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

Syllabus
of

Diploma in Chemical Engineering [CHE]

Part-II (3rd Semester)

Revised 2022

Curricular structure for part-ii (semester 3) of the Full-time diploma courses in chemical engineering

BRANCH: **CHEMICAL ENGINEERING**						**Semester 3**				
SL No	**Category**	**Code No**	**Course Title**	**L**	**P**	**Total Class per week**	**Credit**	**Full marks**	**Internal Marks**	**ESE Marks**
1	**Program core**	**CHEPC 201**	**Outlines of Chemical Engineering**	**3**	**-**	**3**	**3**	**100**	**40**	**60**
2	**Program core**	**CHEEPC 203**	**Momentum Transfer**	**3**	**-**	**3**	**3**	**100**	**40**	**60**
3	**Program core**	**CHEEPC 205**	**Engineering Thermodynamics**	**3**	**-**	**3**	**3**	**100**	**40**	**60**
4	**Program core**	**CHEPC 207**	**Mechanical Operations**	**3**	**-**	**3**	**3**	**100**	**40**	**60**
5	**Program core**	**CHEPC209**	**Energy Engineering**	**3**	**-**	**3**	**3**	**100**	**40**	**60**
6	**Program core**	**CHEPC 211**	**Chemical Technology-I**	**3**	**-**	**3**	**3**	**100**	**40**	**60**
7	**Program core**	**CHEPC 213**	**Momentum Transfer Lab**	**-**	**3**	**3**	**1**	**100**	**60**	**40**
8	**Program core**	**CHEPC 215**	**Mechanical Operations Lab**	**-**	**3**	**3**	**1**	**100**	**60**	**40**
9	**Internship**	**SI201**	**Internship-I**	**-**	**-**	**0**	**1**	**100**	**60**	**40**
Total				**18**	**6**	**24**	**21**	**900**	**420**	**480**

Student contact hours(minimum) per week: 24 hours (Lecture-18 hours; Practical-6 hours)
Theory and Practical Period of 60 minutes each.
FULL MARKS-900 (Internal Marks-420; ESE Marks-480)
L-Lecture, P-Practical, ESE- End Semester Examination

Credit Distribution	**Credit**
Program Core	20
Internship 1	1
Total	21

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

Name of the Course: Diploma in Chemical Engineering	
Category: Programme Core	**Semester: Third**
Code no.: CHEPC 201	**Theory: 100** Marks
Course Title: Outlines of Chemical Engineering.	**Examination Scheme:**
Duration: 17 weeks	**i) External Assessment: 60** Marks (End Semester Examination)
Total lecture class/week: 3	**ii) Internal Assessment: 40** Marks
Credit: 3	[Class Test: 20 Marks Assignment/viva voce: 10 Marks Class attendance: 10 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, students will be able to:

Sl No	Course Outcomes
CO1	Define Chemical Engineering and its application, Unit process and Unit operation.
CO2	Define some important basic chemical engineering terms like unit, dimension, dimensionless group, mole, mole fraction, vapour pressure, partial pressure, average molecular weight and density of mixture etc.
CO3	Solve simple problems associated with theory and solve simple problems using different types of graphs like Log-Log, Semi-Log graph.
CO4	State some fundamental laws of gas.
CO5	Explain material and energy balance
CO6	Solve material and energy balance related simple problems.

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: Introduction	Definition & application of Chemical Engineering. Concept of fundamental units, notations, Derived units, Dimensions, Different Unit system and conversion of one from other unit and related simple numerical problems. Names of some important dimensionless groups and their significance related to Chemical Engineering. Dimensional Analysis: Rayleigh and Buckingham PI theorem with simple examples. Concept of unit operations and unit processes with common examples.	**7**

Unit II: Mole Concept and Use of Different Types of Graphs	Concept of Basis of calculation. Concept of Mole, mole fraction, weight fraction, weight percent, volume percent, atomic fraction. Associated simple numerical problems. Concept of log-log and semi-log graph plotting with simple examples	**~~8~~**
Unit III: Elementary Theories and Laws	Ideal gas law. Concept of Partial Pressure, Pure component volume. Dalton' s law, Amagat' s law. Average molecular weight Density of mixture. Simple numerical problems associated to these theories.	**6**
Unit IV: Concept of Vapour Pressure	Concept of Vapour pressure. Effect of Temperature on vapour pressure: Clausius Clapeyron equation Simple numerical problems related to Clausius Clapeyron equation. Antoine equation (only statement), Raoult's law and Henry's law (Only theory, no numerical problem).	**6**
Unit V: Material Balance	Concept of Material Balance processes involving without chemical reaction like Distillation, Evaporation, Drying, Crystallisation, Mixing, and Simple numerical problems associated with these concepts. Concept of Stoichiometric equation, Excess reactant, Limiting reactant, Percent excess, Percent conversion with simple numerical problems Concept of Material Balance processes with chemical reaction like Combustion of coal, fuel gases and sulphur, and Simple numerical problems related to above mentioned chemical reactions. Concept of Recycling operations, Bypassing and Purge streams (Only theory, no numerical problems)	**10**
Unit VI: Energy Balance	Concept of Energy Balance: Definition of Heat capacity, Mean molal heat capacity, Heat capacities of gaseous mixture, Hess's law of summation, Heat of formation, Heat of reaction, Heat of combustion and Heat of mixing. Simple numerical problems related with above mentioned theories.	**8**
Sub Total: Total Lecture Classes		**45**
No. of classes required for conducting Internal Assessment examination		**06**
Grand Total:		**51**

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

4. 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**

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

Question Type	**Marks**
Objective type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Fill in the blanks type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Q s carrying 8 marks for 5 Qs (Subjective type) out of 10Qs (at least 1 Q from each unit)	8×5 = 40
	Total = 60

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

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

7. Suggested Learning Resources:

Sl. No.	**Title of Book**	**Author**	**Publication**
1.	Basic Principles and Calculations in Chemical Engineering	Himmelblau	Prentice Hall of India, New Delhi
2.	Chemical Engineers' Handbook	Perry	McGraw-Hill
3.	Chemical Process Principles (part I)	Hougen, Watson & Ragatz	Asia Publishing House, New Delhi
4.	Chemical Engineering Fundamentals	Kirkbride	McGraw-Hill Book Co. Ltd., New York & Kogakusha Co. Ltd., Tokyo
5.	Introduction to Chemical Engineering	Ghosal, Sanyal, Dutta	Tata McGraw-Hill Pub. Co. Ltd., New Delhi

6.	Stoichiometry	Bhatt and Vohra	Tata McGraw-Hill Pub. Co. Ltd., New Delhi
7	Process Calculations	V. Venkataramani, N.Anantharaman, K.M.Meera Sheriffa Begum	PHI Learning Private Limited, New Delhi
8	Solved Examples in Chemical Engineering	G.K.Roy	Khanna
9	Objective type questions	O.P.Gupta	Khanna
10	Stoichiometry and Process Calculation	K.V. Narayanan B. Lakshmikutty	PHI Learning Private Limited, New Delhi

Name of the Course: Diploma in Chemical Engineering	
Category: Programme Core	**Semester: Third**
Code no.: CHEPC203	**Theory: 100** Marks
Course Title: Momentum Transfer	**Examination Scheme:** **i) External Assessment: 60** Marks (End Semester Examination) **ii) Internal Assessment: 40** Marks [Class Test: 20 Marks Assignment/viva voce: 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 Outcomes:

On completion of the course the students will be able to	
CO1	Explain stress-strain relationship in fluids, classify their behavior, and establish force balance in static systems.
CO2	Apply Bernoulli's principle and compute pressure drop in different types of flow system.
CO3	Compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed.
CO4	Describe function of flow metering devices and apply Bernoulli equation to determine the performance of flow-metering devices.
CO5	Determine the head developed by the pump.

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: Properties of fluids and concept of pressure	Nature of fluids, physical properties of fluids such as specific weight, mass density, specific gravity, viscosity and surface tension. Types of fluids: Ideal and real, compressible and incompressible. Fluid statics: Pressure-density-height relationship. Concept of atmospheric, absolute, gauge and negative pressure. Pressure measurement using different types of manometers: U-tube, well type, inclined tube and inverted U-tube manometers. Simple problems.	**10**
Unit II: Fluid flow phenomenon	Kinematics of fluid flow: Velocity gradient and shear stress, Newton's law of viscosity, dynamic and kinematic viscosity, Newtonian and non-Newtonian fluids. Reynolds number, laminar flow and turbulent flow. Concept of boundary layer, potential flow.	**7**

Unit III: Basic equations of fluid flow	Concept of **s**treamline flow, steady flow and unsteady flow. Equation of continuity. Simple problems. Bernoulli's equation (derivation not required), statement and explanation, correction for fluid friction and pump work. Simple problems. Momentum correction factor & kinetic energy correction factor.	**8**
Unit IV: Flow of incompressible fluids in conduits	Laminar flow characteristics through pipes: shear stress distribution, concept of fully developed flow Average velocity and maximum velocity. Fanning's friction factor Hagen-Poiseuille equation Frictional losses due to different piping components Losses due to sudden expansion & sudden contraction Entry and exit losses Simple problems	**7**
Unit V: Flow of fluids through solids	Drag and drag co-efficient Flow through beds of solids Friction factor for packed beds Ergun's equation Fluidisation: Mechanism, types, general properties and applications.	**6**
Unit VI: Flow meters and Pumps	Flow measuring devices : Venturi meter – Orifice meter – Pitot tube – Rotameter – Notches & weirs - rectangular, Vee & trapezoidal - Simple problems Pumps: Developed head, power requirement. Simple problems.	**7**
Sub Total: Total Lecture Classes		**45**
Number of classes required for conducting Internal Assessment examination		**6**
Grand Total:		**51**

3. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units. He/she may also conduct viva- voce or quizzes for the students based on the content of the subject.

4. 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**

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

Question Type	Marks
Objective type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Fill in the blanks type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Q s carrying 8 marks for 5 Qs (Subjective type) out of 10Qs (at least 1 Q from each unit)	8×5 = 40
	Total = 60

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

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

7. Suggested Learning Resources:

Sl. No.	Title of Book	Author	Publication
1	Unit Operations of Chemical Engineering	McCabe, Smith & Harriot	McGraw-Hill Book Co. Ltd.
2	Fluid Mechanics and Fluid Power Engineering	Dr. D. S. Kumar	S.K. Kataria & Sons
3	Fluid Mechanics and Its Applications	Vijay Gupta, Santosh K. Gupta	New Academic Science Ltd
4	A Text Book of Fluid Mechanics and Hydraulic Machines	Dr. A. K. Bansal	Laxmi Publications Pvt. Ltd.
5	Introduction to Chemical Engineering	Ghosal, Sanyal, Dutta	Tata McGraw-Hill

Name of the Course: Diploma in Chemical Engineering	
Category: Programme Core	**Semester: Third**
Code no.: CHEPC205	**Theory: 100** Marks
Course Title: Engineering Thermodynamics	**i) Examination Scheme:** **External Assessment: 60** Marks (End Semester Examination) **ii) Internal Assessment: 40** Marks [Class Test: 20 Marks Assignment/viva voce: 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 Outcomes**:

On completion of the course, the students will be able to	
CO 1	understand the conceptual laws of thermodynamics for application in thermodynamic cycles.
CO 2	understand the basic concept on ideal and real gases.
CO 3	understand the concept of free energy.
CO 4	Able to calculate the enthalpy of chemical reaction, heat of combustion, heat of solution, and heat of mixing.

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: Basic Concepts	Thermodynamic concept of system, surroundings and the universe-Classification of thermodynamic systems: Open system-Closed System-Isolated system -Thermodynamic state of a system and properties-Change of state of a system or thermodynamic process-Classification of thermodynamic process: Isothermal-Isobaric-Isochoric-Adiabatic-Isotropic. Reversible and Irreversible Process- State and Path function, exact differentials- Extensive and intensive properties- Thermal Equilibrium and Concept of Temperature- Zeroth Law of Thermodynamics and its significance	7
Unit II: Ideal and Real Gasses and Equation of State	Preliminary concept of Ideal & Real Gases---Vander Waal's Equation---Redlich-Kwong equation---Peng-Robinson equation---Benedict-Webb-Rubin Equation-Reduced equation of state-Equation of Corresponding state-Compressibility factor-acentric factor-Simple Problems	10

Unit III: First Law of Thermodynamics and Internal Energy	Work and Energy- Joules Experiment and Work Energy Relationship- Statements of First Law of Thermodynamics- Perpetual motion machine of the Ist kind- Mathematical formulation of the first Law (IUPAC convention)- Internal energy, Origin of Internal Energy Firs law for cyclic process- First law for open system or flow process, shaft work- Enthalpy, Heat capacities and their relationship -Calculation of work for different processes of expansion of gases- Porous Plug Experiment-Simple Problems.	7
Unit IV: The Second and Third Law of Thermodynamics	Limitations of the First Law and Need of the second law- Statements of the second law- Perpetual motion machine of the second kind-Concept of Entropy- Spontaneous process and entropy-Carnot's cycle, heat engine and heat pumps-Efficiency of Carnot's engine- Iso-entropic process, T-S diagram-Carnot Principle- Clausius inequality- Simple Problems Third Law of Thermodynamics- Absolute value of Parameters- Processes for lowering of temperature-Adiabatic demagnetization	7
Unit V: Free Energy Functions	Concept of Free Energy- Helmholtz free energy-Gibbs free energy- Gibbs free energy and spontaneous process- Gibbs free energy and chemical equilibrium- Gibbs Helmholtz Equation	8
Unit VI: Estimation of Enthalpy	Enthalpy and chemical reaction-Exothermic and Endothermic chemical reactions Standard Heat of Reaction, Heat of Combustion, Heat of Formation –Hess's Law, Born-Haber cycle (only description) - Heat of Solution. Simple Problems	6
Sub Total: Total Lecture Classes		**45**
No. of classes required for conducting Internal Assessment examination		**6**
Grand Total:		**51**

3. Suggested Home Assignments/Students' Activities: The concerned teacher may collect assignments from the students on different units. He/she may also conduct viva- voce or quizzes for the students based on the content of the subject.

4. 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**

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

Question Type	Marks
Objective type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Fill in the blanks type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Q s carrying 8 marks for 5 Qs (Subjective type) out of 10Qs (at least 1 Q from each unit)	8×5 = 40
	Total = 60

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

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

7. Suggested Learning Resources:

Sl. No.	Title of Book	Author	Publication
1	Introduction to Chemical Engineering 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 and R.R. Misra	Vikas Publishing House Pvt Ltd
4	A Textbook of Chemical Engineering Thermodynamics	K.V. Narayanan	Prentice Hall of India

Name of the Course: Diploma in Chemical Engineering	
Category: Programme Core	**Semester: Third**
Code no.: CHEPC207	**Theory: 100** Marks
Course Title: Mechanical Operations	**Examination Scheme:** **i) Examination Scheme:** **External Assessment: 60** Marks (End Semester Examination) **ii) Internal Assessment: 40** Marks [Class Test: 20 Marks Assignment/viva voce: 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 Outcomes: On completion of the course, students will be able to:

1. Describe the basic principles of particles preparation and their characterization.
2. Explain about different size reducing equipment and power requirements during size reduction.
3. Examine on solid fluid separation equipment.
4. Explain solid storage and their conveying in chemical process industries.

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: Size Reduction and Size Enlargement	Crushing & grinding, Laws of crushing (Rittinger's law, Kick's law, Bond's law), Close circuit and open circuit, Dry and wet grinding, free and choke grinding (simple problems) Working principle of size reduction equipment: jaw crusher, Roll crusher, Hammer mill, Ball mill (including critical speed). Basic idea on Extrusion. Basic idea on Granulation and Flocculation.	14
Unit II: Mechanical Separation Operations and Separating Equipment	Sampling, Screening (simple problems), Description on Elutriation, Froth Flotation and Jigging, Cyclone Separator, Bag Filter, Electrostatic Precipitator and Electromagnetic Separator. Settling (including free settling and hindered settling) and sedimentation. Stoke's law and its assumptions. Calculation of terminal settling velocity.	10
Unit III: Filtration and Washing	Basic idea on filtration, Constant Rate and Constant Pressure Filtration (simple problems). Use of Filter aids. Batch and Continuous Filtration equipment - Plate and Frame filter press, Rotary Drum Filter, Leaf filter (principle, description and application).	9

Unit IV: Fundamentals Of Mixing and Handling of Particulate Materials	Types of impellers used in stirred tank — Study of power consumption of mixers — Dimensional analysis of power consumption — Construction and working of stirred tank mixer & sigma mixer Conveying methods, Storage methods, Feeders and elevators.	12
Total Lecture Classes		**45**
Number of classes required for conducting Internal Assessment examination		**06**
Grand Total		**51**

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

4. 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**

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

Question Type	**Marks**
Objective type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Fill in the blanks type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Q s carrying 8 marks for 5 Qs (Subjective type) out of 10Qs (at least 1 Q from each unit)	8×5 = 40
	Total = 60

6. 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

7. Suggested Learning Resources:

Sl. No.	Title of Book	Name of Authors	Publisher
1.	Unit Operations of Chemical Engineering	McCabe and J.C. Smith	McGraw Hill, New York
2.	Chemical Engineering, Vol. II	M. Coulson and J.F. Richardson	Butterworth- Heinemann
3.	Mechanical Operations-Unit Operations of Chemical Engineering	A.P. Kulkarni and R.S. Hiremath	Everest Publishing House

Name of the Course: Diploma in Chemical Engineering	
Category: Programme Core	**Semester: Third**
Code no.: CHEPC209	**Theory: 100** Marks
Course Title: ENERGY ENGINEERING	**Examination Scheme:** **i) Examination Scheme:** **External Assessment: 60** Marks (End Semester Examination) **ii) Internal Assessment: 40** Marks [Class Test: 20 Marks Assignment/viva voce: 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 Outcomes: On completion of the course, students will be able to:

1. Describe the energy production from conventional fuels and renewable energy resources.
2. Compare the process of energy generation by conventional as well as renewable resources.
3. Explain the energy conservation through waste heat recovery.
4. Identify the challenges associated with the use of various energy sources.
5. Describe renewable energy technologies as a basis for further analysis and evaluation.

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: Non-renewable source of energy	Origin, classification, composition, Proximate & Ultimate analysis, properties such as net and gross Calorific value, caking Index, Swelling Index etc., Washing and Storage of Coal, Briquetting, High and Low Temperature Carbonization.	**8**
Unit II: Liquid Fuel Petroleum	Composition of Liquid Fuel, Distillation (ADU and VDU) products with their boiling range & uses. Knocking properties, Anti-knock compound, Octane and Cetane Number. Properties of liquid fuel e.g Pour point, Flash point, Fire point, Smoke point, Char value, Aniline point, Diesel index, Viscosity index, Calorific value-brief idea.	**10**
Unit III: Gaseous Fuels	Manufacture of Water Gas, Carburetted Water gas, Producer gas, Coal Gas, Blast Furnace Gas. Gasification- Kopper-Totzek process, Lurgi Gasifier, Winkler process.	**8**
Unit IV: Nuclear Energy and Renewable sources of energy	Nuclear Fission and Fertile Fuel, Coolants, Nuclear fuel cycle, Nuclear reactions. Fuel conversion and Breeding, Atomic Power Plants. Renewable sources of energy: Brief idea of different types of renewable energy like Wind –Biomass (including Gobor gas plant)-Tidal-Ocean Thermal-Geothermal energy, Solar Energy (Direct and Scattered Radiation)	**11**

	including Flat Plate Collector, Solar Pond.	
Unit V: Furnace and Kilns	Classifications of Furnaces, Working principle of Metallurgical, Ceramic and Electric Furnaces. Waste heat Recovery systems, Economizer. Beehive Coke Oven, By-product Slot type Coke oven, Recovery of By-products (Direct, Indirect and Semi direct processes).	**8**
Total Lecture Classes		**45**
Number of classes required for conducting Internal Assessment examination		**06**
Grand Total		**51**

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

4. **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**

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

Question Type	**Marks**
Objective type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Fill in the blanks type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Q s carrying 8 marks for 5 Qs (Subjective type) out of 10Qs (at least 1 Q from each unit)	8×5 = 40
	Total = 60

6. 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

7. Suggested Learning Resources:

Sl. No.	Title of Book	Name of Authors	Publisher
1.	Fuels and Combustion	Samir Sarkar	Orient Longman
2.	Elements of Fuel Technology	Himus	Leonard Hill Ltd
3.	Elements of Fuels Furnaces, and Refractories	O.P.Gupta	Khanna Publishers

<table>
<tr><td colspan="2">Name of the Course: Diploma in Chemical Engineering</td></tr>
<tr><td>Category: Programme Core</td><td>Semester: Third</td></tr>
<tr><td>Code no.: CHEPC211</td><td>Theory: 100 Marks</td></tr>
<tr><td>Course Title: Chemical Technology - I</td><td rowspan="4">Examination Scheme:
i) Examination Scheme:
External Assessment: 60 Marks
(End Semester Examination)
ii) Internal Assessment: 40 Marks
[Class Test: 20 Marks
Assignment/viva voce: 10 Marks
Class 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>
</table>

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

Sl. No.	Course Outcomes
1	Write raw materials, application and reactions involved in the production of a chemical compound.
2	Explain unit processes and unit operations involved in the production of a chemical compound.
3	Explain purification process of the chemical compound.
4	Sketch the necessary flowchart for the production of chemical compound.
5	Develop knowledge about the equipment used for the production of chemical compound from its raw materials.

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit I: Water Treatment	Sources of water. Name of Impurities present in water. Concept of hardness of water Methods of water softening treatment: Lime – Soda Process, Zeolite softening, Demineralization Concept of Coagulation and Flocculation. Definition of Aeration Process, Types of Aerators: Cascade, Cone, Slat and Coke, Draft, Spray, Pressure, and Centrifugal aerators. Definition of Deaeration process, Types of deaerators: Tray and Spray type Concept of Oxygen Scavenging. Concept of Boiler feed water treatment process.	**5**

Unit II: Acid Industries	Manufacturing of Sulfuric Acid: Raw materials, Reactions and Description of Contact and DCDA process with flow sheet. Manufacturing of Hydrochloric Acid: Raw materials, Reactions and Description of hydrochloric acid production from common salt and synthetic hydrochloric acid production with flow sheet. Manufacturing of Nitric Acid: Raw materials, Reactions and Description of ammonia oxidation process with flow sheet. Manufacturing of Phosphoric Acid: Raw materials, Reactions and Description of Electric Furnace process & Wet process with flow sheet.	**8**
Unit III: Fertilizer Industry	Concept of fertilizer Types of fertilizer. Production of Nitrogenous Fertilizer: Production of Ammonia (by Haber Process) with process flow sheet. Urea (by Ammonium carbamate decomposition process) with process flow sheet. Ammonium nitrate (Prill and Flake), and Nitro lime with process flow sheet. Production of Phosphatic Fertilizer: Production of Super phosphate & Tripple Super Phosphate with flow sheet. Production of N-P-K fertilizer with flow sheet.	**8**
Unit IV: Chlor-Alkali Industry	Production of Soda Ash by Solvay process with flow sheet. Concept of Dual process of soda ash manufacturing. Production of Sodium Hydroxide and Chlorine by Electrolytic Process with flowchart. Working principle of Diaphragm Cell, Membrane Cell, and Mercury cell.	**5**
Unit V: Paper & Pulp Industry	Definition of Pulp, Classification of Pulping Process Composition of Cooking liquor, Description of Kraft Pulping process with flow sheet Bleaching of Pulp Recovery of white liquor from black liquor Making of Paper from Pulp.	**5**
Unit VI: Soap & Detergent Industry	Definition of Soap. Classification of Soap making Process. Description of Full Boiled Process and Continuous process of Soap manufacture with flow sheet. Definition of Detergent. Classification of Detergent. Manufacturing of one anionic Detergent like Dodecyl Benzene Sulphonate	**4**

Unit VII: Cement Industry	Definition of cement Constituents of cement Classification of Cement (Portland & Other) Raw materials of Cement Manufacturing process of Port land Cement with flow sheet.	**2**
Unit VIII: Industrial Gases	Manufacture of Industrial Gases: Carbon dioxide: Source, Raw materials, Reaction, Manufacturing of Carbon dioxide from coke with process flowsheet, Purification of Carbon dioxide Hydrogen: Manufacture of Hydrogen by Electrolytic process and Lane process or steam hydrogen process Nitrogen and Oxygen: Manufacturing of Nitrogen & Oxygen by Linde's Process with flowsheet.	**6**
Unit IX: Glass Industry	Definition of Glass Raw materials of Glass Description of manufacturing of glass.	**2**
Sub Total: Total Lecture Classes		**45**
No. of classes required for conducting Internal Assessment examination		**06**
Grand Total:		**51**

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

4. **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**

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

Question Type	**Marks**
Objective type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Fill in the blanks type questions carrying 1 mark for 10 questions (QSs) out of 15 Qs throughout the syllabus.	1×10 = 10
Q s carrying 8 marks for 5 Qs (Subjective type) out of 10Qs (at least 1 Q from each unit)	8×5 = 40
	Total = 60

6. 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

7. 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.
6	Chemical process Technology	Reger	
7	Chemical process Technology	Roger	

Category: Programme Core	**Semester: Third**
Code no.: CHEPC213	**Theory: 100** Marks
Course Title: Momentum 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	Use manometers as pressure measuring devices.
CO 2	Analyse the laminar and turbulent flow.
CO 3	Apply and analyse Bernoulli's principle, Hagen-Poiseuille's equation.
CO 4	Use flow meters, pumps.
CO 5	Analyse pipe friction.

2. Suggested Assignments for Continuous Assessment:

Following assignments are to be attempted on A4 sheets or Laboratory Note Book:

Sl. No.	Name of Experiment	Teaching hours
1	To study laminar to turbulent transition for flow in a tube and to determine the critical velocity using Reynold's apparatus.	**3**
2	To determine the viscosity of a liquid using Hagen-Poiseuille's equation.	**3**
3	To measure the flow through vee notch and determination of coefficient of discharge.	**3**
4	To measure the flow through a venturi meter and determination of coefficient of discharge.	**3**
5	To measure the flow through an orifice meter and determination of coefficient of discharge.	**3**
6	To measure the flow through a rotameter	**3**
7	Verification of Bernoulli's equation	**3**
8	To study different kinds of joints, bends and valves and their application	**3**
9	To study the characteristics of a centrifugal pump	**6**
10	To study the characteristics of positive displacement pump	**6**
11	To study flow through a packed bed and measurement of pressure drop	**3**
12	Determination of frictional losses in pipes	**3**

Practical Classes	**45 hrs.**
Viva-voce and external examination	**06 hrs.**

Grand total	**51 hrs.**

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

4. Suggested scheme for question paper design for conducting internal assessment examination: (Duration: 30 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Internal Viva-Voce	8	16	16	**40**

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

6. 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

7. Suggested Learning Resources:

Sl. No.	Title of Book	Author	Publication
1	Fluid Mechanics and Its Applications	Vijay Gupta, Santosh K. Gupta	New Academic Science Ltd
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	Fluid Mechanics	Douglas	Pearson Education India
5	Fundamentals of Fluid Mechanics	Munson (2009), 6th edition	Wiley India Edition

Name of the Course: Diploma in Chemical Engineering

Category: Programme Core	**Semester: Third**
Code No.: CHEPC215	**Total Marks: 100**
Course Title: MECHANICAL OPERATION LABORATORY	**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]
Duration: 17 weeks (3 hours per week)	
Total practical class /week: 3	
Credit: 1	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	
Pre requisite: Knowledge of basic concepts of science such as physics, chemistry.	

1. Course Outcomes:

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

1. Describe the fundamentals involved in the Mechanical operations.
2. Apply of the concept of Particulate properties and its measurements.
3. Explain and classify different size reducing equipment and power requirements during size reduction.
4. Examine solid fluid separation equipment.
5. Explain solid storage and their conveying in chemical process industries.

2. Suggested Assignments for Continuous Assessment:

Following assignments are to be attempted on A4 sheets or Laboratory Note Book:

Sl. No.	List of Practical	Teaching Hours (Approx.)
1	To determine crushing efficiency of a Roll Crusher and Jaw Crusher.	**6**
2	To study the screen analysis and determine average particle size of solid particles in a ROTAP type sieve shaker.	**6**
3	To study the grinding characteristics of a Ball mill and determine its critical speed.	**6**
4	To study the filtration characteristics of a slurry in a filter press.	**6**
5	To study the solid-liquid separation characteristics in a centrifuge.	**3**
6	To study the solid-liquid mixing characteristics in a sigma mixer.	**3**
7	To determine the screening characteristics in a vibratory screen.	**6**
8	To study the filtration characteristics in a vacuum filtration apparatus with Buckner funnel.	**3**

9	To study the solid-solid separation in a froth-floatation cell.	**6**

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

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

4. **Suggested scheme for question paper design for conducting internal assessment examination:** (Duration: 30 minutes)

Questions to be set as per Bloom's Taxonomy				
	Distribution of Marks			
	Level 1 (Remember)	Level 2 (understand)	Level 3 (Apply & above)	Total
Internal Viva-Voce	8	16	16	**40**

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

6. Rubrics for the internal assessment of Laboratory practice [30 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

7. Learning Resources:

Sl. No.	**Title of Book**	**Name of Authors**	**Publisher**
1.	Unit Operations of Chemical Engineering	McCabe and J.C. Smith	McGraw Hill., New York
2.	Laboratory Experiments in Chemical and Allied Engineering	G Chandrasekhar	Penram International Publishing (India) Pvt. Ltd.
3.	Mechanical Operations-Unit Operations of Chemical Engineering	A.P. Kulkarni and R.S. Hiremath	Everest Publishing House

Name of the Course: Diploma in Chemical Engineering

Category: Programme Core	**Semester: Third**
Code no.: SI201	**Laboratory: 100** Marks
Course Title: Internship I	**Examination Scheme:** **i) Internal Assessment: 60 marks** [In time submission of report/assignment:30 marks Viva voce**: 3**0 marks] **ii) External Assessment: 40 Marks** (End Semester Examination) [Report/Assignment on the day of viva voce: 20 marks Viva voce: 20 marks]
Duration: 17 weeks	
Total practical 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 Outcomes**:

On completion of the course, the students will be able to	
CO 1	Understand and operate different software
CO 2	Understand the working of industrial batch or continuous setup
CO 3	Understand, and prepare optimization or mathematical modelling of chemical engineering problems

2. **Suggested Assignments:** A report should be made on any one of the following assignments on A4 sheets:

Sl. No	Description of work (any one of the following activity must be performed)
1	Student may undergo 4-6 week vocational training at a working chemical plant/industry. Prepare a detailed technical report of the training
2	Student may undergo online certification course under one of the following probable topic • Aspen Plus simulation Software: a basic course for beginners • Optimization in chemical engineering • Mathematical modelling and simulation of chemical engineering process • Fundamental Algorithms: Design and Analysis • Scientific Computing using MATLAB • Computer Aided design based course • Computer Aided Manufacturing based course • Basic course on SCILAB • Basic course on DWSIM • Or any other application/design based course which is not incorporated in regular curriculum.
3	Student must undergo training or online course such as Microsoft excel VBA or similar software from platform which are recognized by UGC/AICTE/any reputed firm which may help student to solve design problems.
4.	Student may get trained at government ITI centres for hands on skills such as fitting,

	crafting, drafting, welding etc.
5.	Student may undertake one of following courses under the guidance of institute and prepare a detailed report which must include application based approach on the subject: • Plant design and economics • Application of numerical methods in chemical engineering • Or similar subjects may be prescribed by the institute.