West Bengal State Council of Technical & Vocational Education and Skill Development
(Technical Education Division)

Syllabus
of

Diploma in Chemical Engineering [CHE]

Part-II (4th Semester)

Revised 2022

CURRICULAR STRUCTURE FOR PART-II (SEMESTER 4) OF THEFULL-TIME DIPLOMA COURSES IN CHEMICAL ENGINEERING

Discipline: **CHEMICAL ENGINEERING**					**SEMESTER 4**					
SL No	Category	Code No	Course Title	L	P	Total Class per week	Credit	Full marks	Internal marks	ESE marks
1	Program Core	CHEPC202	Process Heat Transfer	3	0	3	3	100	40	60
2	Program Core	CHEPC204	Mass Transfer–I	3	0	3	3	100	40	60
3	Program Core	CHEPC206	Chemical Engineering Thermodynamics	3	0	3	3	100	40	60
4	Program Core	CHEPC208	Chemical Technology-II	3	0	3	3	100	40	60
5	Program Core	CHEPC210	Industrial Chemistry	3	0	3	3	100	40	60
6	Program Elective	CHEPE202(1/2)	Material Science/ Food Technology	3	0	3	3	100	40	60
7	Program Core	CHEPC212	Heat Transfer Lab	0	3	3	1	100	60	40
8	Minor Project	PR202	Minor Project	0	3	3	1	100	60	40
			Total	18	06	24	20	800	360	440
STUDENT CONTACT HOURS PER WEEK: 24 hours (Lecture-18 hours; Practical-06 hours)Theory and Practical Period of 60 minutes each. FULL MARKS-800 (Internal Marks-360; ESE Marks-440)L-Lecture, P-Practical, ESE- End Semester Examination										

Credit Distribution	Credit
Program Elective	3
Program Core	16
Project	1
Total	20

Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately in each subject.

Program Elective (Without Lab)		Total Credit
Material Science [Sub Code: CHEPE202/1]	Any one	3
Food Technology [Sub Code: CHEPE202/2]		

Discipline: **Diploma in Chemical Engineering**	
Category: Programme Core	Semester: **Fourth**
Code no.: **CHEPC202**	Theory: 100 Marks
Course Title: **Process Heat Transfer**	i) Examination Scheme: External Assessment: 60 Marks (End Semester Examination) ii) Internal Assessment: 40 Marks [Class Test: 20 Marks Assignment/Viva voce/Quizzes: 10 Marks Class attendance: 10 Marks]
Duration: 17 weeks	
Total lecture class/week: 3	
Credit: 3	
Pass Criterion: Students must obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Objectives:

1	This subject will provide the students the basic concept of heat transfer.
2	It will provide the knowledge about conduction, convection, and radiation.
3	It will impart knowledge to understand the working of heat exchanger and evaporator.

2. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Identify different mode of heat transfer Calculate the heat transfer due to one-dimension steady state conduction
CO 2	Analyze logically the different types of heat transfer. Calculate heat transfer coefficient with the help for internal flows. Correlate local and overall heat transfer coefficient.
CO 3	Calculate view factor. Calculate radiative heat transfer between black bodies. Explain the process of pool boiling and hysteresis in boiling curve.
CO 4	Identify different part of heat exchanger. Calculate the rate of heat transfer and exit temperatures using LMTD. Select heat exchanger for different process.
CO 5	Material and energy balance across evaporator. Select type of multiple effect evaporator based on process requirement.

3. Pre-Requisites:

The students should have the knowledge of	
1.	Basic sciences such as physics, chemistry.
2.	Mathematics including trigonometry, integration, and differentiation.
3	Unit operations in Chemical Engineering.
4.	Solving numerical problems.

4. Theory Components:

Unit	Description	Contact hours
Unit: 1: Introduction to Heat Transfer and Conduction	Introduction Different modes of Heat Transfer i.e., Conduction, Convection and Radiation. Fourier's Law. Thermal conductivity and its dependency upon temperature for solid, liquid, and gas. Steady state conduction of heat through a composite solid wall, cylinder, sphere. Concept of thermal resistance. Critical Insulation thickness, optimum insulation thickness.	8
Unit 2: Convection and Heat Transfer Coefficient	Free and forced convection, Newton's law of cooling, Heat transfer Coefficient, Concept of local and overall heat transfer coefficient. Overall heat transfer between fluid separated by a plane wall, by a cylindrical wall (correlation between local and overall heat transfer coefficient along with temperature profile), Thermal Contact resistance. Thermal boundary Layer, Dimensionless groups in heat transfer (expression and physical significance) Sieder - Tate equation, Dittus - Boelter equation.	10
Unit 3: Radiation Heat Transfer and Boiling	Basic concepts of radiation from a surface (Absorptivity, Transmissivity, Reflectivity, Emissivity etc.), Black body radiation, Planck's Law, Wein's displacement law, Stefan-Boltzmann law, Kirchhoff's law, Gray body, View factor calculation, Rate of radiationexchange between black bodies, Radiation shield, Radiation combined with conduction and convection. The boiling phenomenon, Hysteresis in boiling curve, Mechanism of nucleate boiling (no problems).	10
Unit 4: Heat Exchanger	Heat Transfer with a variable driving force- co-current and countercurrent operations (LMTD approach), Construction of a shell and tube heat exchanger, Process design consideration (Fouling, LMTD correction, individual and overall heat transfer etc.), Effectiveness NTU method of heat exchanger analysis, Types of shelland tube heat exchangers and its application.	10
Unit 5: Evaporators	Single and multiple-effect evaporator, Mass and energy balance across an evaporator, Capacity and economy, Boiling point elevation, Enthalpy of a solution. Classification of multi-effect evaporators based on the mode of feed supply, Comparison between the forward and backward feed modes, Effect of boilingpoint elevation in a multiple effect evaporator. Types of evaporators and operation. Some simple numerical problems associated with above concepts.	7
Total number of lecture classes		45
Number of classes allotted for internal examination and viva-voce		06
Grand total		51

5. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of Process Heat Transfer. He or She may also conduct Viva-Voce or Quizzes for the students based on the different units of the subject.

6. Suggested scheme for question paper design for conducting internal assessment examination:(Duration: 45minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Class Test - 1	4	8	8	20
Class Test - 2	4	8	8	20

7. Suggested Scheme for End Semester Examination: [Duration 2.5 hours]

Question Paper Type		Marks
1.	Objective type questions carrying 1 mark for 20 questions out of 25 questionsthroughout the syllabus.	1×20=20
2.	Questions carrying 8 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	8×5=40

8. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	Performance Indicators
1	Originality of completing the assigned task
2	Presentation Skill
3	In Time submission of Assignment report / micro-project task
4	Viva-voce or Quizzes

9. Suggested Learning Resources:

Sl. No.	Title of the Book	Name of Authors	Publisher
1	Heat Transfer principles and applications	Binay K. Dutta	PHI Learning Private Limited, Delhi
2	Process Heat Transfer	D.Q. Kern	McGraw-Hill Book Co. Ltd., New York
3	Unit Operations of ChemicalEngineering	McCabe and Smith	McGraw-Hill Book Co. Ltd., New York
4	Heat and Mass Transfer	Dr. D. S. Kumar	S. K. Kataria & Sons.
5	Chemical Engineering (in SIunits), Vol. 1 & 4 /	Coulson and Richardson	Pergamon Press, Oxford
6	Introduction to Chemical Engineering	S.K. Ghosal, S.K.Sanyal, S. Datta	Tata McGraw-Hill

Discipline: **Diploma in Chemical Engineering**	
Category: Programme Core	Semester: **Fourth**
Code no.: **CHEPC204**	Theory: 100 Marks
Course Title: **Mass Transfer-I**	i) Examination Scheme: External Assessment: 60 Marks (End Semester Examination) ii) Internal Assessment: 40 Marks [Class Test: 20 Marks Assignment/Viva voce/Quizzes: 10 MarksClass attendance: 10 Marks]
Duration: 17 weeks	
Total lecture class/week: 3	
Credit: 3	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Objectives:

1.	This subject will provide the students the basic concept of mass transfer.
2.	It will impart knowledge to understand the working of mass transfer equipment used inchemical process industries.
3.	This subject will provide adequate information about the unit operation involved in Absorption, Distillation, and Extraction.

2. Course outcomes:

After completion of the subject the students will be able to:	
CO1	Explain general principles of mass transfer & its application: Different modes of mass transfer, various types of mass transfer coefficients and mass transfer theories.
CO2	Describe the processes of Molecular Diffusion, absorption & stripping. Define diffusivity, absorption factor, HETP, HTU & NTU Explain channelling, loading & flooding, types & selections of regular & random packing. Calculate the diameter and height of packed column using NTU & HTU method.
CO3	Explain vapor-liquid equilibrium diagrams, Raoult's law.Define relative volatility, reflux ratio. Describe the processes of batch, flash, vacuum, steam, low pressure, molecular, azeotropic and extractive Explain the function of a fractionator in multicomponent distillation. Calculate the number of theoretical plates based on McCabe–Thiele method.Describe the function of bubble cap tray & sieve tray column.
CO4	Describe the process of liquid extraction, Explain the use of triangular diagram in extraction process,Define selectivity and distribution coefficient. Explain the choice of solvent. Describe percolation tank, Dorr – agitator, thickener & classifier, Hydro cyclone, roto cell, Kennedy & Bollman extractor. Calculate the number of theoretical plates in single stage and multistage extractor for insoluble liquids.

3. Pre-Requisite:

1.	Knowledge of concepts of basic sciences such as physics, chemistry.
2.	Knowledge of names of equipment related to chemical Engineering field.
3	Knowledge of unit operations.
4.	Knowledge of solving numerical problems.

4. Theory Components:

Contents:	TOTAL PERIODS: 51 hrs	Contact hours
Unit 1: Introduction	General principles of mass transfer & its applications. Fick's law of diffusion, Diffusivity, Variations of diffusivity with temperature and pressure, Steady state molecular diffusion in fluids at rest or in laminar flow - equimolar counter current diffusion and diffusion through a stagnant film. Simple numerical problems. Concept of Mass transfer coefficients, relations among various types of mass transfer coefficients. Theories of mass transfer.	10
Unit 2: Absorption	Overview of absorption & stripping, Choice of solvent for absorption. Minimum solvent requirement, Absorption factor. Concept of channelling, loading & flooding. Types & selections of regular & random packing. Concept of HETP, HTU & NTU. Simple calculation of diameter and height of absorption column using NTU & HTU method. Simple numerical problems.	10
Unit 3: Distillation	Concept of vapor-liquid equilibrium, Raoult's law, relative volatility, Concept of batch distillation and flash vaporisation. Multicomponent distillation- fractionator, use of reflux. McCabe-Thiele method for determination of theoretical stage- Location of feed plate, Minimum total & optimum reflux. (Simple numerical problems) Use of open steam, Cold reflux. Concept of flash, vacuum, steam, low pressure, molecular, azeotropic, and extractive distillation. Basic concept of bubble cap tray & sieve tray column.	15
Unit 4: Extraction	Concept of liquid-liquid extraction, Fields of usefulness, Liquid-liquid equilibria, Use of triangular diagram, Choice of solvent. Single stage, multi-stage cross-current and counter-current extraction (Simple numerical problems for insoluble liquids only). Basic concept about percolation tank, Dorr – agitator, thickener & classifier, hydro cyclone, roto cell, Kennedy & Bollman extractor.	10
Total number of lecture classes		45
Number of classes allotted for internal examination and viva-voce		06
Grand total		51

5. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of Mass Transfer-I. He/she may also conduct Viva-Voce or Quizzes for the students based on the different units of Mass Transfer-I.

6. Suggested scheme for question paper design for conducting internal assessment examination: (Duration: 45minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Class Test - 1	4	8	8	20
Class Test - 2	4	8	8	20

7. Suggested Scheme for End Semester Examination: [Duration 3 hours]

Question Paper Type		Marks
1.	Objective type questions carrying 1 mark for 20 questions out of 25 questions throughout the syllabus.	1×20=20
2.	Questions carrying 2 marks for 5 questions (Subjective type) out of 8 questions (at leastone question from each unit).	2×5=10
3.	Questions carrying 6 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	6×5=30

8. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	Performance Indicators
1	Originality of completing the assigned task
2	Presentation skill
3	In time submission of assignment report / micro-project task
4	Viva-voce or quizzes

9. Suggested Learning Resources:

Sl. No.	Title of Book	Names of Authors	Publisher
1	Principles of Mass Transferand Separation Processes	B. K. Dutta	Prentice Hall of India
2	Mass Transfer Operations	Treybal	McGraw-Hill Book Co. Ltd., New York andKogakusha Co.Ltd., Tokyo.
3	Unit Operations of Chemical Engineering	McCabe and Smith	McGraw-Hill Book Co. Ltd.,New York andKogakusha Co. Ltd., Tokyo.
4	Introduction to Chemical Engineering	Badger and Banchero	McGraw-Hill Book Co. Ltd.,New York andKogakusha Co. Ltd., Tokyo
5	Introduction to Chemical Engineering	Ghosal, Sanyal, Dutta	Tata McGraw-Hill Pub. Co.Ltd., New Delhi
6	Chemical Engineering,Vol.1, 2, 4 & 5	Coulson and Richardson	Pergamon Press, Oxford

Name of the Course: **Diploma in Chemical Engineering**	
Category: Programme Core	Semester: **Fourth**
Code no.: **CHEPC206**	Theory: 100 Marks
Course Title: **Chemical EngineeringThermodynamics**	i) Examination Scheme: External Assessment: 60 Marks (End Semester Examination) ii) Internal Assessment: 40 Marks [Class Test: 20 Marks Assignment/Viva voce/Quizzes: 10 MarksClass attendance: 10 Marks]
Duration: 17 weeks	
Total lecture class/week: 3	
Credit: 3	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Objectives:

To impart the basic knowledge of thermodynamics necessary to analyze the Chemical Engineering operations.
To understand basic working principles of boilers.
To understand the Energy conservation opportunities in steam systems.

2. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	understand the basics of solution thermodynamics.
CO 2	understand and analyze different reactions and asses their feasibility
CO 3	understand the basics of phase and draw simple phase diagrams.
CO 4	comprehend principles of thermo-chemistry and analyze energy requirement of reactions and unit processes.
CO 5	understand different thermodynamic cycles.

3. Pre-Requisites:

1	Knowledge of concepts of basic sciences such as physics, chemistry and mathematics.
2	Knowledge of names of equipment related to chemical Engineering field.

3	Knowledge of Material and energy balance.
4	Knowledge of solving numerical problems.

4. Theory Components:

Unit	Description	Contact hours
Unit 1: Solution Thermodynamics	Thermodynamic properties of solutions - fundamental property relations for open and closed systems, chemical potential and partial molar properties, summability and Gibbs - Duhem Equation, Gibbs theorem of ideal gas mixture, introduction to fugacity and activity, Activity coefficients - Lewis Randall rule	10
Unit 2: Colligative Properties	Colligative properties - elevation of boiling point, depression of freezing point, lowering of vapor pressure and osmotic pressure - Raoult's and Henry's law - ideal and non-ideal solution - solubility and solubility product - common ion effect - simple problems	8
Unit 3: Phase Equilibria	Gibbs phase rule-phase equilibria - criteria for phase equilibrium, criterion of stability, phase equilibria in single and multiple component systems, Duhem's theorem, VLE for Ideal solutions.	7
Unit 4: Thermodynamics of Chemical Reactions	Chemical reaction equilibria - reaction stoichiometry - equilibrium constant - feasibility of reaction - effect of temperature, pressure, volume, and other factors - simple problems, relation between Gibbs energy change and EMF of a cell.	9
Unit 5: Thermodynamic Engines	Rankine cycle - Diesel cycle - Air standard Otto cycle - Bryton cycle - internal combustion engine - steam table - ideal refrigeration cycle - air refrigeration cycle - vapor compression cycle - absorption refrigeration cycle & vacuum refrigeration - choice of refrigerant - COP - Ton of refrigeration - refrigeration capacity (descriptions only)	11
Total number of lecture classes		45
Number of classes required for conducting Internal Assessment examination		06
Grand total		51

5. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of the subject content. He/she may also conduct Viva-Voce or Quizzes for the students.

6. Suggested scheme for question paper design for conducting internal assessment examination: (Duration: 45 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Theory Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Class Test - 1	4	8	8	**20**

Class Test - 2	4	8	8	**20**

7. Suggested Scheme for End Semester Examination: [Duration 2.5 hours**]**

Question Paper Type		**Marks**
1.	Objective type questions carrying 1 mark for 20 questions out of 25 questions throughout the syllabus.	1×20=20
2.	Questions carrying 8 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	8×5=40

8. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	**Performance Indicators**
1	Originality of completing the assigned task
2	Presentation Skill
3	In Time submission of Assignment report / micro-project task
4	Viva-voce or Quizzes

9. Suggested Learning Resources:

Sl. No	Book Title	Author	Publisher
1	Introduction to Chemical engg thermodynamics	Smith &,Vanness	McGrow-Hill Book Co.
2	Engineering Thermodynamics	Y.V.C Rao	University Press
3	An Introduction to Chemical Thermodynamics	R.P. Rastogi, R.R. Misra	Vikas Publishing House Pvt Ltd
4	A Textbook of Chemical Engineering Thermodynamics	K.V.Narayanan	Prentice Hall of India

<table>
<tr><td colspan="2">Name of the Course: Diploma in Chemical Engineering</td></tr>
<tr><td>Category: Programme Core</td><td>Semester: Fourth</td></tr>
<tr><td>Code no.: CHEPC208</td><td>Theory: 100 Marks</td></tr>
<tr><td>Course Title: Chemical Technology - II</td><td rowspan="4">Examination Scheme:
i) External Assessment: 60 Marks
(End Semester Examination)

ii) Internal Assessment:40 Marks
[Class Test: 20 Marks
Assignment/Viva voce/Quizzes: 10 MarksClass attendance: 10 Marks]</td></tr>
<tr><td>Duration: 17 weeks</td></tr>
<tr><td>Total lecture class/week: 3</td></tr>
<tr><td>Credit: 3</td></tr>
<tr><td colspan="2">Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.</td></tr>
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1. Course Objectives:

To impart the basic knowledge about the raw materials required, process involved in the production of various chemical compounds.
To understand the chemical reactions involved in the production of the compounds.
To understand the operation of the equipments used for the production of the compounds.

2. Course Outcomes: On completion of the course, students will be able to:

Sl No	Course Outcomes
CO1	Write raw materials, application and reactions involved in the production of a chemical compound.
CO2	Explain unit processes and unit operations involved in the production of a chemical compound.
CO3	Explain purification process of the chemical compound.
CO4	Sketch the necessary flowchart for the production of chemical compound.
CO5	Develop knowledge about the equipment used for the production of chemical compound from its raw materials.

3. Theory Components:

Contents:	TOTAL PERIODS: 51 hrs /week	Hrs./Unit
Unit: 1 PETROLEUM INDUSTRY	Concept of Origin, Classification and Composition of Crude Petroleum Oil. Overview of refining process of crude oil Atmospheric and Vacuum distillation process of crude oil Some important Petroleum products and their uses. Overview of secondary refining processes: Thermal cracking processes: Vis breaking, Delayed coking. Catalytic Cracking Processes: Single stage Fluidized Bed Process Hydro Cracking.	09
Unit: 2: SUGAR INDUSTRY	Manufacturing of Sugar from sugarcane with flow sheet Refining of raw sugar. Inversion of Sugar.	3
Unit 3: FERMENTATION INDUSTRY	Manufacturing of Industrial Alcohol: Raw materials, Reactions involved and process flow sheet. Manufacturing of Acetic Acid: Raw materials, Reactions involved. Acetic acid production by fermentation method and by Carbonylation of methanol. Production of Vinegar by (i) Orleans Process (ii) Trickling, Quick Process. Manufacturing of Citric Acid: Raw materials, Reactions involved and process flow sheet.	9
Unit 4: OIL & FAT INDUSTRY	Overview of oil and fat Classification of oil Description of vegetable oil extraction with flow sheet Solvent recovery system Oil refining after extraction Extraction of Soybean oil and refining Concept of hydrogenation Hydrogenation of oil with process flow sheet.	**7**
Unit 5 : PESTICIDES INDUSTRY	Overview of Pesticides. Classification of pesticides Manufacturing of DDT with flow sheet Manufacturing of BHC with flow sheet.	**2**
Unit 6: ELECTRO-THERMAL INDUSTRY	Manufacturing of Silicon Carbide: Raw materials, Reactions involved and description of process with flow sheet, Uses of Silicon Carbide. Manufacturing of Calcium Carbide: Raw materials, Reactions involved and description of process with flow sheet Uses of Calcium Carbide.	**3**

Unit 7 : POLYMER INDUSTRY	Overview of Polymer: chemistry, synthesis and end-uses Classification of Polymer Methods of Polymerization: Addition and Condensation; Methods of production: Bulk, Solution, Emulsion and Suspension. Manufacturing of LDPE by ICI process with flow sheet. Manufacturing of HDPE by Ziegler's process with flow sheet. Manufacturing of PVC by emulsion polymerization method with flow sheet.	**8**
Unit 8 : PAINT INDUSTRY	Overview and classification of paints Raw materials of paint Paint manufacturing. Concept of varnish Classification of Varnish, Production of Varnish.	**4**
Total number of lecture classes		**45**
Number of classes allotted for internal examination and viva-voce		**06**
Grand total		**51**

4. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of Chemical Technology II. He /She may also conduct Viva-Voce or Quizzes for the students based on the different units of Chemical Technology II.

5. Suggested scheme for question paper design for conducting internal assessment examination :(Duration: 45 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Theory Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Class Test - 1	4	8	8	**20**
Class Test - 2	4	8	8	**20**

6. Suggested Scheme for End Semester Examination: [Duration 2.5 hours**]**

Question Paper Type		**Marks**
1.	Objective type questions carrying 1 mark for 20 questions out of 25 questions throughout the syllabus.	1×20=20
2.	Questions carrying 8 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	8×5=40

7. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	**Performance Indicators**
1	Sketch Flow sheet for manufacture of a compound
2	Accomplishing assigned problem

3	Presentation Skill
4	In Time submission of Assignment report / micro-project task
5	Viva-voce or Quizzes

8. Suggested Learning Resources:

Sl No	Title of the book	Author	Publication
1.	Chemical Process Industries	Shreve	McGraw-Hill Book Co. Ltd., New Yorkand Kogakusha Co. Ltd., Tokyo.
2.	A Text Book of Chemical Technology, Vol. 1 & 2	Sukla and Pandey	Vikas Publishing House Pvt. Ltd., New Delhi.
3.	Outlines of Chemical Technology	Dryden	Affiliated East-West Press Pvt. Ltd., New Delhi
4.	Introduction to Chemical Engineering	Ghosal, Sanyal, Dutta	Tata McGraw-Hill Pub. Co. Ltd., New Delhi
5	Text Book of Chemical Technology, Vol I & II	G.N Pandey	Vikash Publishing House Pvt. Ltd

Name of the Course**: Diploma in Chemical Engineering**	
Category: Programme Core	Semester: **Fourth**
Code no.: **CHEPC210**	Theory: 100 Marks
Course Title: **Industrial Chemistry**	Examination Scheme: i) External Assessment: 60 Marks (End Semester Examination) ii) Internal Assessment: 40 Marks [Class Test: 20 Marks Assignment/viva voce/ Quizzes: 10 Marks Class attendance: 10 Marks]
Duration: 17 weeks	
Total lecture class/week: 3	
Credit: 3	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Objectives:

To impart the basic knowledge about preparation and properties of various organic compounds related to chemical engineering.
To understand the importance of organic compounds in chemical industry.
To understand some important properties of solutions and indicators.

2. Course Outcomes:

On completion of the course, students will be able to	
1	Write the reactions for given organic compounds.
2	Describe reactions for alkanes, alkenes, alkyl halides and phenols.
3	Identify the properties of the above organic compounds.
4	Explain the colligative properties of solutions.
5	Describe the reactions involved in electrochemical cell.

3. Pre-Requisites:

1	Knowledge of concepts of basic sciences such as physics, chemistry and mathematics.
2	Some practical idea about titration.

4. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
UNIT-I	Nomenclature of organic compounds, Concept of functional groups. Classification of organic compounds: Alkanes, alkenes, alkynes, cycloalkanes, and aromatic compounds. Alkanes: Preparation and uses of alkanes. Extraction of alkanes from Natural gas and crude oil. Reactions of alkanes: Oxidation, halogenation, nitration, pyrolysis, isomerisation, dehydrogenation. Alkenes: Preparation and use of alkenes. Reactions of alkenes: Action of ozone, hydrogenation, halogenation, action of halogen acids, sulphuric acid, polymerization.	14
UNIT-II	Aromatic compounds: Concept of aromaticity, structure of benzene, laboratory and industrial preparation of benzene, industrial uses of benzene, industrial preparation of toluene. Reactions of benzene - halogenation, hydrogenation, pyrolysis only. Alcohols: Classification of alcohols, properties (boiling point and solubility) and preparation including industrial preparation, industrial uses of alcohols. Reactions of alcohols: Dehydration, Esterification, Substitution, Oxidation only. Phenols: Classification and industrial preparation only. Reactions: Oxidation to Quinones, Hydrogenation, Halogenation, Reimer-Tiemann, Formation of Aspirin, Formation of oil of wintergreen only.	14
UNIT-III	Solutions: Concept of equivalent weight, normality and molarity. Electrochemistry: Conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's law. Redox reactions, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibbs energy change and EMF of a cell, Nernst distribution law, limitations of Nernst distribution law, modification in case of association, dissociation, applications of distribution law.	
UNIT-IV	Volumetric Analysis: Primary and secondary standard substances. Principles of acid-base titration - acid-base indicator. Estimation of Acetic acid in commercial vinegar using standard NaOH solution as titrant. (Principle only) Principles of oxidation – reduction/redox titration, indicators for redox titration. Estimation of Fe_2O_3 in portland cement using standard $KMnO_4$ solution as titrant. (Principle only) Estimation of Fe(III) and Fe (II) in a mixture using standard solution of $K_2Cr_2O_7$ as titrant. (Principle only) Estimation of available chlorine in bleaching powder using standard $Na_2S_2O_3$ solution as titrant. (Principle only) Principles of complexometric titrations, complexometric/metal ion indicators. Complexometric estimation of Zn in Brass and Ca+Mg in Dolomite using standard EDTA solutions as titrant. (Principle only)	
Total Lecture Classes		45
Number of classes required for conducting Internal Assessment examination		06
Grand Total		51

5. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of Industrial Chemistry. He or She may also conduct Viva-Voce or Quizzes for the students based on the different units of the subject.

6. Suggested scheme for question paper design for conducting internal assessment examination:(Duration: 45 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Class Test - 1	4	8	8	20
Class Test - 2	4	8	8	20

7. Suggested Scheme for End Semester Examination: [Duration 3 hours]

Question Paper Type	**Marks**
Objective type questions carrying 1 mark for 20 questions out of 25 questions throughout the syllabus.	1×20=20
Questions carrying 8 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	8×5=40

8. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	Performance Indicators
1	Accomplishing assigned problem
2	Presentation Skill
3	In Time submission of Assignment report / micro-project task
4	Viva-voce or Quizzes

9. Suggested Learning Resources:

Sl. No.	Title of Book	Name of Authors	Publisher
1.	Organic Chemistry	R. T. Morrison, R. N. Boyd and S.K Bhattachrajee	Pearson
2.	Text Book of Organic Chemistry	P.L. Soni and H.M.Chawla	Sultan Chand & Sons – Tb
3.	Principles of Physical Chemistry	B.R.Puri, L.R.Sharma and M.S.Pathania	Vikas Publishing House Pvt Ltd.
4	Textbook of OrganicChemistry	K. S.Tewari, S. N Mehrotra, N. K. Vishnoi	Vikas Publishing HousePvt Ltd
5	Organic Chemistry	Subrata Sengupta	Oxford University Press

Name of the Course: **Diploma in Chemical Engineering**	
Category: Program Elective	Semester**: Fourth**
Code no.: **CHEPE202/1**	Theory: 100 Marks
Course Title**: MATERIAL SCIENCE**	Examination Scheme: i) External Assessment: 60 Marks (End Semester Examination) ii) Internal Assessment: 40 Marks [Class Test: 20 Marks Assignment/viva voce/ Quizzes: 10 MarksClass attendance: 10 Marks]
Duration: 17 weeks	
Total lecture class/week: 3	
Credit: 3	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Objectives:

To impart the basic knowledge about general properties of materials related to chemical engineering.
To understand types of crystal structure of compounds in chemical industry.
To explain Phase rule, heat treatment of steel, corrosion prevention.
Knowledge about alloys and composite materials.

2. Course Outcomes:

On completion of the course, students are expected to	
1	Classify of different types of materials (including Electrical Engineering materials and Magnetic materials) with examples.
2	Explain the properties of materials.
3	Illustrate the Crystal structure – BCC crystal, FCC crystal, HCP crystal.
4	Explain Phase rule, Degrees of Freedom, and Equilibrium Diagram.
5	Explain the fundamental concept of Heat Treatment of steel.
6	Explain Corrosion and its prevention.
7	Describe some important Alloys and Composite materials and their uses.

3. Pre-Requisites:

1	Knowledge of concepts of basic sciences such as physics, chemistry and mathematics.
2	Knowledge of basic properties of materials.

4. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: INTRODUCTION	Importance of Material Science, Classification of materials, Basic idea about Metals, Alloys, Ceramic materials, organic materials with suitable examples. Classification of Electrical engineering materials with examples. (Details notnecessary) Classification of Magnetic materials with examples. (Details not necessary) Basic idea about the properties of materials.	10
Unit II: CRYSTAL STRUCTURE	Concept of Crystal Structure: Definition of Unit Cell, Space lattice, Lattice points, Lattice spacing. Crystal structures for metallic elements: BCC, FCC, HCP (Details not necessary). Basic idea about Solid Solution, Classification of Solid Solution. (Details not necessary).	6
Unit III: EQUILIBRIUM DIAGRAM	Concept of Phase, Gibb's Phase rule, Degrees of Freedom, Binary Equilibrium Diagram, Eutectic phase diagram. Iron – Carbon equilibrium diagram, Definition of Critical temperature.	10
Unit IV: HEAT TREATMENT OFSTEELS	Concept of Heat Treatment. Typical heat treatment processes of Steels like Annealing, Normalising, Quenching, Tempering, Case hardening, Induction hardening, Flame hardening, Carburising, Cyaniding, Nitriding.(Process details are not necessary.)	8
Unit V: MECHANICAL PROPERTIES	Stress – Strain Curve for Engineering materials. Fundamental properties: Strength, Elasticity, Stiffness, Plasticity, Ductility, Hardness, Toughness, Creep, Creep curve, Creep resistance, Creep Resistant materials. (Testing methods are not necessary).	6
Unit VI: CORROSION AND ITS PREVENTION	General aspects of Corrosion. Factors influencing Corrosion. Types of Corrosion Control and Prevention of Corrosion.	6
Unit VII: ENGINEERINGALLOYS AND COMPOSITE MATERIAL	ENGINEERING ALLOYS Composition and uses of some important alloys like – Low Carbon Steel, Mild Steel, Medium Carbon Steel, Stainless Steel, Brass, and Bronze. COMPOSITE MATERIAL Elementary idea about composite materials. (Only the names of some important composite materials & uses.)	5
Total Lecture Classes		45
No. of Classes Required for Conducting Internal Assessment Examination		06
Grand Total		51

5. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of Material Science. He/ She may also conduct viva voce or Quizzes for the students based on the different units of the subject.

6. Suggested scheme for question paper design for conducting internal assessment examination:(Duration: 45 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Theory Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply& above)	Total
Class Test - 1	4	8	8	20
Class Test - 2	4	8	8	20

7. Suggested Scheme for End Semester Examination: [Duration 3 hours]

Question Paper Type		**Marks**
1.	Objective type questions carrying 1 mark for 20 questions out of 25 questions throughout the syllabus.	1×20=20
2.	Questions carrying 8 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	8×5=40

8. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	**Performance Indicators**
1	Originality of completing the assigned task
2	Presentation Skill
3	In Time submission of Assignment report / micro-project task
4	Viva-voce or Quizzes

9. Suggested Learning Resources:

Sl. No.	**Title of Book**	**Name of Authors**	**Publisher**
1.	Materials Science and Engineering- A First course.	V. Raghavan	Prentice Hall of India Pvt. Ltd.
2.	A Text Book of Material Science & Engineering	R.K Rajput	S.K. Kataria&Sons , New Delhi.
3.	Callister's Materials Science and Engineering	R. Balasubramaniam	Wiley

Name of the Course: **Diploma in Chemical Engineering**	
Category: Program Elective	Semester: **Fourth**
Code no.: **CHEPE202/2**	Theory: 100 Marks
Course Title: **FOOD TECHNOLOGY**	Examination Scheme: i) External Assessment: 60 Marks (End Semester Examination) ii) Internal Assessment:40 Marks [Class Test: 20 Marks Assignment/viva voce/ Quizzes: 10 Marks Class attendance: 10 Marks]
Duration: 17 weeks	
Total lecture class/week: 3	
Credit: 3	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Objectives:

To impart the basic knowledge about food science and technology.
To impart the basic knowledge about food processing and food processing equipments.
To understand the importance of food preservation and packaging.

2. Course Outcomes

On completion of the course, students will be able to:	
1	Describe the basic technology in food science.
2	Classify different food processing equipments.
3	Classify the food on the basis of spoilage.
4	Interpret the basic idea of food preservation.
5	Apply the basic idea of food packaging.
6	Apply the fundamental principles of Chemical Engineering in Food industry.

3. Pre-Requisites:

1	Knowledge of basic sciences such as physics, chemistry and mathematics.
2	Knowledge of names of equipment related to Chemical Engineering field.
3	Knowledge of unit operations and unit processes in Chemical Engineering.

4. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I Introduction	Definition of food science and technology. Basic ideas of some terms used in food science and technology: Food chemistry, food analysis, food microbiology, food processing, food engineering, and packaging, food additives, food fortification, food fermentation, functional food, food safety and regulation. Objectives of the study of food science and technology.	8
Unit II Food processing and equipment	Basic idea on food processing. Application of Chemical Engineering in foodprocessing: pumping of fluid, conveying, peeling, cutting, size reduction, mixing, screening, filtration, centrifugation, drying. Description of food processing equipments: wet grinder, autoclave, peristaltic pump, spiral bakery mixer, planetary bakery mixer, centrifuge, batch and continuous dryer.	12
Unit III Food Spoilage	Classification food based on spoilage. Signs of food spoilage. Factors affecting the food spoilage. Prevention of food spoilage.	6
Unit IV: Techniques of Food processing and preservation	Concept of food preservation. Principles of food preservation. Methods of food preservation and processing: Asepsis, removal of micro-organisms, preservation by high temperature (Pasteurization, blanching, boiling, sterilization, canning), preservation by irradiation, preservation by high temperature (cellar storage, chilling, freezing), preservation by drying (basic idea on sun drying, mechanical drying, freeze drying).	14
Unit V: Food Packaging	Basic idea on food packaging. Objective of food packaging, classification of packaging: Primary packaging, secondary packaging, tertiary packaging. Packaging materials: Earthen pots, wood, glass, paper and paper-based packaging materials, metal container, plastic films, laminates, tetra brick aseptic packaging.	11
Total Lecture Classes		45
Number of classes required for conducting Internal Assessment examination		06
Grand Total		51

5. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units of Food Technology. He/ She may also conduct viva voce or Quizzes for the students based on the different units of the subject.

6. Suggested scheme for question paper design for conducting internal assessment examination: (Duration: 45 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Theory Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply& above)	Total
Class Test - 1	4	8	8	20
Class Test - 2	4	8	8	20

7. Suggested Scheme for End Semester Examination: [Duration 3 hours]

Question Paper Type		**Marks**
1.	Objective type questions carrying 1 mark for 20 questions out of 25 questions throughout the syllabus.	1×20=20
2.	Questions carrying 8 marks for 5 questions (Subjective type) out of 8 questions (at least one question from each unit).	8×5=40

8. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	**Performance Indicators**
1	Originality of completing the assigned task
2	Presentation Skill
3	In Time submission of Assignment report / micro-project task
4	Viva-voce or Quizzes

9. Suggested Learning Resources:

Sl. No.	Title of Book	Name of Authors	Publisher
1.	Food Processing and Preservation	B Sivasankar	PHI Learning Pvt. Ltd.
2.	Fundamentals of Food Engineering	D G Rao	PHI Learning Private Ltd.
3.	Introduction to Food Engineering	R Paul Singh, DennisR Heldman	Elsevier
4.	Emerging Technologies for Food Processing	Da-Wen Sun	Elsevier

Name of the Course: **Diploma in Chemical Engineering**	
Category: Programme Core	Semester: **Fourth**
Code no.: **CHEPC212**	Theory: 100 Marks
Course Title: **Heat Transfer Laboratory** Duration: 17 weeks Total practical class/week: 3 Credit: 1	Examination Scheme: i) Internal Assessment: 60 marks [Continuous assessment of class performance and in time submission of assignment:30 marks Viva voce: 20 marks Class attendance: 10 marks] ii) External Assessment: 40 Marks(End Semester Examination) [Assignment on the day of viva voce: 20 marks Viva voce (before Board of Examiners): 20 marks]
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

1. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Understand and apply concepts of heat conduction through conducting solids
CO 2	Understand and apply concepts of heat conduction through non-conducting solids
CO 3	Determine the value of heat transfer coefficients in heat exchangers
CO 4	Determine the value of heat transfer coefficient in boilers
CO 5	Determine the coefficient of thermal expansion

2. Suggested Assignments for Continuous Assessment:

Following assignments are to be attempted and corresponding reports should be prepared on A4 sheets or Laboratory Note Book:

Sl. No.	Name of Experiment	Contact hours
1	To determine the linear expansion co-efficient of a metal rod	3
2	To determine the thermal conductivity of solid metal rod.	3
3	To determine thermal conductivity of insulating slab	3
4	To determine the thermal conductivity of bricks in series.	3
5	To determine the rate of heat transfer through bricks in series	3
6	To determine overall heat transfer co-efficient for a double pipe heat exchanger.	3
7	To determine the overall heat transfer co-efficient for a shell and tube heat exchanger.	3
8	To determine rate of evaporation in a jacketed open pan evaporator.	3

Practical Classes	45 hrs.
Viva-voce and external examination	06 hrs.
Grand total	51 hrs.

3. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	Performance Indicators
1	Awareness about the significance of particular test
2	Understanding working principle of machine / set-up
3	Setting and operation of experimental set up
4	Observations and recording data
5	Interpretation of result and conclusion
6	Submission of report in time
7	Answer to sample questions

4. Suggested Learning Resources:

Sl. No.	Title of Book	Author	Publication
1	Heat Transfer principles and applications	Binay K. Dutta	PHI Learning Private Limited,Delhi
2	Unit Operations of Chemical Engineering	Mc Cabe, Smith & Harriot	McGraw-Hill Book Co. Ltd.,New York
3	Introduction to Chemical Engineering	Ghosal, Sanyal, Dutta	Tata McGraw-Hill
4	Process Heat Transfer	D. Q. Kern	McGraw-Hill Book Co. Ltd., New York
5	Heat and Mass Transfer	Dr. D. S. Kumar	S. K. Kataria & Sons

<table>
<tr><td colspan="2">Name of the Course: Diploma in Chemical Engineering</td></tr>
<tr><td>Category: Minor Project</td><td>Semester: Fourth</td></tr>
<tr><td>Code no.: PR202</td><td>Laboratory: 100 Marks</td></tr>
<tr><td>Course Title: Minor Project</td><td rowspan="4">Examination Scheme:
i) Internal Assessment: 60 marks
[Continuous assessment of class performance and in time submission of assignment:30 marks
Viva voce: 20 marks
Class attendance: 10 marks]
ii) External Assessment: 40 Marks(End Semester Examination)
[Assignment on the day of viva voce: 20 marks
Viva voce (before Board of Examiners): 20 marks]</td></tr>
<tr><td>Duration: 17 weeks</td></tr>
<tr><td>Total class/week: 3</td></tr>
<tr><td>Credit: 3</td></tr>
<tr><td colspan="2">Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately. Students should submit two separate reports one based on the general experiments carried out and another on the assigned project work.</td></tr>
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1. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Understand and apply the concept of technical report writing
CO 2	Understand and apply the concept of technical presentation
CO 3	Understand, apply the concept of literature survey
CO 4	Understand and apply the concept of conducting various experiments
CO 5	Prepare technical report and presentation on performed experiment

2. Course Content

Sl. No	Name of the Topic
1	Technical Report Writing
2	Technical Presentation
3	Conducting Literature Survey for a particular project
4	General Experiments related to chemical engineering
5	Assignment of Project and relevant literature survey

3. Rubrics for the Assessment of Students Activity: (20 marks)

Sl No.	Performance Indicators
1	Awareness about the significance of particular project topic
2	Understanding and reviewing the papers through literature survey
3	Setting and operation of experimental set up

4	Observations and recording data
5	Interpretation of result and conclusion
6	Submission of report in time
7	Answer to sample questions

4. Suggested Learning Resources:

Online journals and publications referred by the guide.