Stirred Tank Reactor(2 litter)	1	120000
4	PFR and CSTR in series	1	125000
6	Reigerator (280 lt)	1	40000
7	Electronic Weighing Balance	1	25000
8	Experiments related raw materials.	Misc.	25000

4.3 CHEMICAL TECHNOLOGY-II LABORATORY			
S. N.	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Nephelometer(Turbudity Meter)	1	4000
2	Hydrometer	1	9000
3	Titration experimental set-up	2	2500
4	Laboratory Oven	1	25000
5	Electronic Weighing Balance(Digital)	1	30000
6	Electrolysis experimental set-up	1	1500
7	Experiments related raw materials.	Misc.	15000

4.4 BIO FERTILIZER & AGRO BIO CHEMICALS Lab)			
S.N	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1	Weighing balance	1	25000
2	Hot air Oven	1	30000
3	Laminar air flow chamber	1	60000
4	pH Meter	1	`10000
5	DO Meter with probe	1	15000
6	Refrigerator	1	40000
7	Cooling centrifuge	1	250000
8	Magnetic stirrer with hot plate	1	5000
9	Autoclave	1	40000
10	Incubator	1	35000
11	Anaerobic digestion system	1	30000
12	UV Visible Spectrophotometer	1	300000
14	Vortex Mixture	1	5000
15	Digital colony counter	1	25000
16	Double distillation unit-SS	1	70000
17	Light Microscope-phase contrast	1	40000
18	Orbital shaker incubator	1	150000
19	Vacuum pump	1	15000
20	Ice bath/water bath	2	20000
21	Bacterial identification kits	5	50000
22	Bioreactor	1	1000000

4.5 MASS TRANSFER- I & II LABORATORY			
S.N	**Equipment Name**	**Qty**	**Approx Cost (In Rs./item)**
1.	Liquid Diffusion Apparatus	01	111000
2.	Solid Diffusion Apparatus	01	114000
3.	Wetted Wall Column Apparatus	01	102000
4.	Tray Dryer	01	60000
5.	Rotary Dryer	01	60000
6.	Laboratory Batch Distillation Apparatus	01	130551

7.	Absorption Packed Column Apparatus	01	99958
8.	Electrical Oven	01	30952
9.	Bubble Cap Distillation Column(5 litter)	01	90000
10.	Liquid-Liquid Extractor Setup	01	50000
11.	Cooling Tower	01	112609
12.	Laboratory Crystallizer	01	105975
13	Digital Hygrometer	01	12875

NOTE:

In addition to the above, laboratories in respect of physics, chemistry, Computer Centre etc will be required for effective implementation of the course. Provision for photocopiers, PC facilities along with LCD Projection System etc. has also to be made.

10 - List of Participants / Experts

The following experts participated in various workshop for Developing the Curriculum's Structure and Contents of **Chemical Technology (Petro Chemical)** at I.R.D.T. Kanpur.

1. Mr. Rakesh Kumar, Head of Department (Chemical), Government Polytechnic, Kanpur
2. Mr. Ashwani Kumar Mishra, Head of Department (Chemical), Government Polytechnic, Kotwan, Mathura
3. Mr. Abhinav Jain, Head of Department (Chemical), Government Polytechnic, Mankeda, Agra
4. Dr. Shivcharan Prajapati, Lecturer (Paint Technology), Government Polytechnic, Bindki, Fatehpur
5. Mr. Vinod Prasad Sharma, Lecturer (Paint Technology), Government Polytechnic, Kanpur
6. Mr. Satyaveer Singh, Lecturer (Chemical), Government Polytechnic, Kotwan, Mathura
7. Dr. Shashi Bala Gautam, Lecturer (Chemical), Government Polytechnic, Kanpur
8. Mr. Mausam Kumar, Lecturer (P.M.T.), Government Polytechnic, Kanpur
9. Mr. Devesh Srivastava, Lecturer (Chemical), Government Polytechnic, Bindki, Fatehpur
10. Mrs. Kanchan Kushwaha, Lecturer (Petro-Chemical), Government Polytechnic, Kotwan, Mathura

11 . EVALUATION SCHEME

a. For Theory Courses:

(The weightage of Internal assessment is 40% and for End Semester Exam is 60%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

b. For Practical Courses:

(The weightage of Internal assessment is 60% and for End Semester Exam is 40%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

c. For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Note: The internal assessment is based on the student's performance in mid semester tests (two best out of three), quizzes, assignments, class performance, attendance, viva-voce in practical, lab record etc.

12 -Evaluation Method

ANNEXURE- 1

1. EVALUATION METHOD for THEORY

	Internal Assessment (40 marks)				External Assessment (60 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Written Test**	**Written Test**	**Attendance and Assignments**	**Pre – Semester Examination**	**End Semester Examination**
Portion	2 units	2 units	Regularly	All units	All units
Duration1hr	1hr	1hr	-	3hrs	3hrs
Exam Marks	20	20	20	60	60
Converted to	10	10	15	15	60
Tentative Schedule	5^{th} Week	10^{th} Week	Regularly	12^{th} -13^{th} Week	

IA1 and IA2: A written assessment test worth 20 marks should be conducted for two units. The marks earned (20 marks) will be converted to 10 marks. The best of the two assessments will be evaluated for an internal 10-mark assessment.

IA3: Assignments given after the completion of each unit, along with attendance throughout the semester, will be assessed for a total of 15 marks.

IA4: The pre-semester examination should follow the end-semester examination question pattern. The marks should be adjusted to 15 for internal assessment.

2. EVALUATION METHOD for PRACTICAL

	Internal Assessment (60 marks)				External Assessment (40 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Practical Test**	**Practical Test**	**Attendance and Practical Documentation**	**Practical Test and Quiz – Viva Voce**	**Practical Examination**
Portion	50% Practical	50% practical	All practical	All practical	All practical
Duration	3hrs	3 hrs	Regularly	3 hrs	3hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

IA1 and IA2: Complete all exercises and experiments as outlined and retain them for the practical test. The test should be conducted in accordance with the evaluation scheme. The best of the two practical tests will be internally evaluated for a total of 20 marks.

IA3: Maintain a practical file for each exercise while ensuring attendance throughout the semester. Submit the required documents for the practical file, quiz, and practical test along with a valid certificate (Progress Card). This will be assessed for 20 marks.

IA4: The pre-semester practical examination, quiz, and viva-voce should follow the end-semester practical examination pattern, with marks adjusted to 20 for internal assessment.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Diagram	**5**
C.	Procedure	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Practical Test	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR **EXTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Diagram	**5**
C.	Procedure	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Viva-Voce	**10**
	Total	**40**

3. EVALUATION METHOD for PRACTICUM (End Exam-Practical)

	Internal Assessment (60 marks)				External Assessment (40 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Practical Test**	**Practical Test**	**Attendance and Practical Documentation**	**Micro Project**	**Practical Examination**
Portion	50% practical	50% practical	All practical	All practical	All practical
Duration	3hrs	3 hrs	Regularly	Regularly	3hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

- **IA1 and IA2:** Complete all exercises and experiments as instructed and retain them for the practical test. The test should be conducted according to the evaluation scheme. The best of the two practical tests will be internally assessed for a total of 20 marks.
- **IA3:** Maintain a practical file for each exercise, ensuring attendance throughout the semester. Submit the required documents for the practical file, quiz, practical test, and end-semester examination, along with a valid certificate (Progress Card). This will be evaluated by 20 marks.
- **IA4:** Submit a micro-project report along with a fabrication model or analysis report. The performance of each student in the group will be assessed by both the laboratory supervisor and an internal examiner. This evaluation will contribute 20 marks.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Diagram	**5**
C.	Procedure	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Mini Project	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR **EXTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Diagram	**5**
C.	Procedure	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Viva-Voce	**10**
	Total	**40**

4. EVALUATION METHOD for PRACTICUM (End Exam-Theory)

	Internal Assessment (40 marks)						External Assessment (60marks)
	IA 1		IA 2		IA 3	IA 4	
Mode	**Written Test**	**Practical Test**	**Written Test**	**Practical Test**	**Attendance and Practical Documentation**	**Pre Semester Examination and Micro Project**	**End Semester Examination**
Portion	2 units	Practical related to the units	2 units	Practical related to the units	All unit	All Practical	All unit
Duration	1hr	3hrs	1hr	3 hrs	3hrs	Regularly	3hrs
Exam Marks	10	20	10	20	60	60	60
	30		30				
Converted to	10		10		15	15	60
Tentative Schedule	5th Week		10th Week		Regularly	12th -13th Week	

IA1 and IA2: A written assessment test worth 10 marks should be conducted for two **UNIT**s. Complete all exercises and experiments as outlined and retain them for the practical test worth 20 marks. The practical test should be conducted in accordance with the evaluation scheme. The total marks earned (30 marks) will be converted to 10 marks. The best of the two assessments will be internally evaluated for a total of 10 marks.

IA3: Attendance and the pre-semester examination should follow the end-semester examination question paper pattern. The marks should be adjusted to 15 for internal assessment.

IA4: Maintain a practical file for each exercise. Submit the required documents for the practical file, quiz/viva-voice, practical test, and end-semester examination, along with a valid certificate (Progress Card). This will be assessed for 40 marks. Additionally, submit a micro-project report along with a fabrication model or analysis report. The performance of each student in the group will be evaluated by both the laboratory supervisor and an internal examiner. The total of 60 marks will be converted to 15 marks.