DEPARTMENT OF TECHNICAL EDUCATION (DIPLOMA SECTOR)
UTTAR PRADESH

CURRICULUM FOR DIPLOMA PROGRAMME IN CHEMICAL ENGINEERING (3rd to 4th Semester)

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Semester System
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(EFFECTIVE FROM YEAR 2025-26)

Prepared By:

INSTITUTE OF RESEARCH, DEVELOPMENT & TRAINING, U.P., KANPUR

CONTENTS

PREFACE

An important issue generally debated amongst the planners and educator's 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 have 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 must 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 the 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 are being taken by the State Board of Technical Education, UP to revise the existing curricula as per the needs of the industry and make NSQF compliant.

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.

F.R. Khan
Director
Institute of Research Development & Training, Kanpur

1. ACKNOWLEDGEMENTS

We gratefully acknowledge the guidance and contribution received from the following people:

1. Sh. Narendra Kumar Bhushan, IAS Additional Chief Secretary, Technical Education Govt. of U.P. for his exemplary vision & approach.

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

3. All the participants from Polytechnics and other technical institutions for their professional input during curriculum workshops.

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

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2. SALIENT FEATURES

1. Name of the Programme	➢ Diploma in Chemical Engineering
2. Duration of the Programme	➢ Three years (Six Semesters)
3. Entry Qualification	➢ Matriculation or equivalent NEP-2020/NSQF Level 5 as Prescribed by State Board of Technical Education, U.P.
4. Pattern of the Programme	➢ Semester System
5. Ratio between theory and Practice	➢ 40% (Theory) / 60% (Practical)

1) <u>Industrial Training/Internship:</u>

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.

2) <u>Audit & Pathways</u>:

As per AICTE and NEP-2020 directives, Essence of Indian Knowledge & Tradition, Indian Constitution, Entrepreneurship & Startup, subjects on Environmental Studies have been incorporated in the curriculum.

3) <u>Student Centered Activities</u>:

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 co–curricular activities such as expert lectures, classroom seminars, games, hobby club like photography, painting, singing etc. declamation contests, field visits, NCC, NSS and other cultural activities, etc.

4) <u>Project work:</u>

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

3. EMPLOYMENT OPPORTUNITIES

Employment opportunities for diploma holders in Chemical Engineering are visualized in the following industries at various levels/positions:

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
- Distillery
- Paint and dyeing 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
- Defense laboratories
- Atomic energy establishments, etc.

iii) Boards and Corporations

iv) Entrepreneurs of small/tiny units, especially in food, agriculture, and chemical industries such as paints, soap, detergents, equipment repairing, etc.

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

4. (A) PROGRAM OUTCOMES (POS)

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

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.

4. (B) LEARNING OUTCOMES OF THE PROGRAM

After undergoing this program, 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 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 commiserating with laid specifications.
9.	Recognise the need for and have the ability to engage in lifelong learning
10.	Conduct experiments, analyses, interpret data and synthesis valid conclusion.
11.	Operate conventional machines by changing components as per specifications and ensure their effective functioning 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 equipment’s 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 the local language, both orally and in written form, with others.
23.	Manage resources effectively at workplace.

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

1. PROGRAM CORE COURSES

1. Fluid Flow Operations (Theory/Lab)
2. Chemical Process Calculations
3. Chemical Engineering Thermodynamics
4. Chemical Technology-I
5. Mechanical Operations & Solid Handling
6. Process Heat Transfer
7. Chemical Reaction Engineering
8. Chemical Technology-II
9. Mass Transfer Operations-I
10. Advance Skill Development (Open Elective-1)
11. Mass Transfer Operations-II
12. Process Equipment Design
13. Computer Applications in Chemical Engineering (Lab)
14. Entrepreneurship and Start-ups
15. Process Control Instrumentation

2. PROGRAM ELECTIVE COURSE

1. **Program Elective-1**
   Material Science and Technology
   OR
   Food Technology

2. **Program Elective-2**
   Plant Utilities
   OR
   Modern Separation Technique

3. PROJECT WORK, SEMINAR & INTERNSHIP IN INDUSTRY

Internship / In-House Project/ Industrial Training

4. AUDIT COURSES

1. Essence of Indian Knowledge and Tradition

6. STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING (352)

THIRD SEMESTER **CHEMICAL ENGINEERING (352)**

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	40		40	60	3	-	-	60	100
3.2	FLUID FLOW OPERATIONS (LAB)	PROGRAM CORE (PRACTICAL)	-	-	4	2	-	60	60	-	-	40	3	40	100
3.3	CHEMICAL PROCESS CALCULATIONS	PROGRAM CORE (THEORY)	3	-	-	3	40	-	40	60	3	-	-	60	100
3.4	CHEMICAL ENGINEERING THERMODYNAMICS	PROGRAM CORE (THEORY)	3	-	-	3	40	-	40	60	3	-	-	60	100
3.5	CHEMICALTECHNOLOGY- I	PROGRAM CORE (PRACTICUM)	2	-	4	4	40	-	40	60	3	-	-	60	100
3.6	MECHANICAL OPERATIONS & SOLID HANDLING	PROGRAM CORE (PRACTICUM)	2	-	4	4	-	60	60	-	-	40	3	40	100
3.7	SUMMER INTERNSHIP** (4 WEEKS)		-	-	-	2	-	-	50	-	-	-	-	-	50
#STUDENT CENTERED ACTIVITIES			-	-	12	-	-	50	50	-	-	-	-	-	50
TOTAL			**12**	**-**	**24**	**20**	**160**	**170**	**380**	**240**		**80**		**320**	**700**

****** 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.

STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING (352)

FOURTH SEMESTER **CHEMICAL ENGINEERING (352)**

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 (PRACTICUM)	2	-	4	4	40	-	40	60	3	-	-	60	100
4.2	CHEMICAL REACTION ENGINEERING	PROGRAM CORE (PRACTICUM)	2	-	4	4	40	-	40	60	3	-	-	60	100
4.3	CHEMICAL TECHNOLOGY-II	PROGRAM CORE (PRACTICUM)	2	-	2	3	40	-	40	60	3	-	-	60	100
4.4	MASS TRANSFER OPERATIONS-I	PROGRAM CORE (PRACTICUM)	2	-	2	3	40	-	40	60	3	-	-	60	100
4.5	PROGRAM ELECTIVE - 1	PROGRAM CORE (THEORY)	2	-	-	2	40	-	40	60	3	-	-	60	100
4.6	PROGRAM ELECTIVE - 2	PROGRAM CORE (THEORY)	2	-	-	2	40	-	40	60	3	-	-	60	100
4.7	ADVANCE SKILL DEVELOPMENT	(Q) OPEN ELECTIVE-1 (THEORY)	2	-	-	2	50	-	-	-	-	-	-	-	NA
		(Q) OPEN ELECTIVE-1 (Certification Course)					-	-	-	-	-	-	-	-	NA
4.8	(Q) ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	AUDIT COURSE	2	-	-	-	50	-	50	-	-	-	-	-	NA
# STUDENT CENTERED ACTIVITIES			-	-	8	-	-	50	50	-	-	-	-	-	50
TOTAL			**16**	**-**	**20**	**20**	**240**	**50**	**290**	**360**	**-**	**-**	**-**	**360**	**650**

NOTE: -

1. (Q) It is compulsory to appear and to pass the examination, but marks will not be included for percentage and division of obtained marks.
2. Advance skill development mention at the table provides the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agencies of repute of duration not less than 20 Hrs (Offline/Online).

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.

STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING

PROGRAM ELECTIVE-1

SR. NO.	SUBJECT NAME
1	MATERIAL SCIENCE AND TECHNOLOGY
2	FOOD TECHNOLOGY

PROGRAM ELECTIVE-2

SR. NO.	SUBJECT NAME
1.	PLANT UTILITIES
2.	MODERN SEPARATION TECHNIQUES

OPEN ELECTIVE-1

SR.NO.	(Q) THEORY COURSES NAME
1.	RENEWABLE ENERGY TECHNOLOGIES (Course offered by Polytechnic Institute)
2.	ENERGY EFFICIENCY AND AUDIT (Course offered by Polytechnic Institute)

SR.NO.	CERTIFICATE COURSES
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc) (Annexure-1)
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

ANNEXURE-I

LIST OF COURSES CONDUCTED BY TATA TECHNOLOGIES

1. Fundamentals of Innovation and Design Thinking
2. Product Design and Development
3. Product Verification and Analysis
4. Advanced Automobile
5. Electric Vehicle
6. Internet of Things
7. Advanced Manufacturing
8. Advanced Welding & Painting using Simulator
9. Industrial Automation and MES
10. Industrial Robotics
11. Inspection and Quality Control
12. Advanced Plumbing
13. AI and ML

7. DETAILED CONTENTS OF VARIOUS SUBJETS

THEORY	3.1 FLUID FLOW OPERATIONS	L	T	P
		2	-	-

COURSE OBJECTIVES

The subject gives knowledge of measurement of fluid flow and various fluid transportation machinery. The knowledge gained by this subject is directly used in different subjects studied in Chemical Engineering. The knowledge of this subject helps in installation of different fluid flow and transportation machinery.

LEARNING OUTCOMES

After studying this subject, the students will be able to:

- Distinguish between different types of fluids.
- Understand the concept of viscosity.
- Calculate flow rates.
- Calculate the power of pump required to do a certain pumping job.
- Understand the principles behind different flow meters.
- Install and calculate the flow rate of fluid with different flow meters in closed pipe line.
- Understand different flow control devices and to gain the knowledge of using different valves for different types of fluids and different flow situations.
- Understand the principle and working of different fluid flow machinery.
- Install the fluid flow machinery in closed pipelines.

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: Streamline 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, Nonreturn 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	L	T	P
		-	-	4

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

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

- Measurement of flow rate through flow meter by using flow measuring device such as Orifice meter, Venturi meter, Rotameter and weir.
- Measurement of Pressure, Density and Viscosity
- Computation of frictional losses in straight pipes.
- Demonstration of centrifugal pump and reciprocating pump.
- Demonstrate various types of valves.

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 pipefittings, 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 (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

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.

WEBSITES FOR REFERENCE:

http://swayam.gov.in

THEORY	3.3 CHEMICAL PROCESS CALCULATIONS	L	T	P
		3	-	-

COURSE OBJECTIVES

This subject equips the students with basic chemical engineering calculations. It is one of the core subjects. In this subject, students learn the fundamental concepts on which chemical engineering design is based. This subject helps the student to prepare the material and enthalpy balance of a process. It also helps them to calculate the quantity of material input and output of a process plant.

LEARNING OUTCOMES

After studying this course, the students will be able to:

- Understand scope of material and balance in chemical industries.
- Carry out conversions of units and equations.
- Have knowledge of the solution concentrations, specific gravity, density, molarity, normality, molality in the chemical industries.
- Find the contents and properties of given analysed gas.
- Find out quantity of material input and outputs of various unit operations.
- Calculate material input and outputs of chemical reactions to identify excess and limiting reactants.
- Calculate the enthalpy associated with a reaction.
- Carry out combustion calculations, proximate analysis and ultimate analysis

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 (06 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 (10 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, recycle and purge.

Unit-4: Material Balance with Chemical Reaction (10 Periods)

1. Limiting component, excess component, percent excess, yield, conversion and selectivity.
2. Combustion: proximate and ultimate analysis, air fuel ratio in Boiler/Furnaces, Theoretical oxygen/air required.
3. Basic numerical problems on Combustion.

Unit-5: Energy Balance (12 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.

INSTRUCTIONAL STRATEGY

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

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests

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

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	10
2.	06	15
3.	10	25
4.	10	25
5.	12	25
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.

LEARNINGOUTCOMES

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

- Know about basic concepts of thermodynamics.
- Understands laws of thermodynamics.
- Understand the application of laws of thermodynamics.
- Understand about the phase equilibrium.

COURSE CONTENTS

Unit-1: Introduction and Basic Concepts (06 Periods)
Thermodynamic systems: closed, open, isolated, homogenous, hetero geneous 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 (04 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.

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: Entropy (02 Periods)
Concept of entropy and Statement of third law of thermodynamics

Unit-6: 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 behaviour. 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.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests

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.	04	15
4.	10	25
5.	02	5
6.	10	25
Total	42	100

PRACTICUM	3.5 CHEMICAL TECHNOLOGY-I	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

After studying this course, the students will be able to:

- State basic principles of chemical process industry.
- Understand various processes used for manufacturing different compounds.
- Draw different types of flow sheet used in process industry.
- Describe engineering problems of various chemical industries.
- Understand use of various equipment/instruments used in process industry.

COURSE CONTENTS

Unit-1: Introduction (04 Periods)

1. Introduction to Major chemical process industries (such as fertilizer industries, fermentation industries, Oil refineries etc.) with reference to Indian resources, trade and export potential.
2. Process symbols used for various equipment and their uses.
3. Introduction to Good Manufacturing practices (GMP) and Good Laboratory Practices (GLP)

Unit-2: Sugar Industry (04 Periods)

1. Manufacturing of crystal sugar using cane sugar.
2. Various engineering problems encountered in sugar industry
3. Pollution abatement in sugar industry.

Experiment:

1. To measure the concentration of sugar solution by Refractometer.

Unit-3: Fermentation Industry (05 Periods)

1. Introduction of fermentation industry and classification of fermentation processes
2. Production of ethyl alcohol by fermentation
3. Various engineering problems encountered in fermentation industry
4. Pollution abatement in fermentation industry.

Experiment:

1. Preparation of vinegar using sugarcane juice etc.

Unit-4: 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. Hydrogenation of vegetable oils
4. Manufacturing of House disinfectants
5. Various engineering problems encountered in soaps and detergent industry.

Experiments:

1. Preparation of Soap by Coconut Oil
2. Preparation of Soap by mustard oil
3. Preparation of Detergent/liquid detergent.

Unit-5: Pulp and Paper Industry (06 Periods)

1. Different pulping process
2. Manufacturing of paper
3. Role of additives
4. Various engineering problems encountered in paper industry.
5. Pollution abatement in pulp and paper industry.

Experiment:

1. Recycling of Paper waste

Unit-6: Polymer and Paint Industry (03 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:

1. Preparation of phenyl formaldehyde Resin.
2. Preparation of Urea formaldehyde Resin
3. To prepare natural dye from different Raw Materials-Hibiscus petals or leaves, Vinegar or Water.
4. To determine the Acid Value of Castor oil.

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.

MEANS OF ASSESSMENT

- Demonstration of practical by using experimental set-up.
- Viva-Voce.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	10
2.	04	10
3.	05	20
4.	06	20
5.	03	20
6.	06	20
Total	28	100

PRACTICUM	3.6 MECHANICAL OPERATIONS AND SOLID HANDLING	L	T	P
		2	-	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.

LEARNING OUTCOMES

After completing this course, students will be able to:

- Understand the different properties of particulate solids and conduct their analysis.
- Select appropriate size reduction equipment based on its final application in various chemical industries, such as paint and pharmaceuticals.
- Apply theoretical knowledge to the fundamental design of solid-liquid and solid-gas separation operations.

COURSE CONTENTS

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

Unit-2: Characterization of Solid Particles **(**06 periods)

Sphere city, 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 (06 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.

Experiments:

Ex. 1To perform on experiment on Jaw crusher and find its crushing efficiency.
Ex. 2To determine the crushing efficiency by a roll crusher using a sample of solid particles.
Ex. 3To determine the crushing efficiency of ball-mill using a sample of solid particles.

Unit-4: Mechanical Separation (04 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.

Experiments:

Ex. 1 To find the sieve analysis of a given sample of solid particles by sieve shaker

Unit-5: Filtrations: (06 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.

Experiments:

Ex. 1 To find the rate of filtration with the help of filter press.
Ex. 2 To perform an experiment on rotary vacuum filter and find rate of filtration.
Ex. 3 To perform an experiment on cyclone separator.
Ex. 4 To perform an experiment on centrifuge.

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

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

Experiments:

Ex.1: To perform an experiment on ribbon mixer for solid-liquid mixing and find rate/time of mixing.
Ex. 2: To perform an experiment on industrial slurry mixer for solid-liquid mixing rate/time of mixing.

Instructional Strategy

Mechanicaloperationshavesignificantimportanceintheareaofchemicalengineering.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.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests

LIST OF RECOMMENDED 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	05
2.	06	15
3.	06	20
4.	04	20
5.	06	20
6.	04	20
Total	28	100

PRACTICUM	4.1 PROCESS HEAT TRANSFER	L	T	P
		2	-	4

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.

LEARNING OUTCOMES

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

- Understand basic laws of heat transfer
- Analyze problems involving steady heat conduction in simple geometries.
- Understand the concept of convective heat transfer and to analyze the problems involving heat transfer coefficients for natural and forced convection
- Analyze heat exchanger performance using LMTD and use it for parallel or counter flow
- Recognizer various type of heat exchanger working principle, and basic geometries of heat exchanger.
- Determine the overall heat transfer coefficient for a heat exchanger.
- Understand the concept of boiling and condenser
- Analyze the performance of evaporator

COURSE CONTENTS

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

Unit-2: Conduction (04 Periods)

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

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.

Unit-3: Convection (04 Periods)

1. Natural and forced convection, Dimensionless numbers: Reynold, Prandtl, Nusselt and Grash off, 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).

Experiments:

Ex.1 To calculate the heat transfer co-efficient for natural convection.

Ex.2 To calculate the heat transfer co-efficient for forced convection.

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.

Experiments:

Ex.1 To determine the heat transfer coefficient with the help of double pipe heat exchanger using parallel and counter flow.

Ex.2 To determine heat transfer coefficient in shell and tube heat exchanger using parallel and counter flow.

Ex.3 To determine heat transfer rate in 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,

Experiments:

Ex.1 To determine overall heat transfer co-efficient for an open pan evaporator.

Ex.2 To determine the rate of evaporation in a jacketed bottle (open pan evaporation).

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. Principles of Heat Transfer by Kreith, Harper and Row Publication.
3. Process Heat Transfer by Kern, McGraw Hill Publication.
4. Heat Transfer by McAdams, McGraw Hill Publication.
5. Heat Transfer by KA Gavahane, NiraliPublications.
6. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York
7. Heat Transfer 7th Ed. By Holman JP; McGraw Hill, New York
8. Applied Process Design for Chemical and Petrochemical Plants, Volume III by Ludwig, E; Gulf Publishing Co., Houston, Texas
9. Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India.
10. 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	10
3.	04	15
4.	06	25
5.	06	25
6.	02	10
7.	04	10
Total	**28**	**100**

PRACTICUM	4.2 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.

LEARNING OUTCOMES

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

- Know about rate of chemical reaction.
- Understand various types of reactors.
- Know the fundamentals of reactor design.
- Know the fundamentals of heterogeneous reacting system
- Understand the concept of catalysis

COURSE CONTENTS

Unit-1: Introduction to Chemical Kinetics (06 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. (08 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 (08 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: 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.	06	15
2.	08	30
3.	08	35
4.	06	20
Total	28	100

PRACTICUM	4.3 CHEMICAL TECHNOLOGY- II	L	T	P
		2	-	2

COURSE OBJECTIVES:

This subject will cover essential features of Chemical process industries regarding manufacture of various types of chemicals. The subject gives ideas to about various parameters like temperature, pressure, concentration and catalyst which affect the yield of the product. The subject will also give the knowledge about the sources of Raw Materials used in the Manufacturing of certain Inorganic Chemicals.

LEARNING OUTCOMES

After studying this course, the students will be able to:

- State basic principles of chemical industry.
- Understand various processes used for manufacturing different chemicals
- Draw different types of flow sheet used in process industry.
- Describe engineering problems of various chemical industries
- Describe pollution abatement methods in various chemical industries.

COURSE CONTENTS

Unit-1: Sulphuric Acid Industry (04 Periods)

1. Manufacturing process of Sulphuric Acid by Double Contact Double Absorption Method.
2. Manufacturing of oleum
3. Pollution abatement in Sulphuric Acid Industry

Experiments:

Ex.1 To Determine the Density of Sulphuric Acid.
Ex.2 To Determine the NTU of Sulphuric Acid.
Ex.3 To Determine the Percentage Purity of Sulphuric Acid.
Ex.4 Draw Process Flow Sheet of manufacturing of Sulphuric Acid by DCDA Process.

Unit-2: Fertilizer Industry (06 Periods)

1. N-P-K, Types of Fertilizers
2. Manufacturing of Ammonia
3. Manufacturing of Nitric acid
4. Manufacturing of Urea
5. Manufacturing of Single Super Phosphate
6. Manufacturing of Triple Super Phosphate
7. Engineering Problems and Pollution abatement in fertilizer industry

Experiments:

Ex.1 To Determine the NPK Value of Urea.
Ex.2 To Determine the phosphorus content of SSP & TSP.
Ex.3 To Perform the Proximate Analysis of Urea, SSP & TSP.
Ex.4 To find percentage purity of commercial Nitric Acid.
Ex.5 Draw Process Flow Sheet of manufacturing of Ammonia & Urea.

Unit-3: Chlor-alkali Industry (04 Periods)

1. Manufacturing process of Caustic Soda
2. Manufacturing process of Soda ash.
3. Engineering Problems in Chlor-alkali Industry

Experiments:

Ex.1 To find percentage purity of commercial hydrochloric acid.
Ex.2 To Determine the Density of Caustic Soda.
Ex.3 Electrolysis of Brine Solution to produce Chlorine, Hydrogen and Sodium Hydroxide.

Ex.4 Draw Process Flow Sheet of manufacturing of Caustic Soda

Unit-4: Flue and Industrial Gases (06 Periods)

1. Classification of Flue and Industrial Gases
2. Manufacturing process of Oxygen and Nitrogen from Air
3. Manufacturing process of Water Gas
4. Manufacturing process of Producer Gas

Unit-5: Cement Industry (08 Periods)

1. Classification of cement based on application
2. Constituents of cement and Gypsum
3. Manufacturing of Cement &Portland cement
4. Manufacturing of Plaster of Paris
5. Pollution abatement in cement industry

Experiments:

Ex.1 Draw Process Flow Sheet of manufacturing of Cement.

Ex.2 Analysis of Cement

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.

RECOMMENDED BOOKS

1. Dryden's Outlines of Chemical Technology by M. Gopal Rao and Marshal Sitting; Affiliated Press Pvt. Ltd.
2. Shreve's Chemical Process Industries by Jorge Austin; Tata McGraw Hill
3. Unit Process in Organic Synthesis by P.H. Groggins; Tata McGraw Hill
4. Chemical Technology Vol I and II by G. N. Pandey

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	20
2.	06	20
3.	04	20
4.	06	20
5.	08	20
Total	**28**	**100**

PRACTICUM	4.4 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

LEARNING OUTCOMES:

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

- Understand the fundamentals of mass transfer operations.
- Estimate the diffusivity for molecular diffusion in gases and liquids.
- Find out local and overall mass transfer coefficient for interphase mass transfer.
- Understand various mass transfer processes like diffusion, adsorption, stripping, humidification and drying.

COURSECONTENTS

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

Unit-2: Diffusion (07 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: equimolecular 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, channelling, weeping and loading.

Experiments:

Exp 1: 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 1: To determine the humidity using Hygrometer.

Exp 2: To determine temperature using wet bulb thermometer.

Unit-5: Drying (6 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. Dryingequipment (Description, construction, Working, advantage and disadvantage) – tray dryer, rotary dryer, spray dryer, fluidized bed dryer and application.

Experiments:

Exp 1: To study drying operation and calculate time of drying using tray-dryer

Exp 2: 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

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	01	05
2	07	25
3	07	25
4	07	25
5	06	20
Total	28	100

THEORY	4.5 MATERIAL SCIENCE AND TECHNOLOGY (POE 1)	L	T	P
		2	-	-

COURSE OBJECTIVES

Lot of developments has taken place in the field of materials. New materials are being developed and it has become possible to change the properties of materials to suit the requirements. Diploma holders in this course are required to make use of different materials for various applications. For this purpose, it is necessary to teach them basics of metal structure, properties, usage and testing of various ferrous and non-ferrous materials and various heat treatment processes. This subject aims at developing knowledge about the characteristics, testing and usage of various types of materials used in industries.

LEARNING OUTCOMES

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

- Understand different types of bonding in materials
- Select and characterize engineering materials
- Understand different properties of materials used in industries
- Distinguish between various engineering materials based on mechanical, magnetic and electrical properties.
- Identify materials for applications in chemical process industry.

COURSE CONTENTS

Unit-1: Introduction (04 Periods)

1. Introduction: Importance of materials, Periodic table, Chemical bonding.
2. Crystallography and imperfections: Concept of unit cell, space lattice, Bravais lattices, common crystal structures. X-ray crystallography techniques, Imperfections, Defects &Dislocations in solids.

Unit-2: Properties of Materials (08 Periods)

1. Mechanical Properties and Testing: Stress strain diagram, Ductile and brittle materials, stress vs strength, toughness, hardness, fracture, fatigue and creep. Testing, such as Strength testing, Hardness testing, Impact testing, Fatigue testing Creep testing, Non-destructive testing (NDT)
2. Magnetic Properties: Concept of magnetism-Dia, para, ferro magnetic materials, Soft and hard magnetic materials.
3. Electric Properties: Concept of conductor, insulator and semiconductor. Intrinsic and extrinsic semi-conductors, Diffusion of Solid, Super conductivity, Type I & II superconductors. High temperature superconductors.

Unit-3: Phase Diagram and Equilibrium Diagram (04 Periods)

Unitary and Binary diagrams, Phase rules, Types of equilibrium diagrams: solid solution type, Iron-carbon equilibrium diagram.

Unit-4: Ferrous and Non-ferrous Materials and Alloys (06 Periods)

1. Ferrous materials: Types of iron and steel, Manufacture of steel, its properties and uses.

2. Heat Treatment: Annealing, Normalizing, Quenching, Tempering and Case hardening, Time Temperature Transformation (TTT) diagrams
3. Non-Ferrous Materials and Alloys: Non-ferrous metals- Cu, Al, Zn, Cr, Ni and its applications. Various types of brass, bronze, their properties and uses. Aluminium alloys such as Duralumin.

Unit-5: Ceramics and Other Advanced Materials (06 Periods)

1. Ceramics: Structure, types, properties and applications of ceramics.
2. Introduction to glass and refractories.
3. Introduction to advanced material (Biomaterials, Nano Materials, Green Building Materials and composites)

INSTRUCTIONAL STRATEGY

Audio-visuals can be used as teaching aid. Processes of Heat-treatment can be shown to students in workshop.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
- Mid-term and end-term written tests

RECOMMENDED BOOKS

1. Material Science & Engineering by William D. Callisster Jr.; John Wiley and Sons Inc
2. Elements of Material Science & Engineering by Van Vlack; John Wiley &Sons.
3. Material Science by V. Raghvan; Prentice Hall of India.
4. Material Science by Narula; Tata Mc GrawHill.
5. Science of Materials Engineering by Srivastava, Srinivasan; New Age International

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	04	15
2	08	20
3	04	15
4	06	25
5	06	25
Total	28	100

THEORY	4.5 FOOD TECHNOLOGY (POE 1)	L	T	P
		2	-	-

COURSE OBJECTIVE:

To impart knowledge to the students about advanced technology in food science and recent trends adapted in food industry.

LEARNING OUTCOMES:

Upon successful completion of this course, the student should be able to

- Explain properties of food in relation to its quality.
- Elucidate the theory and applications of unit operations in food processing.
- Describe the various equipments used in food industry.
- Explain the factors affecting the growth and survival of food microorganisms.
- Describe various food preservation techniques.

COURSE CONTENT

UNIT 1: (05 Periods)

Fundamentals of Food Process Engineering, Application of Quantitative methods of Material & Energy balances in Food Engineering Practices. Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control

Unit 2: (05 Periods)

Fluid Flow, Thermal Process Calculations, Refrigeration, Evaporation and Dehydration operations in Food Processing

Unit 3: (06 Periods)

Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – metal, Glass and Flexible packaging, Canning Procedures for Fruits, Vegetables, Meat, Poultry and Marine Products

Unit 4: (06 Periods)

Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling, Packaging Methods

Unit 5: (06 Periods)

Cereal, Grains, Pulses, Vegetables, Fruits, Spices, Fats and Oils, Bakery, Confectionary and Chocolate Products, Soft and Alcoholic Beverages, Dairy Products, Meat, Poultry and Fish Products

INSTRUCTIONAL STRATEGY

Audio-visuals can be used as teaching aid. Processes of various food productions can be shown to students in workshop.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests
  Mid-term and end-term written tests

RECOMMENDED BOOKS:

1. B Sivasankar, 'Food Processing and Preservation, 'PHI Learning Pvt. Ltd.,
2. Rao DG, ' Fundamentals of Food Engineering', PHI Learning Private Ltd.,.
3. R Paul Singh, Dennis R Heldman, 'Introduction to Food Engineering,'4/e, Elsevier.
4. Da-Wen Sun, 'Emerging Technologies for Food Processing, Elsevier.

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**

THEORY	4.6 PLANT UTILITIES (POE 2)	L	T	P
		2	-	-

COURSE OBJECTIVE:

The objective of this subject is to teach the students about requirement of different utilities for the process plant and effective utilization. Main utilities required for process plants are water, steam, air and refrigerants. Steam and non-steam heating media is used for conversion of raw material to products in reactors and to elevate the temperature in the chemical processes. Similarly, refrigeration is important to maintain the temperature in the process plant. Compressed air and process air is used in processes and instrument air is used in pneumatic devices and controls.

COURSE OUTCOMES

After studying this course, the students will be able to:

- Acquire the knowledge for selection of different utilities.
- Understand basic calculations involved in steam generation, psychometric operation and refrigeration.
- Describe the different equipment used to run the process plant with different utilities.
- State the principles involved during water treatment
- Know different fuels used in boilers

COURSE CONTENTS

Unit-1: Importance and Classification of utilities: (04 Periods)

1. Hard and soft water, requisites of industrial water and its uses.
2. Methods of water treatment such as chemical softening and demineralization, resins used for water
3. Softening and reverse osmosis. Effects of impure boiler feed water.

Unit-2: Steam and steam generation: (06 Periods)

1. Properties of steam, problems based on steam, types of steam generator such as solid fuel fired boiler, waste gas fired boiler and fluidized bed boiler.
2. Scaling and trouble shooting. Steam traps and accessories.

Unit3: Refrigeration: (06 Periods)

Refrigeration cycles, methods of refrigeration used in industry and different types of refrigerants such as monochloro-difluro methane, chlorofluro carbons and brins. Refrigerating effects and liquefaction processes.

Unit-4: Compressed air: (08 Periods)

1. Classification of compressor, reciprocating compressor, single stage and two stage compressor, velocity diagram for centrifugal compressor, silp factor, impeller blade Shape. Properties of air – water vapors and use of humidity chart.
2. Equipments used for humidification, Dehumidification and cooling towers.

Unit-5: Fuel and waste disposal: (04 Periods)

1. Types of fuel used in chemical process industries for power generation such as natural gas, liquid petroleum fuels, coal and coke. Internal combustion engine, petrol and diesel engine.
2. Waste disposal.

INSTRUCTIONAL STRATEGY

- Teacher should focus on conceptual clarity.
- 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
- Mid-term and end-term written tests

RECOMMENDED BOOKS

1. Thermal Engineering by P.L. Ballaney; Khanna Publisher New Delhi
2. Industrial water treatment by S.T. Powel; McGraw Hill New York
3. Boiler Operations by Chattopadhyay; Tata McGraw Hill, New Delhi
4. Perry's chemical Engineer's Handbook by Perry R.H. Green D.W; McGraw Hill, New York
5. Elements of Heat Engines Vol. II,III by R.C. Patel C.J.Karmchandani; Acharya Book Depot Vadodara
6. Refrigeration & Air conditioning by P.N. Ananthanarayan; Tata McGraw Hill
7. Industrial chemistry by Jain & Jain; Tata McGraw Hill

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	15
2.	06	20
3.	06	20
4.	08	30
5.	04	15
Total	**28**	**100**

THEORY	4.6 MODERN SEPERATION TECHNIQUES (POE 2)	L	T	P
		2	-	-

COURSE OBJECTIVES:
To identify about the kind of separation processes in general and novel separations are integral part of any process chemical industries.

LEARNING OUTCOMES:
On completion of the course the students will be able to
• Differentiate the conventional techniques and modern techniques
• Understand the principles of modern separation techniques
• Application of this techniques in Industries
• Identify the importance of economics involved in its applications

COURSE CONTENT

Unit-1: (06 Periods)
Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipment's design and Applications. Zone Melting

Unit-2: (06 Periods)
Chroma to graphic techniques, Equipment and Commercial processes, Molecular Sieves.

Unit-3: (04 Periods)
Cryogenic, Supercritical fluid extraction and Azeotropic separation.

Unit-4: (06 Periods)
Principle of membrane separations process; Classification: Reverse osmosis, Ultra-filtration, Micro-filtration, Nano-filtration and Dialysis; Membrane modules and application; Electro-dialysis. Per-evaporation and gas separation using membranes; Electrophoresis; Liquid membranes.

Unit-5: (06 Periods)
Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Surface Adsorption, Nature of foams.

INSTRUCTIONAL STRATEGY
- Teacher should focus on conceptual clarity.
- 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
- Mid-term and end-term written tests

RECOMMENDED BOOKS:
1. Schoen H. M., New Chemical Engineering Separation Techniques, 2nd Edition, Inter Science Publications, New York.
2. Seader, J.D, and Henley E.J.,Separation 'Process Principles,' John Wiley & Sons, Inc.
3. Perry R.H. and. Green D.W.,Perry's Chemical Engineers Handbook, 6th Edition. McGraw Hill, New York.
4. King C.J. 'Separation Processes', 4th Edition, Tata McGraw Hill, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

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

THEORY	4.7 RENEWABLE ENERGY TECHNOLOGIES (OE-1)	L	T	P
		2	-	-

COURSE LEARNING OBJECTIVES:

The objective of this course is to provide a comprehensive understanding of the current and future global energy scenario, with a focus on non-conventional energy sources. It aims to introduce the fundamentals of solar and wind energy systems, explore various forms of bioenergy and their applications, and help students identify and evaluate different alternative energy sources.

LEARNING OUTCOMES:

Upon completion of the course the students will be able to

- Understand the present and future energy scenario of the world.
- Understand various methods of solar energy harvesting.
- Identify various wind energy systems.
- Evaluate appropriate methods for Bio energy generations from various Bio wastes.
- Identify suitable energy sources for a location.

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.

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

THEORY	4.7 ENERGY EFFICIENCY AND AUDIT (OE-1)	L	T	P
		2	-	-

COURSE LEARNING OBJECTIVES:

This course aims to develop the competency to undertake energy efficiency measures and conduct energy audits through practical and industry-relevant learning experiences.

LEARNING OUTCOMES:

Upon completion of the course the students will be able to

- Undertake energy efficient activities
- Use energy efficient pumps, compressors and blowers
- Use energy efficient Air Compressors and DG sets
- Use energy efficient Lighting Systems
- Apply energy efficient electrical machines.
- Use Co-generation and relevant tariff for reducing losses in facilities.

COURSE CONTENT

Unit – 1 **(4 Periods)**

Introduction to Energy Efficiency
Energy Scenario: Energy demand and supply, National scenario.
Energy Efficiency and Energy Conservation; concepts
Indian Electricity Act 2001; relevant clauses of energy conservation
BEE and its Roles
Star Labelling: Need and its benefits.

Unit – 2 **(5 Periods)**

Pumping Systems, Fans and Blowers
Factors affecting pump performance
Efficient Pumping system operation
Energy conservation opportunities in Pumping systems
Fan types, flow control strategies
Fan performance Assessment
Energy Conservation opportunities in Pumping systems
Tips for energy saving in fans and blowers

Unit – 3 **(5 Periods)**

Air Compressors and Diesel Power Generator sets
Classification of compressors
Pneumatic System components
Effect of various parameters on efficiency of Compressor
Capacity control of Compressors
Checklist for Energy Efficiency in Compressed air systems
Operating guidelines for diesel generator, operational factors
Effects of improper ventilation of genset
Energy saving measures for DG sets

Unit – 4 **(4 Periods)**

Energy Conservation in Lighting System
Replacing Lamp sources
Using energy efficient luminaries
Using light controlled gears
Installation of separate transformer / servo stabilizer for lighting

Periodic survey and adequate maintenance programs
Innovative measures of energy savings in lighting
Open Elective Courses 454

Unit– 5 **(6 Periods)**

Energy Efficient Electrical Machines
Need for energy conservation in induction motor and transformer
Energy conservation techniques in induction motor by:
Energy conservation techniques in Transformer
Energy Conservation Equipment: Soft starters, Automatic star delta convertor, Variable Frequency Drives, Automatic p. f. controller (APFC)
Energy efficient motor; significant features, advantages, applications and Limitations
Energy efficient transformers, amorphous transformers; epoxy Resin cast transformer / Dry type of transformer
Aggregated Technical and commercial losses (ATC), Technical losses; causes and measures to reduce, Commercial losses: pilferage, causes and remedies
Application of tariff system to reduce energy bill
Co-generation and Tariff; concept, significance for energy conservation

Unit– 6 **(4 Periods)**

Energy Audit of Electrical Systems
Energy audit (definition as per Energy Conservation Act)
Energy audit instruments and their use
Questionnaire for energy audit projects
Energy flow diagram (Sankey diagram)
Simple payback period, Energy Audit procedure (walk through audit and detailed audit).
Energy Audit report format.

INSTRUCTIONAL STRATEGY

- Teacher should focus on conceptual clarity.
- 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. Guidebooks No. 1 and 3 for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency (BEE), Bureau of Energy Efficiency (Statutory body under Ministry of Power, Government of India) (Fourth Edition 2015).
2. O.P. Gupta, Energy Technology, Khanna Publishing House, Delhi, Edition 2018, (ISBN: 978-93-86173-683).
3. Henderson, P. D., India - The Energy Sector, University Press, Delhi, 2016. ISBN: 978-0195606539
4. Turner, W. C., Energy Management Handbook, Fairmount Press, 2012, ISBN 9781304520708
5. Sharma, K. V., Venkataseshaiah; P., Energy Management and Conservation, I K International Publishing House Pvt. Ltd; 2011 ISBN 9789381141298
6. Mehta,V. K., Principles of Power System, S. Chand andCo.New Delhi, 2016, ISBN

9788121905947
7. Singh, Sanjeev; Rathore, Umesh, Energy Management, S K KatariaandSons, New Delhi ISBN-13: 9789350141014.
8. Desai, B. G.; Rana, J. S.; A. Dinesh, V.; Paraman, R., Efficient Use and Management of Electricity in Industry, Devki Energy Consultancy Pvt. Ltd.
9. Chakrabarti, Aman, Energy Engineering And Management, e-books Kindle Edition

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	04	15
2.	05	17
3.	05	17
4.	04	15
5.	06	21
6.	04	15
Total	28	100

AUDIT COURSE	4.8 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 OUTCOMES

Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:

- Overview, importance, and relevance of the Indian Knowledge System, including Vedas, Upavedas, Vedangas, and Upangas.
- Relevance of science and spirituality, and contributions of ancient Indian science and technology.
- Basic principles of Yoga, benefits of holistic healthcare, and integration with modern healthcare.
- Practical applications and case studies of the Indian Knowledge System's relevance today.

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

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	16	50
2.	06	20
3.	04	15
4.	02	15
Total	**28**	**100**

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

1. 15 Marks for general behaviour and discipline (by HODs in consultation with all the teachers of the department)

2. 10 Marks for attendance as per following: (by HODs in consultation with all the teachers of the department)
   2.1. 75 - 80% 06 Marks
   2.2. 80 - 85% 08 Marks
   2.3. Above 85% 10 Marks

3. 25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSS activities as per following: (by In-charge Sports/NCC/Cultural/Co-curricular/NSS)
   3.1. 25 - State/National Level participation
   3.2. 20 - Participation in two of above activities
   3.3. 15 - Inter-Polytechnic level participation

9. RESOURCE REQUIREMENT

9.1. PHYSICAL RESOURCES

9.1.1. Space requirement

Norms and standards laid down by All India Council for Technical Education (AICTE) are to be followed to work out space requirement in respect of classrooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

9.1.2. Equipment Requirement:

Following Laboratories are required for diploma programme in Chemical Engineering (3rd and 4th Semester)

- Fluid Flow Operations
- Chemical technology-I
- Mechanical Operations and Solid Handling
- Process Heat Transfer
- Chemical Reaction Engineering
- Chemical Technology-II

3.2 FLUID FLOW OPERATIONS LABORATORY

S. No.	Equipment Name	Qty
1.	Density Bottles (5,10,100 ml)	6
2.	Hydrometer	1
3.	Ostwald Viscometer/Digital Viscometer	1
4.	Redwood Viscometer/Digital Viscometer	1
5.	U-Tube manometer (For Demonstration Purposes)	1
6.	Reynolds Experiment set-up	1
7.	Bernoulli's Theorem Experiment Set-up	1
8.	Venturi Meter & Orifice Meter Experiment Set-up	1
9.	Vacuum pump with experiment set-up	1
10.	Determination of Frictional losses through pipe	1
11.	Centrifugal pumps and reciprocating pump (For Demonstration Purposes)	1 Each
12.	Rotameter, Venturi meter, Orifice meter, pitot tube	1
13.	Globe valve, check valves, Butterfly valve, Needle valve, Gate Valve, Diaphragm Valve	1 Each
14.	Experiments related raw materials	Misc.

3.5 CHEMICAL TECHNOLOGY-I LABORATORY		
S. No.	**Equipment Name**	**Qty**
1.	Open pan evaporator	1
2.	Fermenter (Bioreactor)- Aerobic and Anaerobic	1 each
3.	Distillation Apparatus	1
4.	Distillation flask with side arm	1
5.	Heating Mantle	2
6.	Beakers (100 ml, 200 ml, 500 ml)	05 each
7.	Round bottom flasks	5
8.	Experiments related raw materials.	Misc.

3.6 MECHANICAL OPERATIONS AND SOLID HANDLING LABORATORY		
S. N.	**Equipment Name**	**Qty**
1.	Ball Mill	1
2.	Jaw Crusher	1
3.	Sieve shaker with sieves	1
4.	Roller mill/Roll crusher	1
5.	Cyclone Separator	1
6.	Plate and frame filter press	1
7.	Mixer: Liquid-Liquid Mixer and Solid-Liquid Mixer	2
8.	Centrifuge experimental set-up	1
9.	Ribbon Mixer	1
10.	Industrial slurry mixer	1
11.	Experiments related raw materials.	Misc.

4.1 PROCESS HEATTRANSFER LABORATORY		
S. N.	**Equipment Name**	**Qty**
1.	Equipment to measure thermal conductivity of metal rod.	1
2.	Heat transfer through compound wall equipment.	1
3.	Thermal conductivity (Insulating powder) Apparatus	1
4.	Forced convection apparatus	1
5.	Natural convection apparatus	1
6.	Open pen evaporator	1
7.	Drop and film wise condensation apparatus	2
8.	Parallel and counter flow apparatus for heat exchanger	1
9.	Shell and tube heat exchanger	1
10.	Double pipe heat exchanger for heat transfer coefficient	1
11.	Single effect evaporator	1
12.	Finned tube heat exchanger	1
13.	Experiments related raw materials.	Misc.

4.2 CHEMICAL REACTION ENGINEERING		
S. N.	**Equipment Name**	**Qty**
1.	Batch Reactor	1
2.	Isothermal Plug Flow Reactor	1
3.	Isothermal Mixed Flow Reactor/Continuous Stirred Tank Reactor	1
4.	PFR and CSTR in series	1
5.	Electronic Weighing Balance	1
6.	Experiments related raw materials.	Misc.

4.3 CHEMICAL TECHNOLOGY-II LABORATORY		
S. N.	**Equipment Name**	**Qty**
1.	Nephelometer	1
2.	Hydrometer	1
3.	Titration experimental set-up	2
4.	Laboratory Oven	1
5.	Electronic Weighing Balance	1
6.	Electrolysis experimental set-up	1
7.	Experiments related raw materials.	Misc.

9.1.3 Furniture Requirement

Norms and standards laid down by AICTE -APH (latest) be followed for working out furniture requirement for diploma courses

9.2 Human Resources:

Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, workload norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE.

10. EVALUATION STRATEGY INTRODUCTION

Evaluation plays an important role in the teaching-learning process. The major objective of any teaching-learning endeavour is to ensure the quality of the product which can be assessed through learner's evaluation. The purpose of student evaluation is to determine the extent to which the general and the specific objectives of curriculum have been achieved. Student evaluation is also important from the point of view of ascertaining the quality of instructional processes and to get feedback for curriculum improvement. It helps the teachers in determining the level of appropriateness of teaching experiences provided to learners to meet their individual and professional needs. Evaluation also helps in diagnosing learning difficulties of the students. Evaluation is of two types: Formative and Summative (Internal and External Evaluation)

Formative Evaluation

It is an on-going evaluation process. Its purpose is to provide continuous and comprehensive feedback to students and teachers concerning teaching-learning process. It provides corrective steps to be taken to account for curricular as well as co-curricular aspects.

Summative Evaluation

It is carried out at the end of a unit of instruction like topic, subject, semester or year. The main purpose of summative evaluation is to measure achievement for assigning course grades, certification of students and ascertaining accountability of instructional process. The student evaluation has to be done in a comprehensive and systematic manner since any mistake or lacuna is likely to affect the future of students. In the present educational scenario in India, where summative evaluation plays an important role in educational process, there is a need to improve the standard of summative evaluation with a view to bring validity and reliability in the end-term examination system for achieving objectivity and efficiency in evaluation.

STUDENTS' EVALUATION AREAS

The student evaluation is carried out for the following areas:

- Theory
- Practical Work
- Project Work
- Industrial Training

A. Theory

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems. The formative evaluation for theory subjects may be caused through sessional /class-tests, home-assignments, tutorial-work, seminars, and group discussions etc. For end-term evaluation of theory, the question paper may comprise of three sections.

Section-I

It should contain objective type items e.g. multiple choice, matching and completion type. Total weightage to Section-1 should be of the order of 20 percent of the total marks and no choice should be given in this section. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.

Section-II

It should contain short answer/completion items. The weightage to this section should be of the order of 40 percent of the total marks. Again, no choice should be given in section-II

Section-III

It may contain two to three essay type questions. Total weightage to this section should be of the order of 40 percent of the total marks. Some built-in, internal choice of about 5

Table: Suggested Weightage to be given to different ability levels

Abilities	**Weight to be assigned**
Knowledge	10-30 percent
Comprehension	40-60 percent
Application	20-30 percent
Higher than application i.e. Analysis, Synthesis and Evaluation	Upto 10 percent

B. Practical Work

Evaluation of students performance in practical work (Laboratory experiments, Workshop practical's/field exercises) aims at assessing students ability to apply or practice learnt concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behaviour and it should be followed by viva-voce.

C. Internship / In-House Project/ Industrial Training

The purpose of evaluation of project work is to assess students ability to apply, in an integrated manner, learnt knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The formative and summative evaluation may comprise of weightage to nature of project, quality of product, quality of report and quality of presentation followed by viva-voce. Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of materials, industrial processes, practices in the industry/field and their ability to engage in activities related to problem-solving in industrial setting as well as understanding of application of learnt knowledge and skills in real life situation. The formative and summative evaluation may comprise of weightages to performance in testing, general behaviour, quality of report and presentation during viva-voce.

11. RECOMMENDATIONS FOR EFFECTIVE IMPLEMENTATION OF CURRICULUM

This curriculum document is a Plan of Action and has been prepared based on exhaustive exercise of curriculum planning and design. The representative sample comprising selected senior personnel (lecturers and HODs) from various institutions and experts from industry/field have been involved in curriculum design process. The document so prepared is now ready for its implementation. It is the faculty of polytechnics who have to play a vital role in planning instructional experiences for the courses in four different environments viz. classroom, laboratory, library and field and execute them in right perspective. It is emphasized that a proper mix of different teaching methods in all these places of instruction only can bring the changes in stipulated student's behaviour as in the curriculum document. It is important for the teachers to understand curriculum document holistically and further be aware of intricacies of teaching-learning process (T-L) for achieving curriculum objectives. Given below are certain suggestions which may help the teachers in planning and designing learning experiences effectively. These are indicative in nature and teachers using their creativity can further develop/refine them. The designers of the programme suggest every teacher to read them carefully, comprehend and start using them.

(A) Broad Suggestions:

1. Curriculum implementation takes place at programme, course and class-room level respectively and synchronization among them is required for its success. The first step towards achieving synchronization is to read curriculum document holistically and understand its rationale and philosophy.
2. An academic plan needs to be prepared and made available to all polytechnics well in advance. The principals have a great role to play in its dissemination and, percolation upto grass-root level. Polytechnics, in turn are supposed to prepare institutional academic plan.
3. HOD of every Programme Department along with HODs and in-charge of other departments are required to prepare academic plan at department level referring to institutional academic plan.
4. All lecturers/Senior lecturers are required to prepare course level and class level lesson plans referring departmental academic plan.

(B) Course Level Suggestions

Teachers are educational managers at classroom level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives.

Polytechnic teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practical, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practical and field experiences. Teachers are also required to do all these activities within a stipulated period of time. It is essential for them to use the given time judiciously by planning all above activities properly and ensure execution of the plan effectively.

Following is the gist of suggestions for subject teachers to carry out T-L process effectively:

1. Teachers are required to prepare a course plan, taking into account departmental academic plan, number of weeks available and courses to be taught.

2. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of contents to be covered, learning material for execution of a lesson plan. They may follow steps for preparing lesson plan e.g. drawing attention, state instructional objectives, help in recalling pre-requisite knowledge, deliver planned subject content, check desired learning outcomes and reinforce learning etc.
3. Teachers are required to plan for expert lectures from field/industry. Necessary steps are to plan in advance, identify field experts, make correspondence to invite them, take necessary budgetary approval etc.
4. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The assignments and seminars can be thought of as terminal outcome of library experiences.
5. Concept and content-based field visits may be planned and executed for such content of course which is abstract in nature and no other requisite resources are readily available in institute to impart them effectively.
6. There is a dire need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem-based learning/activity learning/ experiential learning approach effectively. The development of lab instruction sheets for the course is a good beginning to provide lab experiences effectively.
7. Planning of progressive assessment encompasses periodical assessment in a semester, preparation of proper quality question paper, assessment of answer sheets immediately and giving constructive feedback to every student
8. The student-centered activities may be used to develop generic skills like task management, problem solving, managing self, collaborating with others etc.
9. Where ever possible, it is essential to use activity-based learning rather than relying on delivery based conventional teaching all the time.
10. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.
11. Students be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.
12. Students may be given relevant and well thought out project assignments, which are purposeful and develop practical skills. This will help students in developing creativity and confidence for their gainful employment.
13. A Project bank may be developed by the concerned department of the polytechnics in consultation with related Industry, research institutes and other relevant field organizations in the state.

12. LIST OF EXPERTS

1. Shri Rakesh Kumar, HOD Chemical Engineering, Govt. Poly. Kanpur.
2. Dr. Shashi Bala, Lecturer, Chemical Engineering, Govt. Poly. Kanpur.
3. Shri. Abhinav Jain, Lecturer Chemical Engineering, Govt. Poly. Sutawali, Amroha.
4. Dr. Anuj Chaturvedi, Lecturer, Chemical Engineering, MMIT, Auraiya.
5. Shri. Devesh Kumar Srivastava, Lecturer, Chemical Engineering, Govt. Poly. Bindki, Fatehpur.
6. Shri. Pawan Kumar, Lecturer, Chemical Engineering, Govt. Poly. Firozabad.
7. Basudha Maurya, Lecturer, Chemical Engineering, Govt. Poly. Kanpur.
8. Shri. Yatendra Kumar, Lecturer, Chemical Engineering, Govt. Poly. Kotvan Mathura.
9. Shri. Satyaveer Singh, Lecturer, Chemical Engineering, Govt. Poly. Kotvan Mathura.

13. EVALUATION SCHEME GUIDELINES: As Per AICTE ATTACHED (ANNEXURE- 1)

a. For Theory Courses:

(The weightage of Internal assessment is 40% and for End Semester Exam is 60%) The student must 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

ANNEXURE- 1

Evaluation Method for Practicum Based Course Paper (End Exam: PRACTICAL)

Internal Assessment (60 Marks)			**External Assessment (40 Marks)**		
Mode	Sessional Exam (02 Best of 03)	Practical Test	Practical Documentation	Attendance and Assignment	Practical Exam
Portion	2 Units	100% Practical	All Practicals	All Units	All Practicals
Duration	1 Hr	3 Hrs	Regularly Monitored by Faculty	Regularly	4Hrs
Exam Marks	20	20	10	10	40
Tentative Schedule	6th Week	12th Week	13th Week	14th – 15th Week	Semester End Exam

NOTE:

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

2. Maintain a practical file for each exercise. Submit the document for the practical file with a valid certificate (Progress Card) and Lab/classroom attendance and evaluate it for 10 marks.

3. Submit a micro project report along with the fabrication model/analysis report. The performance of each student in the group will be evaluated by the laboratory supervisor and an internal examiner evaluate it for 10 marks.

Evaluation Method For Practical Based Course Paper (End Exam: PRACTICAL)

Internal Assessment (60 Marks)					External Assessment (40 Marks)
Mode	Practical Test	Practical Test	Attendance and Practical Documentation	Micro Project	Practical Exam
Portion	50% Practicals	50% Practicals	All Practicals	All Practicals	All Practicals
Duration	3Hr	3 Hrs	Regularly	Regularly	4 Hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	6th Week	12th Week	13th Week	14th – 15th Week	Semester End Exam

NOTE:

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

2. Maintain a practical file for each exercise. Submit the document for the practical file with a valid certificate (Progress Card) and Lab/classroom attendance and evaluate it for 20 marks.

3. Submit a micro project report along with the fabrication model/analysis report. The performance of each student in the group will be evaluated by the laboratory supervisor and an internal examiner evaluate it for 20 marks.

Evaluation Method for THEORY Based Course Paper

Internal Assessment (40 Marks)					External Assessment
Mode	Sessional Exam-1	Sessional Exam-2	Sessional Exam-3	Attendance and Assignment	Written Exam
Portion	2 Units	2 Units	All Units	Regularly	All Units
Duration	1 Hr	1 Hr	1 Hr	1 Hr	3 Hrs
Exam Marks	10	10	10	10	60
Tentative Schedule	4th Week	8th Week	12-14th Week	Regularly	Semester End Exam

Evaluation Method For Practicum Based Course Paper (End Exam: THEORY)

Internal Assessment (40 Marks)					External Assessment (60 Marks)
Mode	Sessional Exam (02 Best of 03)	Practical Test	Practical Documentation	Attendance and Assignment	Written Exam
Portion	2 Units	100% Practical	All Practicals	All Units	All Units
Duration	1 Hr	3 Hrs	Regularly Monitored by Faculty	Regularly	3 Hrs
Exam Marks	10	10	10	10	60
Tentative Schedule	6th Week	12th Week	13th Week	14th – 15th Week	Semester End Exam